

**LEARJET 60/60XR  
MAINTENANCE MANUAL**

**FLARED TUBING - MAINTENANCE PRACTICES**

**1. Removal/Installation** *(LES 1020, LES 1023, 205)*

A. Removal of the Flared Tubing

**NOTE:** When you replace a tube that is damaged, you must find the cause of the damage and correct it.

**WARNING:** YOU MUST OBEY ALL THE OXYGEN SYSTEM MAINTENANCE PRECAUTION WHEN YOU REMOVE OXYGEN TUBING. IT YOU DO NOT DO THIS, YOU CAN BE INJURED.

- (1) Get the necessary tools and equipment.

**NOTE:** You can use equivalent alternatives for this item.

NAME	PART NUMBER	MANUFACTURER	USE
Cap or Plug		Commercially Available	Cap or plug the tubing ends and fittings

- (2) When a flared tube is removed from the aircraft, immediately put a cap on the tubing ends and fittings.
- (3) When you remove several tubes from the same area at one time, tag the ends of the tubing.

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**CAUTION:** USE ONLY A 37 DEGREE AVIATION FLARE. DO NOT USE AN AUTOMOTIVE FLARE. AUTOMOTIVE FLARES WILL GIVE THE INCORRECT FLARE ANGLE AND SHAPE. THIS WILL CAUSE LEAKS, INCORRECT FIT, AND STRESS.

B. Installation of the Flared Tubing  
(See Figure 201.)

**NOTE:** If an inspection shows or if damage occurs, it can be necessary to make new flared tubing assemblies. This section gives the standard permitted methods to make the flared tubing assemblies.

**NOTE:** It is recommended that the flared tubing be replaced and not repaired. When a flared tube is replaced, the replacement tubing must be of the same diameter, wall thickness, and material.

**NOTE:** The used tube can be used as a template to make the new tube. If you cannot use the old tube then soft steel wire can be used to make the template.

**NOTE:** Start the bends in the tubing a sufficient distance from the end of the tube. This will let the nut and the sleeve to be moved so that the tube can be flared.

**NOTE:** Tubing fittings have an AN819 sleeve in an AN818 nut. Do not use dissimilar metals, when you assemble the end fittings on a tube. The use of dissimilar metals can cause corrosion. Make sure that you use the correct fittings and sleeves.

**NOTE:** Aluminum alloy tubing that has an outside diameter of 0.375 inch [9.53 mm] or less must be double flared. All other tubing must be single flared.

**NOTE:** Aluminum in the T-6 condition must not be double flared.

**NOTE:** While you work on the oxygen equipment make sure that you do not damage the oxygen equipment. Remove the oxygen equipment from the sealed containers only before installation. It is important to clean the hands, tools and fittings before you work on the oxygen equipment.

**NOTE:** Attach the tube and tube groups tightly with a clamp, but insulation or tube wrapping must not be pinched or damaged. Support clamps of the correct size must be used.

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- (1) Get the necessary tools and equipment.

NOTE: You can use equivalent alternatives for these items.

NAME	PART NUMBER	MANUFACTURER	USE
Anti-Seize Polytetrafluorethylene Thread Tape	A-A-58092	Commercially Available	Seal the connector threads, except for oxygen fitting threads
Anti-Seize Thread Compound	Loctite C5-A (MIL-PRF 907)	Loctite Corp., Troy, MI	Lubricate the hot air CRES fitting threads
	Liquid-Moly NV (MIL-PRF-907)	The Lockrey Company Inc., Merchantville, NJ	Lubricate the hydraulic, emergency air, fuel, and pitot-static fitting threads
Engine Oil	MIL-PRF-23699 or MIL- PRF-7808	Commercially Available	Lubricate the fuel fitting threads
Fitting Seals	7A (x) for Aluminum tubes 7N (x) for Stainless Steel tubes	Seco Seal Inc., Costa Mesa, CA	Seal small leaks in the fuel, hydraulic, pneumatic, and oxygen lines
Hydraulic Oil	MIL-PRF-5606	Commercially Available	Lubricate the hydraulic fitting threads
Oxygen Resistant Grease	Christo-lube MCG 111 (MIL-PRF-27617)	Lubrication Technology Inc., Franklin Furnace, OH	Lubricate the oxygen fitting threads
Petrolatum	VV-P-236	Commercially Available	Lubricate the hydraulic, emergency air, and pitot- static fitting threads
Pipe Thread Sealant	Type #48	3M Company St. Paul, MN	Teflon thread sealant
Rector Seal	100-W or 100 Virg (Teflon-filled thread compound)	The Rectorseal Co., Houston, TX	Lubricate the hydraulic, emergency air, and pitot- static fitting threads
Ribbon Dope Thread Sealant	Permacel 412	Permacel Co., New Brunswick, NJ	Teflon thread sealant

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**WARNING:**     **CLEAN YOUR HANDS BEFORE YOU DO WORK WITH THE OXYGEN LINES OR EQUIPMENT. YOU CAN HAVE A NON-APPROVED LUBRICANT ON YOUR HANDS. THIS CAN COME IN CONTACT WITH THE OXYGEN AND CAN CAUSE AN EXPLOSION OR FIRE.**

**WARNING**     **USE OF UNAPPROVED THREAD COMPOUNDS ON OXYGEN SYSTEM COMPONENTS IS STRICTLY PROHIBITED DUE TO THE POTENTIAL OF EXPLOSION DURING SYSTEM OPERATION.**

- (2) Make sure the tubing is clean and has protective caps. If the tubing does not have a protective cap, you must clean it. ([Refer to 20-30-00.](#))
- (3) Examine the aluminum or aluminum alloy tubing for damage to the chemical corrosion resistant and/or the epoxy primed coated surfaces.

**CAUTION:**     **DO NOT USE RECTOR SEAL THREAD COMPOUND ON THE CONNECTIONS IN THE FUEL, HOT AIR, OR OXYGEN SYSTEMS. THIS COMPOUND CAN CAUSE A FUEL FILTER TO BECOME CLOGGED, CAUSE FUMES IN THE BLEED AIR SYSTEM, AND CAN CAUSE AN EXPLOSION OR FIRE IN THE OXYGEN SYSTEM.**

- (4) Lubricate the fitting threads or apply thread tape to prevent galls or seizure of the threads. ([See Table 204.](#))
- (5) Lubricate the oxygen system fitting threads with oxygen resistant grease. ([See Figure 209 and Table 204.](#))
- (6) Lubricate the hydraulic system fitting threads with system fluid or apply thread tape, if applicable. ([See Table 204.](#))
- (7) Do not apply thread compounds to the items that follow:
  - (a) Fitting ends
  - (b) Cone surfaces
  - (c) In the flare surfaces
  - (d) In the bore of the fittings
  - (e) The internal surfaces of the tubes
  - (f) The first 1-1/2 threads.
- (8) Wind the fitting with 1-1/2 turns of stretched thread tape to conform to the thread contour. Wind the tape in the direction of the approach of the threads (the direction that the nut will turn) so the tape will not be removed when the nut is tightened.

**NOTE:**     Do not apply thread tape to the first 1-1/2 threads.

- (9) Put the tubing in the correct position and loosely connect the fittings and the clamps.

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**CAUTION: THE LOAD ON THE TITANIUM TUBING MUST BE AT A MINIMUM OR REMOVED. TOO MUCH LOAD CAN CAUSE DAMAGE TO THE TITANIUM TUBING.**

- (10) With the clamps loose and without the use of force to align the tubing, tighten the nuts until the tubing flare touches the fitting. If the tubing flare does not touch the fitting, examine the alignment as follows:
- (a) Use a wrench and lightly torque the nut on one end of the tubing.
  - (b) Loosen the nut on the other end of the tubing and move the nut down the tubing until the flare can be seen.
  - (c) The angular mismatch of the tubing must be 2 degrees or less.
  - (d) The length mismatch of the tubing must be 0.031 inch [0.793 mm] or less for each 10 inches [25.4 cm] of tube length.
  - (e) The radial mismatch of the tubing must be 0.031 inch [0.793 mm] or less for each 10 inches [25.4 cm] of tube length.
  - (f) If the tubing cannot be bent to meet these requirements, it must be replaced.
- (11) Tighten the nuts to the correct torque value. ([Refer to 20-40-00.](#))
- (12) Make sure that the tubing has the correct colored tape identification markings. ([Refer to 20-30-00.](#))
- (13) Install the fitting seals as follows:

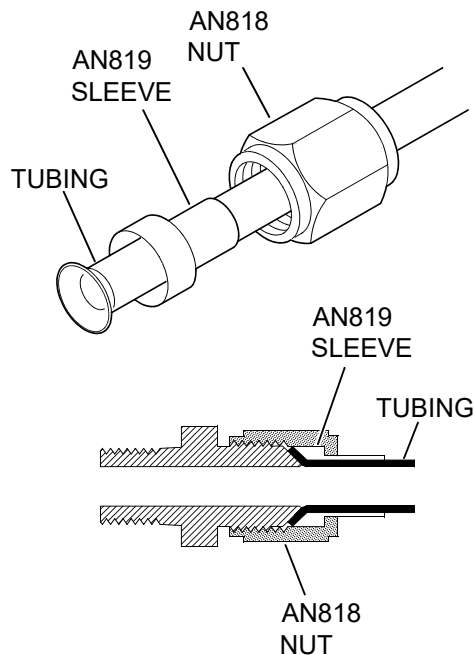
NOTE: Fitting seals 7A (X), where X is the tube size, are used for aluminum tubing.

NOTE: Fitting seals 7N (X), where X is the tube size, are used for stainless steel tubing.

NOTE: In the event that an aluminum line or fitting is attached to a stainless steel line or fitting, an aluminum (SECO 7A (X)) gasket seal must be used. The assembly shall then be torqued to the correct torque value. ([Refer to 20-40-00.](#))

- (a) Make sure that system pressure has been removed.
- (b) Remove the tube as necessary to get access to the flared end.
- (c) Examine the flared end of the tube. Make sure that the flared end does not have damage that prevents the use of a fitting seal.
- (d) Get the correct size of the fitting seal.
- (e) Put the fitting seal on the fitting cone.
- (f) Put the tubing flare on the fitting cone. Make sure that the fitting seal has not moved.
- (g) Tighten the nut with your hand.
- (h) Connect the other end of the tube.
- (i) Torque the nuts to the correct torque value. ([Refer to 20-40-00.](#))

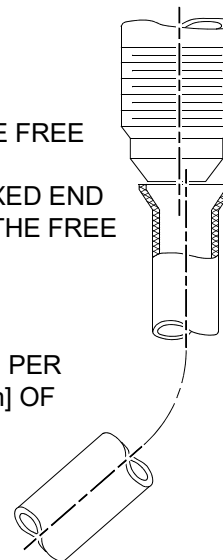
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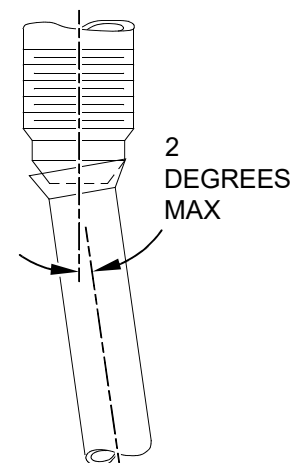
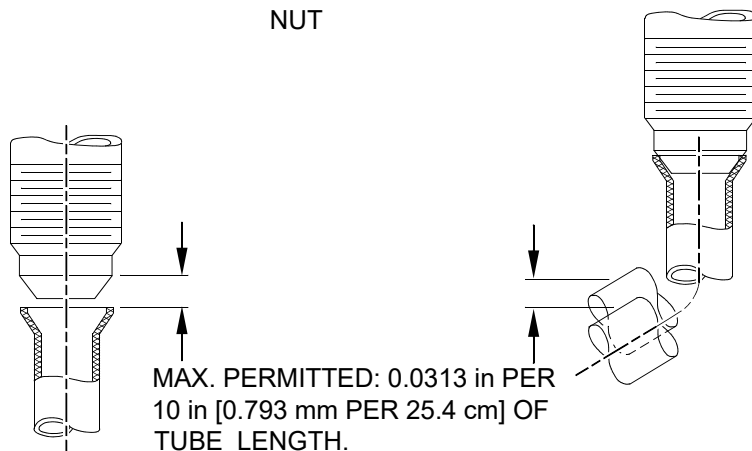
## RADIAL MISMATCH

MEASURE THE MISMATCH WITH THE FREE TUBE END CLEAR OF THE FITTING. IF NECESSARY, PUSH NEAR THE FIXED END OF THE TUBE ASSEMBLY SO THAT THE FREE END IS CLEAR.

MAX. PERMITTED: 0.0313 in PER 10 in [0.793 mm PER 25.4 cm] OF TUBE LENGTH.



## RADIAL MISMATCH



## ANGULAR MISMATCH

## LENGTH MISMATCH

IF TUBE ASSEMBLY IS TOO SHORT, MEASURE THE GAP. IF TUBE ASSEMBLY IS TOO LONG, DO ONE OF THE STEPS THAT FOLLOW:

1. REMOVE THE FITTING, AND MEASURE THE CHANGE IN POSITION OF THE FREE END; OR
2. PUSH NEAR FIXED TUBE END, AND MEASURE THE DISTANCE TO JUST UNSEAT AND FREE THE FLARE.

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Flared Tubing - Removal/Installation  
Figure 201

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**C. Hose Installation**

**NOTE:** All hose and hose assemblies must be clean when installed in the aircraft. The protective caps or plugs must not be removed from the parts until immediately before installation.

- (1) Get the necessary tools and equipment.

**NOTE:** You can use equivalent alternatives for these items.

<b>NAME</b>	<b>PART NUMBER</b>	<b>MANUFACTURER</b>	<b>USE</b>
Hydraulic Oil	MIL-PRF-5606	Commercially Available	Lubricate the bearing surfaces
Anti-Seize Thread Compound	Liquid-Moly NV	The Lockrey Company Inc., Merchantville, NJ	Seal the exposed male threads
Rector Seal	100-W	The Rectorseal Co., Houston, TX	Seal the exposed male threads

- (2) Lubricate the bearing surfaces between the nut hex and the nipple.  
(3) Lubricate the nut retaining wire by applying some drops of Hydraulic Oil.  
(4) Apply some drops of Hydraulic Oil between the nut and nipple.  
(5) Hold the hose assembly until the oil drain into the bearing surface between the nut and nipple and turn the nut to supply the oil.  
(6) Align the hose assembly with the fitting end and tighten the nut 1/2 to 1 turn.  
(7) Apply Rector Seal or Anti-seize thread compound to the exposed male threads.

**NOTE:** Thread compound is not allowed on fitting ends, cone surface, in the bore of fittings, or inside any system components.

- (8) Torque the hose nuts to the minimum torque value since the threaded connection is lubricated.  
(Refer to 20-40-00.)  
(9) Hold the hose to prevent twist while tightening the hose nut.  
(10) Do not untwist any hoses that twist on installation without witness of a QA representative.

**NOTE:** QA must determine if the hose is serviceable by the amount of twist and visual inspection of the internal surfaces. Any evidence of permanent deformation to the hose can be cause for rejection.

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D. Installation of Hose Clamps

- (1) Get the necessary tools and equipment.

NOTE: You can use equivalent alternatives for this item.

NAME	PART NUMBER	MANUFACTURER	USE
Torque Wrench 0 to 50 in-lb [0 to 5.64 Nm]		Commercially Available	Torque the attaching parts

- (2) Each hose clamp must be examined before installation, for defects in welding, riveting and/or operation of the tightening screw.

NOTE: Defective clamps or those which are damaged from rough handling or previous usage must be scrapped.

- (3) Position the hose clamp carefully on the hose.

NOTE: Care must be taken to avoid positioning of clamp above the bead.

Standard (AN 737 type) clamps must have a minimum of 0.125 inch [3.175 mm] length of hose extending more than the clamp band.

Vendor hose clamps, which are wider than AN 737 type clamps, must have minimum visible edge of the hose extending more than the hose clamp.

General Connector Corp. Lightweight and NAS 1922 Lightweight (narrow band) clamps must have a minimum of 0.2 inches [5.08 mm] length of hose extending more than the clamp band.

- (4) The tightening screw must be positioned to allow maximum space for the use of torque wrenches in tightening and to prevent interference with adjacent parts.
- (5) Torque standard (AN 737 type) hose clamps to 25 in-lb [2.82 Nm].
- (6) Torque general Connector and NAS 1922 Lightweight hose clamps to 15 in-lb [1.7 Nm].
- (7) All hose clamps installation must be suitably marked by Inspection to indicate proper tightening.
- (8) Do not safety wire the Hose clamps.



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### 2. Inspection/Check *(LES 1020, 205)*

#### A. Inspection of the Tubing Before Installation

(See [Figure 202](#), [Figure 203](#), [Figure 204](#), [Table 201](#), and [Table 202](#).)

- (1) Examine the tubing for nicks, scratches, and gouges as follows:
  - (a) Nicks, scratches, and gouges in the tubing must have smooth edges to be permitted. The depth of the nick, scratch, or gouge is not more than 5% of the nominal wall thickness.
  - (b) Replace tubing that has a nick or a scratch deeper than 5% of the nominal wall thickness.
- (2) Examine the tubing for dents as follows:
  - (a) Smooth dents, free from nicks or cuts are permitted in the straight sections of the tube if they do not decrease the outside diameter by more than 5% of the nominal outside diameter of the tubing or 0.030 inch [0.762 mm].
- (3) Examine the tubing for wrinkles.
- (4) Examine the tubing bend for flattening, mandrel hump protrusion, and heel protrusion.
- (5) Replace all the tubing that has too much ovality in the bend.

NOTE: To measure the ovality with calipers, find the minimum diameter (maximum flattening) around the bend surface and then measure the maximum diameter at 90 degrees to the minimum diameter.

- (6) Replace all the tubing that has too much mandrel hump protrusion at the bend.

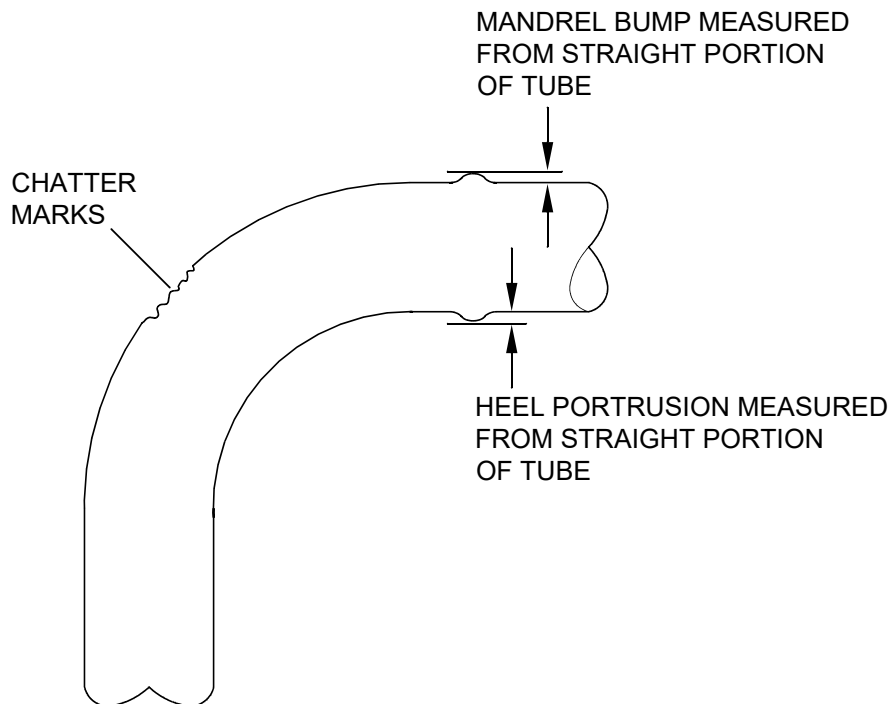
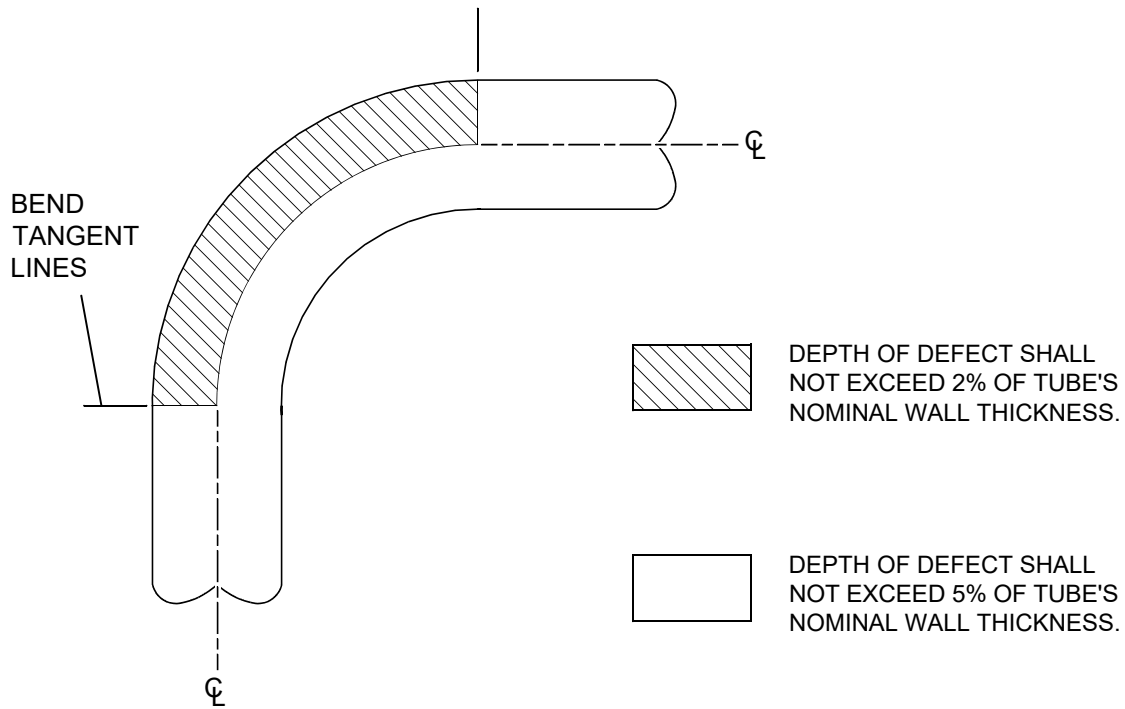
NOTE: Measure the mandrel bump by measuring the maximum diameter at the mandrel bump.

- (7) Replace all the tubing that has too much heel protrusion at the bend.

NOTE: Measure the heel protrusion by measuring the maximum diameter at the heel protrusion.

- (8) Replace all tubing that has chatter marks in the bend.
- (9) Examine the flare and replace the tubing as needed.
- (10) Repair the aluminum or aluminum alloy tubing which has been damaged by chemical corrosion resistant and/or damage to the epoxy primed coated surfaces. [Refer to 20-72-00](#) for anti-corrosion chemical film treatment. [Refer to 20-55-00](#) for epoxy primer.

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Tubing Defect Limits  
Figure 202

EFFECTIVITY: ALL

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SYSTEM OPERATING PRESSURE	TUBE O.D.	TUBE MATERIAL	MAXIMUM ALLOWABLE WRINKLE HEIGHT	ALLOWABLE OVALITY (%)	ALLOWABLE MANDREL BUMP (%)	ALLOWABLE HEEL PROTRUSION (%)	ALLOWABLE CHATTER MARKS
				<div>1</div> <div>4</div>	<div>3</div>	<div>3</div>	
1000 to 4000 psi	All Sizes	CRES	0.010 in [0.254 mm]	5.0	2.0	2.0	<div>2</div>
		Aluminum	0.005 in [0.127 mm]	5.0	2.0	2.0	<div>2</div>
		Titanium	<div>2</div>	3.0	2.0	2.0	<div>2</div>
All other systems less than 1000 psi	Less than 0.990 in [25.146 mm]	Titanium	<div>2</div>	5.0	2.0	2.0	<div>2</div>
		CRES	0.040 in [1.016 mm]	10.0	2.0	2.0	<div>2</div>
		Aluminum	0.020 in [0.508 mm]				
	1.000 in [2.540 cm] to 1.990 in [5.055 cm]	CRES	0.060 in [1.524 mm]	10.0	2.0	2.0	<div>2</div>
		Aluminum	0.030 in [0.762 mm]				
	2.000 in [5.080 cm] to 2.990 in [7.595 cm]	CRES	0.080 in [2.032 mm]	10.0	2.0	2.0	<div>2</div>
		Aluminum	0.040 in [1.016 mm]				
	3.000 in [7.620 cm] and over	CRES	0.100 in [2.540 mm]	10.0	2.0	2.0	<div>2</div>
		Aluminum	0.050 in [1.270 mm]				

## NOTES

1

$$\% \text{ Ovality} = \left[ \frac{\text{O.D. Maximum} - \text{O.D. Minimum}}{\text{O.D. Nominal}} \right] \times 100$$

2

 No visible indication.

3

$$\% \text{ Mandrel Bump or \% Heel Protrusion} = \left[ 1 - \frac{\text{O.D. Nominal}}{\text{O.D. Maximum at Bump}} \right] \times 100$$

4

 Maximum allowable ovality for all aluminum and CRES tubes, which have an outside diameter of 0.375 in [9.525 mm] or less, shall be 15%. (See Table 202.)

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Allowable Tube Bend Imperfections  
Table 201

EFFECTIVITY: ALL

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	TUBE O.D.										
	1/4 (0.250) in [6.35 mm]	3/8 (0.375) in [9.52 mm]	1/2 (0.500) in [12.70 mm]	5/8 (0.625) in [15.87 mm]	3/4 (0.750) in [19.05 mm]	1.00 in [2.54 cm]	1.50 in [3.81 cm]	2.00 in [5.08 cm]	2.25 in [5.71 cm]	2.50 in [6.35 cm]	3.00 in [7.62 cm]
3% OVALITY MAX. O.D. – MIN. O. D.	0.0075 in [0.1905 mm]	0.0113 in [0.2870 mm]	0.0150 in [0.381 mm]								
3% OVALITY MAX. O.D. – MIN. O. D.	0.0125 in [0.3175 mm]	0.0188 in [0.4752 mm]	0.0250 in [0.6350 mm]	0.0313 in [0.7950 mm]	0.0375 in [0.9525 mm]	0.0500 in [1.270 mm]	0.0750 in [1.905 mm]	0.1000 in [2.540 mm]	0.1125 in [2.8575 mm]	0.1250 in [3.175 mm]	0.1500 in [3.810 mm]
3% OVALITY MAX. O.D. – MIN. O. D.	0.0250 in [0.635 mm]	0.0375 in [0.9525 mm]	0.0500 in [1.27 mm]	0.0625 in [1.5875 mm]	0.0750 in [1.905 mm]	0.0150 in [0.381 mm]	0.1500 in [3.810 mm]	0.2000 in [5.080 mm]	0.2250 in [5.715 mm]	0.2500 in [6.350 mm]	0.3000 in [7.620 mm]
3% OVALITY MAX. O.D. – MIN. O. D.	0.0375 in [0.9525 mm]	0.0563 in [1.430 mm]									
MANDREL BUMP OR HEEL PROTRUSION MAXIMUM HEIGHT	0.0050 in [0.127 mm]	0.0075 in [0.1905 mm]	0.0100 in [0.254 mm]	0.0135 in [0.3429 mm]	0.0150 in [0.381 mm]	0.0200 in [0.508 mm]	0.0300 in [0.762 mm]	0.0400 in [1.016 mm]	0.0450 in [1.143 mm]	0.0500 in [1.270 mm]	0.0600 in [1.524 mm]

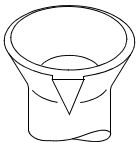
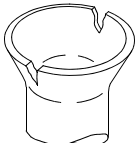
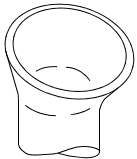
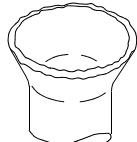
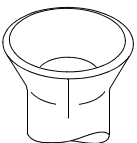
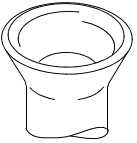
Dimensions for Allowable Imperfections  
Table 202

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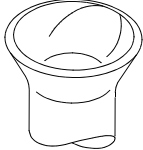
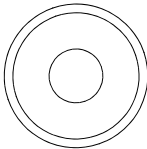
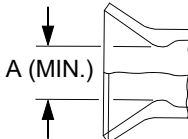
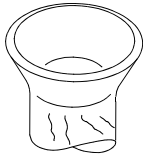
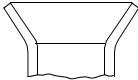

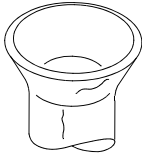
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 <p><b>EXTRUDED FIN</b></p>	<p>WEDGE RAISED ABOVE SURFACE OF FLARE. TWO MARKS DIAMETRICALLY OPPOSITE.</p> <p>CAUSED BY WORN THROAT ON CLAMPING DIE.</p> <p>BASIS FOR REJECTION AS IT PREVENTS SLEEVE FROM SEATING PROPERLY.</p>
 <p><b>CRACKED FLARE</b></p>	<p>CRACKS USUALLY LONGITUDINAL IN FLARED PORTION.</p> <p>CAUSED BY TOO GREAT AN ECCENTRIC SETTING ON ROTARY MANDREL. TOO MUCH PRESSURE ON RAM MANDREL. FLAW IN MATERIAL.</p> <p>NOT ACCEPTABLE.</p>
 <p><b>ANGLED/ECCENTRIC FLARE</b></p>	<p>FLARE IS ECCENTRIC WITH TUBE. TIP NOT PERPENDICULAR TO CENTER LINE OF TUBE. THICKNESS OF FLARE VARIES.</p> <p>CAUSED BY LOOSE CLAMPING OR MANDREL OR DIES OUT OF ALIGNMENT. ALSO ANGLE CUT TUBE.</p> <p>NOT ACCEPTABLE.</p>
 <p><b>ROUGH EDGE</b></p>	<p>LIP OF FLARE HAS JAGGED OR UNEVEN EDGE.</p> <p>CAUSED BY IMPROPER CUTTING OR BURRING OR TOO MUCH MANDREL PRESSURE.</p> <p>NOT ACCEPTABLE.</p>
 <p><b>DIE CREASE</b></p>	<p>SLIGHT LONGITUDINAL FIN ALONG FLARE OR TUBE.</p> <p>CAUSED BY SLIGHTLY LARGER THAN NOMINAL TUBE.</p> <p>CREASE MUST BE MORE THAN 0.004 in [0.102 mm] HIGH ON FLARE.</p> <p>ACCEPTABLE IF SLEEVE PASSES FREELY ONTO FLARE.</p>
 <p><b>SCRATCHES/GROOVES - INTERNAL ANGULAR</b></p>	<p>MARKS APPROXIMATELY PARALLEL TO FLARE TIP.</p> <p>CAUSED BY METAL CHIP PICKUP ON MANDREL.</p> <p>ACCEPTABLE UNLESS DEPTH EXCEEDS 10% OF FLARE THICKNESS.</p>

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Single Flare Acceptance Limits  
Figure 203 (Sheet 1 of 2)

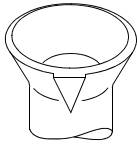
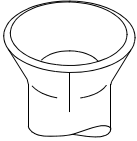
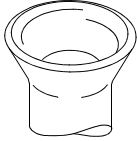

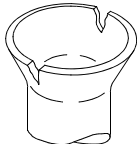
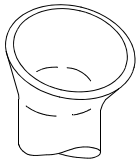
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 <p><b>SCRATCHES/GROOVES- INTERNAL LONGITUDINAL OR SPIRAL</b></p>	<p>MARKS PERPENDICULAR OR SPIRALLING TO FLARE TIP CAUSED BY SCORED MANDREL OR METAL CHIP PICKUP.</p> <p>NOT ACCEPTABLE IF MARKS ARE ON OUTER 30% OF FLARE.</p> <p>ACCEPTABLE IF MARKS ARE ON INNER 70% OF FLARE AND DEPTH DOES NOT EXCEED 10% OF FLARE THICKNESS.</p>																					
 <p><b>TUBE CLOSURE</b></p>	 <p>TUBE ID DECREASED BY FLARING.</p> <p>CAUSED BY TOO GREAT AN ECCENTRIC ON ROTARY MANDREL.</p> <p>ACCEPTABLE IF ID IS NOT SMALLER THAN DIMENSION BELOW.</p> <table><tr><td>TUBE SIZE</td><td>1/8 in [3.18 mm]</td><td>3/16 in [4.76 mm]</td><td>1/4 in [6.35 mm]</td><td>5/16 in [7.94 mm]</td><td>3/8 in [9.53 mm]</td><td>1/2 in [12.70 mm]</td><td>5/8 in [15.88 mm]</td><td>3/4 in [19.05 mm]</td><td>1 in [25.4 mm]</td></tr><tr><td>A MIN.</td><td>0.049 in [1.24 mm]</td><td>0.112 in [2.84 mm]</td><td>0.150 in [3.81 mm]</td><td>0.221 in [5.61 mm]</td><td>0.284 in [7.21 mm]</td><td>0.378 in [9.60 mm]</td><td>0.471 in [11.96 mm]</td><td>0.506 in [12.85 mm]</td><td>0.820 in [20.82 mm]</td></tr></table>	TUBE SIZE	1/8 in [3.18 mm]	3/16 in [4.76 mm]	1/4 in [6.35 mm]	5/16 in [7.94 mm]	3/8 in [9.53 mm]	1/2 in [12.70 mm]	5/8 in [15.88 mm]	3/4 in [19.05 mm]	1 in [25.4 mm]	A MIN.	0.049 in [1.24 mm]	0.112 in [2.84 mm]	0.150 in [3.81 mm]	0.221 in [5.61 mm]	0.284 in [7.21 mm]	0.378 in [9.60 mm]	0.471 in [11.96 mm]	0.506 in [12.85 mm]	0.820 in [20.82 mm]	
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 <p><b>CLAMPING DIE MARKS</b></p>	<p>SMALL IRREGULAR MARKS IN CLAMPING AREA OF TUBE.</p> <p>CAUSED BY DIE CLAMPS.</p> <p>ACCEPTABLE IF DEPTH DOES NOT EXCEED 5% OF WALL THICKNESS.</p>																					
 <p><b>SHARP INNER EDGE</b></p>	<p>SHARP EDGE AT JUNCTION OF INNER FLARE AND TUBE DIAMETER.</p> <p>ACCEPTABLE.</p>																					
 <p><b>ABRASIVE SCRATCHES</b></p>	<p>SMOOTH ABRASIVE AREA ON FLARE TIP.</p> <p>CAUSED BY CLEANUP POLISHING.</p> <p>ACCEPTABLE IF DEPTH DOES NOT EXCEED 5% OF WALL THICKNESS.</p>																					
 <p><b>SCRATCHES/DINGS</b></p>	<p>SCRATCHES OR DINGS ON TUBING AND/OR FLARE SURFACE.</p> <p>CAUSED BY STORING AND HANDLING.</p> <p>ACCEPTABLE IF DEPTH DOES NOT EXCEED 5% OF WALL THICKNESS.</p>																					

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Single Flare Acceptance Limits  
Figure 203 (Sheet 2 of 2)


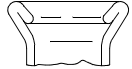

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 <p><b>EXTRUDED FIN</b></p>	<p>WEDGE RAISED ABOVE THE SURFACE OF THE FLARE. TWO MARKS DIAMETRICALLY OPPOSITE.</p> <p>CAUSED BY WORN THROAT ON CLAMPING DIE.</p> <p>BASIS FOR REJECTION IS IT CAUSES THE SLEEVE TO SEAT INCORRECTLY.</p>
 <p><b>DIE CREASE</b></p>	<p>SLIGHT LONGITUDINAL FIN ALONG THE FLARE OR THE TUBE.</p> <p>CAUSED BY SLIGHTLY LARGER THAN NOMINAL TUBE.</p> <p>CREASE MUST BE MORE THAN 0.004 in [0.101 mm] HIGH ON THE FLARE.</p> <p>PERMITTED IF SLEEVE CAN BE INSTALLED ONTO THE FLARE.</p>
 <p><b>SCRATCHES/GROOVES - INTERNAL ANGULAR</b></p>	<p>MARKS APPROXIMATELY PARALLEL TO THE FLARE TIP.</p> <p>CAUSED BY METAL CHIP PICKUP ON THE MANDREL.</p> <p>PERMITTED UNLESS THE DEPTH IS MORE THAN 10% OF THE FLARE THICKNESS.</p>
 <p><b>SCRATCHES/GROOVES- INTERNAL LONGITUDINAL OR SPIRAL</b></p>	<p>MARKS PERPENDICULAR OR SPIRALLING TO THE FLARE LIP.</p> <p>CAUSED BY SCORED MANDREL OR METAL CHIP PICKUP.</p> <p>NOT PERMITTED IF MARKS ARE ON THE OUTER 30% OF THE FLARE.</p> <p>PERMITTED IF MARKS ARE ON THE INNER 70% OF THE FLARE AND THE DEPTH IS NOT MORE THAN 10% OF THE FLARE THICKNESS.</p>
 <p><b>CRACKED FLARE</b></p>	<p>CRACKS USUALLY LONGITUDINAL IN THE FLARED PORTION.</p> <p>CAUSED BY TOO LARGE AN ECCENTRIC SETTING ON THE ROTARY MANDREL. TOO MUCH PRESSURE ON THE RAM MANDREL. FLAW IN THE MATERIAL.</p> <p>NOT PERMITTED.</p>
 <p><b>ANGLED/ECCENTRIC FLARE</b></p>	<p>FLARE IS ECCENTRIC WITH THE TUBE.</p> <p>TIP NOT PERPENDICULAR TO THE CENTER LINE OF THE TUBE.</p> <p>THICKNESS OF THE FLARE CHANGES.</p> <p>CAUSED BY LOOSE CLAMPING OR MANDREL OR DIES OUT OF ALIGNMENT. ALSO ANGLE CUT OF THE TUBE.</p> <p>NOT PERMITTED.</p>

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Double Flare Acceptance Limits  
Figure 204 (Sheet 1 of 3)

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MAINTENANCE MANUAL**

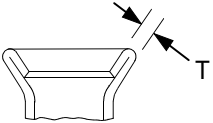
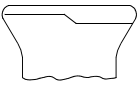
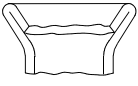
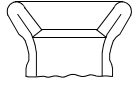
 <p><b>CLAMPING DIE MARKS</b></p>	<p>SMALL IRREGULAR MARKS IN THE CLAMPING AREA OF THE TUBE.</p> <p>CAUSED BY DIE CLAMPS.</p> <p>PERMITTED IF THE DEPTH IS NOT MORE THAN 5% OF THE WALL THICKNESS.</p>
 <p><b>ABRASIVE SCRATCHES</b></p>	<p>SMOOTH ABRASIVE AREA ON THE FLARE TIP.</p> <p>CAUSED BY CLEANUP POLISHING.</p> <p>PERMITTED IF THE DEPTH IS NOT MORE THAN 5% OF THE WALL THICKNESS.</p>
 <p><b>SCRATCHES/DINGS</b></p>	<p>SCRATCHES OR DINGS ON THE TUBING AND/OR THE FLARE SURFACE.</p> <p>CAUSED BY STORING AND HANDLING.</p> <p>PERMITTED IF THE DEPTH IS NOT MORE THAN 5% OF THE WALL THICKNESS.</p>
 <p><b>EXTRUDED FLARE</b></p>	<p>FLARE EXTENDS INTO THE ID OF THE TUBE.</p> <p>CAUSED BY THE TUBE BEING TOO FAR OUT OF THE CLAMPING DIE BEFORE FLARING. TOO MUCH PRESSURE. CONE MANDREL WITHOUT STOP.</p> <p>PERMITTED IF THE FLARE DOES NOT EXTEND PAST THE MINIMUM THE TUBE ID.</p>
 <p><b>INDENTATION-INNER TUBE</b></p>	<p>MARK ON THE TUBE ID BELOW THE FLARE.</p> <p>CAUSED BY SECOND OPERATION PILOT WHEN THE MANDREL IS INCORRECTLY ALIGNED WITH THE CLAMPING DIE.</p> <p>NOT PERMITTED.</p>
 <p><b>FLATTENED LIP</b></p>	<p>FLATTENED OR RINGED FLARE OUTER LIP.</p> <p>CAUSED BY VARIOUS MACHINE SETTINGS.</p> <p>PERMITTED IF THE FLARE IS PERPENDICULAR TO THE TUBE CENTER LINE AND IS NOT CRACKED AT THE BEND.</p>

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Figure 204 (Sheet 2 of 3)



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 <p><b>THIN FLARE</b></p>	<p>FLARE THICKNESS UNUSUALLY THIN.</p> <p>CAUSED BY CONE MANDREL WITHOUT STOP.</p> <p>PERMITTED IF THE THICKNESS "T" IS NOT LESS THAN 1.5 TIMES THE TUBE WALL THICKNESS.</p>
 <p><b>VARYING FLARE THICKNESS</b></p>	<p>FLARE THICKNESS CHANGES.</p> <p>CAUSED BY THE DIE INCORRECTLY ALIGNED.</p> <p>PERMITTED IF THE VARIATION IS NOT MORE THAN 0.004 in [0.101 mm].</p>
 <p><b>WAVY EDGE</b></p>	<p>UNEVEN FLARE INNER EDGE.</p> <p>CAUSED BY TOOLING VARIABLES.</p> <p>PERMITTED IF THE FLARE DOES NOT GO PAST THE MINIMUM TUBE ID.</p>
 <p><b>SLEEVE INDENTATION</b></p>	<p>TUBE INDENTED AT OUTSIDE BASE OF THE FLARE.</p> <p>CAUSED BY WORN TOOLING.</p> <p>PERMITTED IF THE INDENTION IS NOT MORE THAN 12% OF THE NOMINAL THICKNESS.</p>

Double Flare Acceptance Limits  
Figure 204 (Sheet 3 of 3)

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**B. Leak Test of the Installed Oxygen Plumbing** *(LES 1023)*

**CAUTION:**     **HYDROGEN TRACER GAS MUST NOT BE USED TO LEAK TEST THE OXYGEN BOTTLE/REGULATOR ASSEMBLY, THE TRACER GAS MIXTURE CAN ONLY BE USED IN THE SYSTEM PLUMBING/COMPONENTS.**

**CAUTION:**     **HYDROGEN TRACER GAS, A MIXTURE OF 5% HYDROGEN AND 95% NITROGEN MUST NOT BE USED FOR TIMED PRESSURE TESTS.**

- (1) Get the necessary tools and equipment.

**NOTE:**     You can use equivalent alternatives for these items.

<b>NAME</b>	<b>PART NUMBER</b>	<b>MANUFACTURER</b>	<b>USE</b>
Adixem Extrima Hydrogen Detector	Sensitor Tech, 267 Boston Road Suite 3, N.Billerica, MA	Commercially Available	To detect the leakage
Cylinder Hydrogen (5% Hydrogen 95% Nitrogen)	NIHY 5200	Commercially Available	Hydrogen leak test
Hydrogen Regulator	GP402-15-350	Commercially Available	Hydrogen leak test
NuvoTrace Safe Trace 101 Hydrogen Detector	NuvoTrace Technologies Inc. 231 S. 3rd Street, Suite 285, Las Vegas, NV	Commercially Available	To detect the leakage

- (2) All the oxygen plumbing connections and components, except the bottle/regulator, must be leak checked before the functional test of the complete system.
- (3) Allow the electronic gas detector to warm up per the manufacturer recommendations, and verify the calibration.

**NOTE:**     Adixem Extrima Hydrogen Detector alarm level can be set to  $2 \times 10^{-4}$  cc/s.

**NOTE:**     NuvoTrace Safe Trace 101 Hydrogen Detector alarm level can be set to 15 ppm.

- (4) Connect the regulated tracer gas supply to the oxygen plumbing and slowly increase the regulated pressure to 70 ( $\pm 10$ ) psi [482.63 ( $\pm 68.95$ ) kPa]. Vent the plumbing at the furthest point downstream from the tracer gas connection to make sure that the plumbing system is saturated. Tight the connection used for venting.

**NOTE:**     Increase pressure slowly to prevent the seal valves from closing.

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- (5) Check all the connections and components for leakage using the detector.
- (6) Repair the leaks as required and torque the connections to the correct torque value.
- (7) Make sure that all the leaks have been corrected.
- (8) After all the connections/components have been checked and found to be leak free, shut off the tracer gas and disconnect the test hose from the oxygen plumbing.
- (9) Connect the dry nitrogen source to the oxygen plumbing.
- (10) Make sure that the plumbing is free to vent at the furthest point downstream from the nitrogen source connection.
- (11) Adjust the nitrogen pressure to 40-60 psi [275.79 to 413.68 kPa] and purge for approximately one to two minutes to remove any remaining tracer gas from the system.
- (12) Make sure that all the tracer gas has been removed from the system using the detector at the downstream vent point.
- (13) Hard the cap any open lines.

**C. Leak Check of Installed Emergency Air Plumbing and Components Including Hydraulic Accumulators**

(LES 1023)

**CAUTION: HYDROGEN TRACER GAS, A MIXTURE OF 5% HYDROGEN AND 95% NITROGEN MUST NOT BE USED FOR TIMED PRESSURE TESTS.**

- (1) Get the necessary tools and equipment.

**NOTE:** You can use equivalent alternatives for these items.

<b>NAME</b>	<b>PART NUMBER</b>	<b>MANUFACTURER</b>	<b>USE</b>
Adixem Extrima Hydrogen Detector	Sensitor Tech, 267 Boston Road Suite 3, N.Billerica, MA	Commercially Available	To detect the leakage
Cylinder Hydrogen (5% Hydrogen 95% Nitrogen)	NIHY 5200	Commercially Available	Hydrogen leak test
Hydrogen Regulator	GP402-15-350	Commercially Available	Hydrogen leak test
NuvoTrace Safe Trace 101 Hydrogen Detector	NuvoTrace Technologies Inc. 231 S. 3rd Street, Suite 285, Las Vegas, NV	Commercially Available	To detect the leakage

- (2) All the emergency air plumbing connections and components with the emergency air bottles and hydraulic accumulators, must be leak checked before the functional test of the complete system.

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- (3) Allow the electronic gas detector to warm up per the manufacturer recommendations, and check the calibration.

NOTE: Adixem Extrima Hydrogen Detector alarm level can be set to 2x10<sup>-4</sup> cc/s.

NOTE: NuvoTrace Safe Trace 101 Hydrogen Detector alarm level can be set to 15 ppm.

- (4) Connect the regulated tracer gas supply to the emergency air plumbing and increase the regulated pressure to 50 (±10) psi [344.74 (±68.95) kPa]. Vent the plumbing at the furthest point downstream from the tracer gas connection to make sure that the plumbing system is saturated. Tight the connection used for venting. Increase the tracer gas regulated pressure to 800(±50) psi.
- (5) Check all the connections and components for leakage using the detector.
- (6) Repair the leaks as required and torque the connections to the correct torque value.
- (7) Make sure that all the leaks have been corrected.
- (8) After all the connections/components have been checked and found to be leak free, shut off the tracer gas and disconnect the test hose from the emergency air plumbing.
- (9) Hard cap any open lines.

### D. Clearance Requirements for Flared Tubing *(LES 1023)*

NOTE: A section of tubing that is supported is that part of the tubing that is 4 inches [9.16 cm] or less from the support clamp.

NOTE: A section of tubing that is not supported is that part of the tubing that is more than 4 inches [9.16 cm] past the support clamp.

- (1) Get the necessary tools and equipment.

NOTE: You can use equivalent alternatives for this item.

NAME	PART NUMBER	MANUFACTURER	USE
Thickness Gage 0.35 in [8.89 mm]		Locally Manufactured	Determine if the minimum clearance exists between crossflow tube and control cables.

- (2) Clearance Requirements for Flared Tubing (Excludes Oxygen Lines and Crossflow Tube):
  - (a) A minimum clearance of 0.125 inch [3.18 mm] between any unsupported section of tubing and the adjacent structure, other tubing, or equipment if the tubing is sufficiently rigid to prevent chafing.
  - (b) A minimum clearance of 0.06 inch [1.52 mm] between any supported section of tubing and the adjacent structure, or equipment.
  - (c) A minimum clearance of 0.50 inch [12.7 mm] between any unsupported section of tubing and operating mechanisms such as control cables, pushrods, etc.

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- (d) A minimum clearance of 0.25 inch [6.35 mm] between any supported section of tubing and operating mechanisms such as control cables, pushrods, etc.
  - (e) Fluid lines that carry flammable fluid must have a minimum clearance of 6.0 inches [15.24 cm] from all electrical wiring and conduits. When you cannot get a 6.0 inches [15.24 cm] clearance, a clearance of 2.0 inches [5.08 cm] is permitted if the fluid tubes and the electrical wiring are clamped so that there is no movement between them. When you cannot get a 2.0 inches [5.08 cm] clearance, a clearance of 0.5 to 2.0 inches [1.27 to 5.08 cm] is permitted if the fluid tubes and the electrical wiring are so rigidly clamped that you get a positive standoff of a minimum 0.5 inch [12.7 mm].
  - (f) Electrical connections must not be directly below a flammable fluid line unless an approved procedure is made to make sure that a leak from the fluid line cannot drip on the electrical connections.
- (3) Clearance Requirements for Flared Oxygen Lines:
- (a) The oxygen lines, fittings, and system components must have a minimum clearance of 6.0 inches [15.24 cm] from all fuel, oil, and hydraulic systems.
  - (b) The oxygen lines, fittings, and system components must have a minimum clearance of 6.0 inches [15.24 cm] from all electrical wiring and conduits. When you cannot get a clearance of 6.0 inches [15.24 cm], a clearance of between 2.0 to 6.0 inches [5.08 to 15.24 cm] is permitted if the electrical wiring and conduits are rigidly clamped. When you cannot get a 2.0 inches [5.08 cm] clearance, a clearance of 0.5 to 2.0 inches [1.27 to 5.08 cm] is permitted if the electrical wiring and conduits are rigidly clamped and covered with electrical insulation. A clearance of less than 0.5 inch [12.7 mm] is not permitted unless specified in engineering drawing.
  - (c) The oxygen lines, fittings, and system components must have a minimum clearance of 2.0 inches [5.08 cm] from a coaxial cable. When you cannot get a 2.0 inches [5.08 cm] clearance, a clearance between 0.1 to 2.0 inches [0.25 to 5.08 cm] is permitted if the coaxial cable is rigidly clamped and covered with a protective covering. A clearance of less than 0.1 inch [0.25 cm] is not permitted.
  - (d) The oxygen lines, fittings, and system components must have the correct clearance between all heat sources to prevent a temperature increase of 5 °F [2.8 °C] above the ambient air temperatures.
- (4) Clearance Requirements for Crossflow Tube:
- (a) The minimum clearance between the fuel crossflow tube and the flight control cables is 0.35 inch [8.89 mm].
- NOTE: Do not use a scale to measure clearance. The position of the fuel crossflow tube and flight control cables in the keelbeam area will not allow an accurate measurement using this method.
- (b) Fabricate a 0.35 inch [8.89 mm] thickness gage of suitable material and insert between crossflow tube and the control cables to determine if the minimum clearance exists.
  - (c) If the minimum clearance does not exist after installation of the fuel crossflow tube, contact Learjet Field Service for disposition.

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### 3. Repairs

#### A. Bend and Flare the Tubing

(See Figure 205, Figure 206, Figure 207, and Figure 208.)

- (1) Get the necessary tools and equipment.

NOTE: You can use equivalent alternatives for these items.

NAME	PART NUMBER	MANUFACTURER	USE
Flaring Tools		Commercially Available	Flare tubing ends
Soft Steel Wire		Commercially Available	Make tube template
Tubing Bender, Hand Operated or Machine		Commercially Available	Bend tubing

- (2) Remove the damaged tube from the aircraft.
- (3) If the tube cannot be use as a template, use a piece of soft steel wire to form a shape that will match the fittings on the aircraft.

NOTE: Always select a path for the tubing which makes it necessary to put bends in the tubing. The bends are necessary to release the mechanical strain, permit temperature expansion and contraction, and absorb vibration.

- (4) Measure the outside diameter, wall thickness, and identify the material type of the used tube.
- (5) Select a new piece of tubing with the same outside diameter, wall thickness, and material as the used tubing.
- (6) Cut the new tubing approximately 10% longer than the tube being replaced. This is necessary for changes in the tube bends.

NOTE: The ends must be cut square within 30 minutes to the centerline of the tube.

NOTE: Cut the titanium tube at speeds sufficiently slow to stop the formation of white sparks or discoloration of the tube deeper than a straw color.

NOTE: Do not use abrasive cutting materials on titanium.

- (7) Deburr the tube end. Remove all the burrs and a minimum amount of the material is removed.
  - (a) Deburr the titanium tube at slow speeds to stop the formation of white sparks or discoloration of the tube.

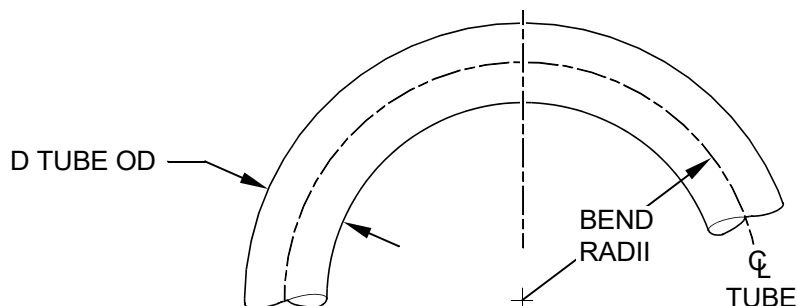
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- (8) Use one of the methods that follow and bend the new tubing to agree with the template.
- (a) Hand bending without tools - This method is not recommended but it can be used on tubing with an outside diameter of less than 0.25 inch [6.3 mm]. The minimum bend radius table must be used as a guide. Bend the tube carefully so that it does not flatten, kink, or wrinkle. A slight flatten is permitted if the outside diameter at the flattened portion is not less than 75% of the original outside diameter.
  - (b) Hand bending with a hand bender - To bend tubing with a hand tube bender almost the same as that shown in do as follows:
    - 1) To put the tubing into the bender, raise the slide bar handle fully up.
    - 2) Hook the clip over the tube and make sure that the full length of the slide bar groove is in contact with the tubing.
    - 3) With the zero marks aligned, turn the handle until you get the necessary bend.
  - (c) Tube bending machine - Power tube bending machines are manufactured for all types of tubing. On large diameter and hard material tubing, a power tube bender is necessary. Power bending machines use the same principle as the hand bender.

NOTE: Form the tubes so that when you install them you do not need to tighten the fitting to move the tube into position.

- (9) Put the nut and the sleeve on the end of the tube.
- (10) Move the nut and sleeve down the tube so there is no interference when the tube is flared.
- (11) Use the appropriate flaring tool and the specification to flare the tube ends.

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TUBE OD	SPECIAL RADII		RECOMMENDED BEND RADII		ADDITIONAL BEND RADII
	1-1/2 D	2 D	3 D	4 D	6 D
1/8 (0.125) in [3.17 mm]	0.188 in [4.77 mm]	0.250 in [6.35mm]	0.375 in [9.52 mm]	0.500 in [12.70 mm]	0.750 in [19.05 mm]
3/16 (0.187) in [4.74 mm]	0.281 in [7.13mm]	0.375 in [9.52 mm]	0.563 in [14.30 mm]	0.750 in [19.05 mm]	1.125 in [3.17 cm]
1/4 (0.250) in [6.35 mm]	0.375 in [9.52 mm]	0.500 in [12.70 mm]	0.750 in [19.05 mm]	1.00 in [2.54 cm]	1.500 in [3.49 cm]
5/16 (0.312) in [7.92 mm]	0.469 in [11.91 mm]	0.625 in [15.87 mm]	0.938 in [23.82 mm]	1.250 in [3.17 cm]	1.875 in [4.76 cm]
3/8 (0.375) in [9.52 mm]	0.563 in [9.52 mm]	0.750 in [9.52 mm]	1.125 in [9.52 mm]	1.500 in [9.52 mm]	2.250 in [5.39 cm]
7/16 (0.437) in [11.09 mm]	0.056 in [16.66 mm]	0.875 in [22.22 mm]	1.312 in [3.31 cm]	1.750 in [11.09 mm]	2.625 in [6.66 cm]
1/2 (0.500) in [12.70 mm]	0.750 in [19.05 mm]	1.00 in [2.54 cm]	1.500 in [3.81 cm]	2.00in [12.70 mm]	3.00 in [7.62 cm]
5/8 (0.625) in [15.87 mm]	0.938 in [23.82 mm]	1.250 in [3.17 cm]	1.875 in [4.76 cm]	2.500 in [15.87 mm]	3.750 in [9.52 cm]
3/4 (0.750) in [19.05 mm]	1.125 in [2.85 cm]	1.500 in [3.81 cm]	2.250 in [5.39 cm]	3.00 in [19.05 mm]	4.500 in [11.43 cm]
7/8 (0.875) in [22.22 mm]	1.312 in [3.33 cm]	1.750 in [4.44 cm]	2.625 in [6.66 cm]	3.500 in [22.22 mm]	5.250 in [13.33 cm]
1.00 in [2.54 cm]	1.500 in [3.81 cm]	2.00 in [5.08 cm]	3.00in [7.62 cm]	4.00 in [2.54 cm]	6.00 in [15.24 cm]
1 1/8 in [2.85 cm]	1.688 in [4.28 cm]	2.250 in [5.39 cm]	3.375 in [8.57 cm]	4.500 in [2.85 cm]	6.750 in [17.14 cm]
1 1/4 in [3.17 cm]	1.875 in [4.76 cm]	2.500 in [6.35 cm]	3.750 in [9.52 cm]	5.00 in [3.17 cm]	7.500 in [19.05 cm]
1 3/8 in [3.49 cm]	2.063 in [5.24 cm]	2.750 in [6.98cm]	4.125 in [10.47 cm]	5.500 in [3.49cm]	8.250 in [20.95 cm]
1 1/2 in [3.81 cm]	2.250 in [6.35 cm]	3.00 in [7.62 cm]	4.500 in [11.43 cm]	6.00 in [3.81 cm]	9.00 in [22.86 cm]
1 5/8 in [4.12 cm]	2.438 in [6.19 cm]	3.250 in [8.25 cm]	4.875 in [12.38 cm]	6.500 in [4.12 cm]	9.750 in [24.76 cm]
1 3/4 in [4.44 cm]	2.625 in [6.66 cm]	3.500 in [8.89 cm]	5.250 in [13.33 cm]	7.00 in [4.44 cm]	10.500 in [26.67 cm]
1 7/8 in [4.76 cm]	2.813 in [7.14 cm]	3.750 in [9.52 cm]	5.625 in [14.28 cm]	7.50 in [4.76 cm]	11.250 in [28.57 cm]
2.00 in [5.08 cm]	3.00 in [7.62 cm]	4.00 in [10.16 cm]	6.00 in [15.24 cm]	8.00 in [5.08 cm]	12.00 in [30.48 cm]
2 1/4 in [5.39 cm]	3.375 in [8.57 cm]	4.500 in [11.43 cm]	6.750 in [17.14 cm]	9.00 in [5.39 cm]	13.500 in [34.29 cm]
2 1/2 in [6.35 cm]	3.750 in [9.52 cm]	5.00 in [12.70 cm]	7.500 in [19.05 cm]	10.00 in [6.35 cm]	15.00 in [38.10 cm]
3.00 in [7.62 cm]	4.50 in [11.43 cm]	6.00 in [15.24cm]	9.00 in [22.86 cm]	12.00 in [7.62 cm]	18.00 in [45.72 cm]

## NOTE



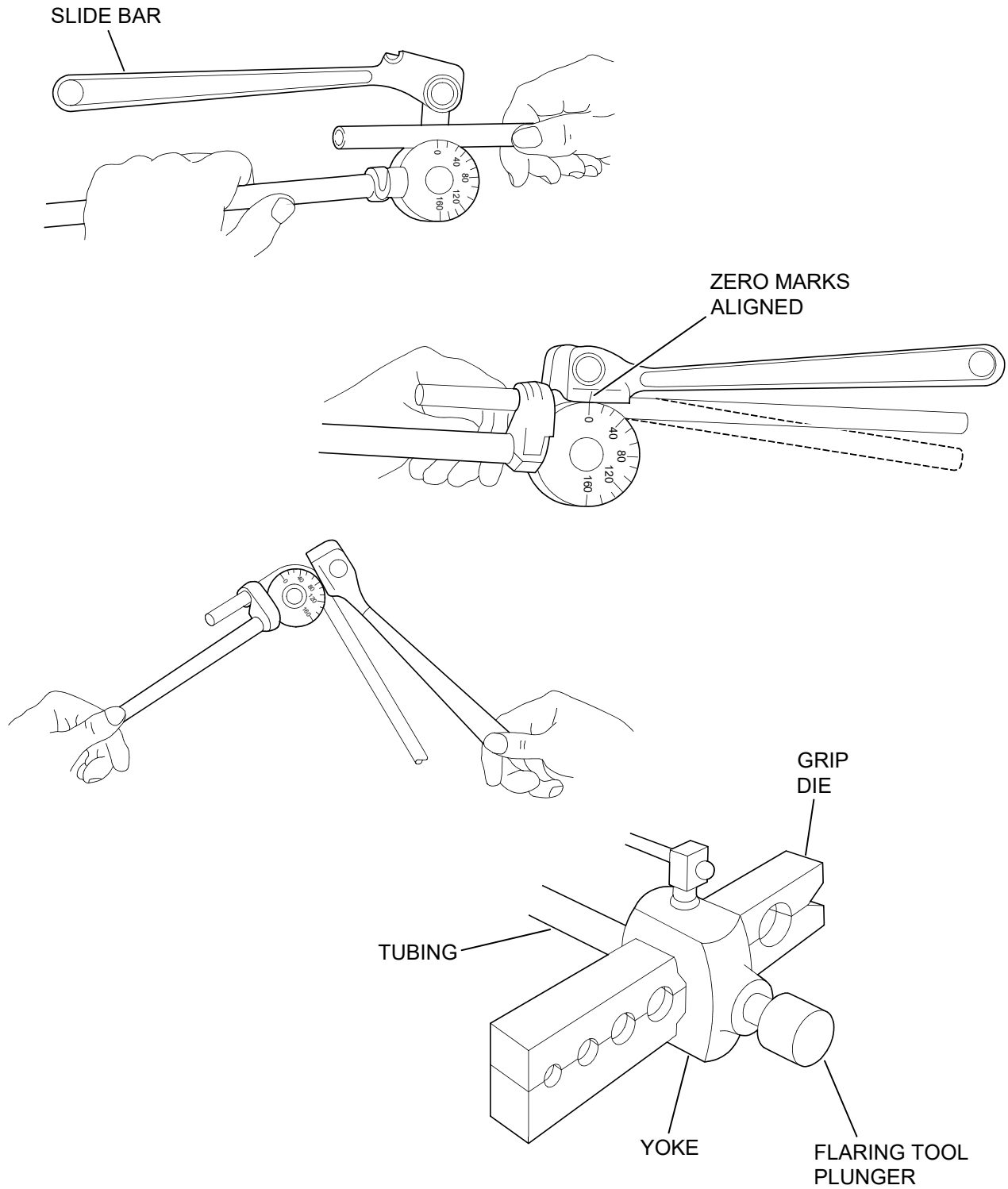
Where special bend radius is required, 2 D plus 0.0625 in [1.587 mm] may be used.

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Tube Bending Minimum Radii Data  
Figure 205



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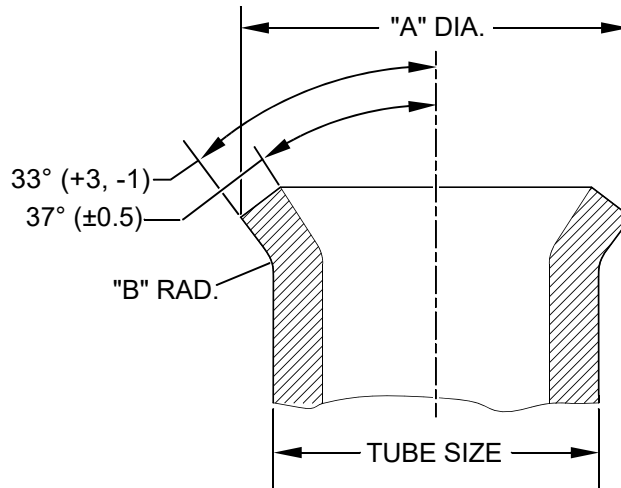
M60-203000-206-01

Tubing Fabrication Tools  
Figure 206

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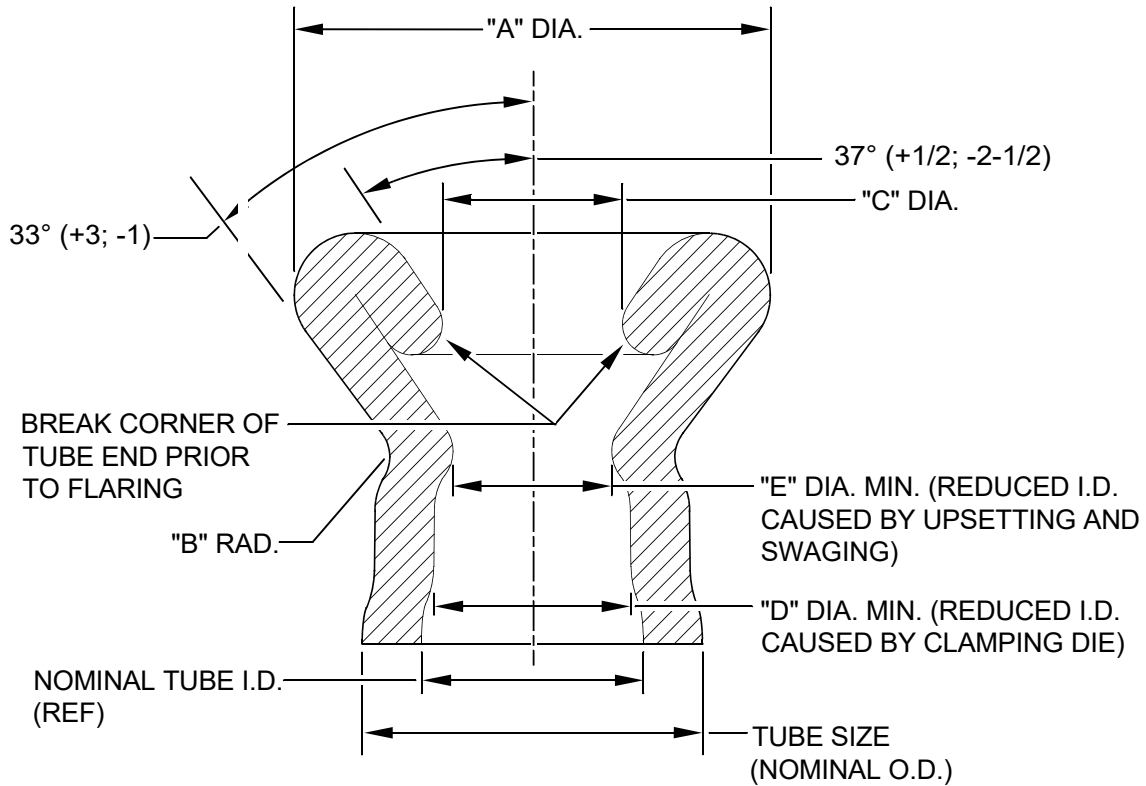


TUBE SIZE NOMINAL O.D	"A" DIA.				"B" RAD. ±.010
	AL ALLOY TUBING		STEEL TUBING		
1/8 (0.125) in [3.17 mm]	0.200 in [5.079 mm]	+0.000 in -0.010 in [+0.000 mm] [-0.254 mm]	0.200 in [5.079 mm]	+0.000 in -0.010 in [+0.000 mm] [-0.254 mm]	0.032 in [0.812 mm]
3/16 (0.187) in [4.74 mm]	0.302 in [7.670 mm]		0.302 in [7.670 mm]		
1/4 (0.250) in [6.35 mm]	0.359 in [9.118 mm]		0.359 in [9.118 mm]		
5/16 (0.312) in [7.92 mm]	0.421 in [10.693 mm]		0.421 in [10.693 mm]		
3/8 (0.375) in [9.52 mm]	0.484 in [12.293 mm]		0.484 in [12.293 mm]		0.046 in [1.168 mm]
1/2 (0.500) in [12.70 mm]	0.656 in [16.662 mm]		0.656 in [16.662 mm]		0.062 in [1.574 mm]
5/8 (0.625) in [15.87 mm]	0.781 in [19.887 mm]		0.781 in [19.887 mm]		0.078 in [1.981 mm]
3/4 (0.750) in [19.05 mm]	0.937 in [23.799 mm]		0.937 in [23.799 mm]		
1.00 in [2.54 cm]	1.187 in [3.014 cm]	+0.000 in -0.015 in [+0.000 mm] [-0.381 mm]	1.187 in [3.014 cm]	+0.000 in -0.015 in [+0.000 mm] [-0.381 mm]	0.093 in [2.362 mm]
1 1/4 in [3.17 cm]	1.500 in [3.810 cm]		1.500 in [3.810 cm]		0.109 in [2.768 mm]
1 1/2 in [3.81 cm]	1.721 in [4.371 cm]		1.721 in [4.371 cm]		
1 3/4 in [4.44 cm]	2.106 in [5.349 cm]		2.106 in [5.349 cm]		
2.00 in [5.08 cm]	2.356 in [5.984 cm]		2.356 in [5.984 cm]		
2 1/4 in [5.39 cm]	2.606 in [6.619 cm]		2.606 in [6.619 cm]		
2 1/2 in [6.35 cm]	2.856 in [7.254 cm]		2.856 in [7.254 cm]		
3.00 in [7.62 cm]	3.356 in [8.524 cm]		3.356 in [8.524 cm]		

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Single Flare Specifications  
Figure 207

# **LEARJET 60/60XR MAINTENANCE MANUAL**



TUBE SIZE NOMINAL O.D. (REF)	WALL THKNS. (REF)	NOMINAL TUBE I.D. (REF)	"A" DIA. +0.000; -0.010 [+0.000; -0.254 mm]	"B" RAD. +0.000; -0.010 [+0.000; -0.254 mm]	"C" DIA.		"D" DIA. MIN.	"E" DIA. MIN.	
					MAX.	MIN.			
1/8 (0.125) in [3.17 mm]	0.028 in [0.711 mm]	0.069 in [1.752 mm]	0.200 in [5.079 mm]	0.032 in [0.812 mm]	0.096 in [2.438 mm]	0.062 in [1.574 mm]	0.062 in [1.574 mm]	0.056 in [1.422 mm]	
	0.035 in [0.889 mm]	0.055 in [1.397 mm]			0.086 in [2.184 mm]	0.048 in [1.219 mm]	0.048 in [1.219 mm]	0.041 in [1.041 mm]	
3/16 (0.187) in [4.74 mm]	0.028 in [0.711 mm]	0.132 in [3.352 mm]	0.302 in [7.670 mm]		0.168 in [4.267 mm]	0.124 in [3.149 mm]	0.124 in [3.149 mm]	0.117 in [2.971 mm]	
	0.035 in [0.889 mm]	0.118 in [2.997 mm]			0.158 in [4.013 mm]	0.110 in [2.794 mm]	0.110 in [2.794 mm]	0.102 in [2.590 mm]	
1/4 (0.250) in [6.35 mm]	0.028 in [0.711 mm]	0.194 in [4.927 mm]	0.359 in [9.118 mm]		0.230 in [5.842 mm]	0.187 in [4.749 mm]	0.187 in [4.749 mm]	0.176 in [4.470 mm]	
	0.035 in [0.889 mm]	0.180 in [4.592 mm]			0.219 in [5.562 mm]	0.173 in [4.394 mm]	0.173 in [4.394 mm]	0.160 in [4.064 mm]	
5/16 (0.312) in [7.92 mm]	0.035 in [0.889 mm]	0.243 in [6.172 mm]	0.421 in [10.693 mm]		0.281 in [7.137 mm]	0.235 in [5.969 mm]	0.235 in [5.969 mm]	0.221 in [5.613 mm]	
	0.049 in [1.244 mm]	0.215 in [5.461 mm]			0.259 in [6.578 mm]	0.205 in [5.207 mm]	0.205 in [5.207 mm]	0.189 in [4.800 mm]	
3/8 (0.375) in [9.52 mm]	0.028 in [0.711 mm]	0.319 in [8.102 mm]	0.484 in [12.293 mm]		0.046 in [1.168 mm]	0.354 in [8.991 mm]	0.312 in [7.924 mm]	0.312 in [7.924 mm]	0.299 in [7.594 mm]
	0.035 in [0.889 mm]	0.305 in [7.747 mm]				0.344 in [8.737 mm]	0.298 in [7.569 mm]	0.298 in [7.569 mm]	0.284 in [7.213 mm]
	0.049 in [1.244 mm]	0.277 in [7.035 mm]				0.322 in [8.178 mm]	0.268 in [6.807 mm]	0.268 in [6.807 mm]	0.254 in [6.451 mm]

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Double Flare Specifications  
Figure 208

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### 4. Cleaning/Painting *(LES 1418)*

#### A. Clean the Tubing

**NOTE:** A newly made tube assembly must be cleaned, capped, and, if necessary, painted. Tubing that was stored in unclean conditions must be cleaned before installation.

**NOTE:** The equipment used to clean the tubing must have a metal tank with a solvent reservoir, pump, filtration unit (25 micron nominal), and rack or screen which will prevent the immersion of tubing into the solvent. The pump nozzle must have a pressure high enough to remove chips, oil, and other unwanted materials from the tube.

(1) Get the necessary tools and equipment.

**NOTE:** You can use equivalent alternatives for these items.

NAME	PART NUMBER	MANUFACTURER	USE
Cleaning Solvent Type II High Flash Point Mineral Spirits		Commercially Available	Clean parts
Cleaning Tank (Metal)		Commercially Available	Clean parts
Cotton Cloth, Clean, White, and Lint-Free		Commercially Available	Apply solvents and cleaning
Cotton Gloves, White and Lint-Free		Commercially Available	Keep cleaned surfaces clean
Nitrogen		Commercially Available	Purge oxygen tubing
Plastic Bags		Commercially Available	Seal non-threaded tubing ends
Rubber Bands		Commercially Available	Attach plastic bags
Stoddard Solvent	MIL-PRF-680A	Commercially Available	Clean titanium tubing
Tape		Commercially Available	Attach plastic bags

(2) Clean the tubing that is not installed as follows:

- Flush the outside and inside of the tubing. Make sure that the flare, nut, and sleeve are fully cleaned. For titanium hydraulic tubing, use Stoddard solvent.
- Let the unwanted solvent drain from the tube.
- Remove the solvent from the tube exterior, interior, and fittings with clean and dry compressed air.
- Immediately put a cap on the tubing with clean hardware. Non-threaded titanium tube ends and small titanium parts can be put in plastic bags and sealed with tape or rubber bands.

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- (3) Clean the installed oxygen tubing as follows:

**WARNING:**     **DO NOT FLUSH AN INSTALLED OXYGEN SYSTEM WITH SOLUTIONS OR SOLVENTS. THE SOLUTIONS OR SOLVENTS CAN CAUSE AN EXPLOSION OR FIRE.**

**CAUTION:**     **WHEN THE ENDS OF THE LINE, FITTINGS, OR COMPONENTS HAVE BEEN LEFT OPEN, THE OXYGEN SYSTEM MUST BE PURGED. IF YOU DO NOT DO THIS, YOU WILL CAUSE CONTAMINATION OF THE OXYGEN SYSTEM.**

- (a) Disconnect the oxygen bottle from the system.
- (b) Connect a cylinder of nitrogen to the oxygen line at the oxygen bottle connection.
- (c) Make sure that the nitrogen will flow through all sections that are to be purged.
- (d) Let the nitrogen flow through the oxygen system for a minimum of 10 minutes.
- (e) When the lines have been purged, install a plug or close the lines to prevent contamination.
- (f) Disconnect the cylinder of nitrogen and install a plug, close, or connect an oxygen bottle to the system to prevent contamination.

**B. Paint the Tubing**

**NOTE:**     New tubing must be painted the same as the used tubing. It is not necessary to apply a finish to stainless steel tubing.

- (1) Get the necessary tools and equipment.

**NOTE:**     You can use equivalent alternatives for this item.

NAME	PART NUMBER	MANUFACTURER	USE
Masking Tape		Commercially Available	Mask tubing ends

**CAUTION:**     **THE INTERIOR SURFACE OF FIRE EXTINGUISHER AND OXYGEN TUBES MUST BE KEPT FREE OF ALL FINISH. THE FINISH CAN CAUSE AN EXPLOSION OR FIRE.**

- (2) With the nut and the sleeve against the flare, apply the masking tape 0.75 inch [19.0 mm] from the back face of the nut.
- (3) Find the type of finish that was used on the tube. The aluminum tubing will have been chemically cleaned and then chemical film treated followed by an epoxy primer.

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### C. Identify System Tubing with Colored Tape (LES 1023)

(See Table 203.)

**NOTE:** If you apply a finish to the tubing, apply the identification tape after the finish cures.

- (1) Get the necessary tools and equipment.

**NOTE:** You can use equivalent alternatives for these items.

NAME	PART NUMBER	MANUFACTURER	USE
Clean Cotton Cloth		Commercially Available	Clean parts
Cotton Cloth, Clean, White, and Lint-Free		Commercially Available	Apply solvents and cleaning
Cotton Gloves, White and Lint-Free		Commercially Available	Keep cleaned surfaces clean
		Commercially Available	Identify system tubing

**CAUTION:** DO NOT APPLY IDENTIFICATION TAPE TO THE TUBES INSTALLED IN THE FUEL TANK. THE FUEL WILL DISSOLVE THE TAPE AND CAN CAUSE CONTAMINATION OF THE FUEL FILTER.

- (2) Apply the system identification tape as follows:

**NOTE:** No tape is necessary on tubing that is 0 to 4 inches [0 to 10.16 cm] in length.

- (a) For tubing that is 4 to 12 inches [10.16 to 30.48 cm] in length, apply the tape 1.25 inches [3.175 cm] from one end of the tube.
- (b) For tubing that is 12 inches [30.48 cm] or more in length, apply the tape 1.25 inches [3.175 cm] from each end of the tube.
- (c) For tubing that is longer than 4 feet [1.2 m] in length, or passes from one compartment to another, apply additional tape for easy identification.

**CAUTION:** DO NOT TOUCH THE CLEANED AREA OF THE TUBING WITH YOUR BARE HAND. IF YOU DO THIS, THE AREA OF THE TUBE MUST BE CLEANED AGAIN.

- (3) Clean the tubing area with a clean cotton cloth moist with the solvent. (Refer to 20-13-00.)
- (4) Select the correct system identification tape.
- (5) Apply the tape tightly around the tubing. Make sure that you do not touch the adhesive side of the tape.

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SYSTEM IDENTIFICATION TAPES	
SYSTEM	TAPE COLOR
FUEL	RED
LUBRICATION	YELLOW
HYDRAULIC	BLUE/YELLOW
PNEUMATIC	ORANGE/BLUE
INSTRUMENT AIR	ORANGE/GRAY
BREATHING OXYGEN	GREEN
AIR CONDITIONING	BROWN/GRAY
FIRE PROTECTION	BROWN
DE-ICING	GRAY
ELECTRICAL CONDUITS	MAROON/ORANGE
DIRECTION OF FLOW	WHITE WITH BLACK ARROWS
VACUUM	GRAY/ORANGE/GRAY

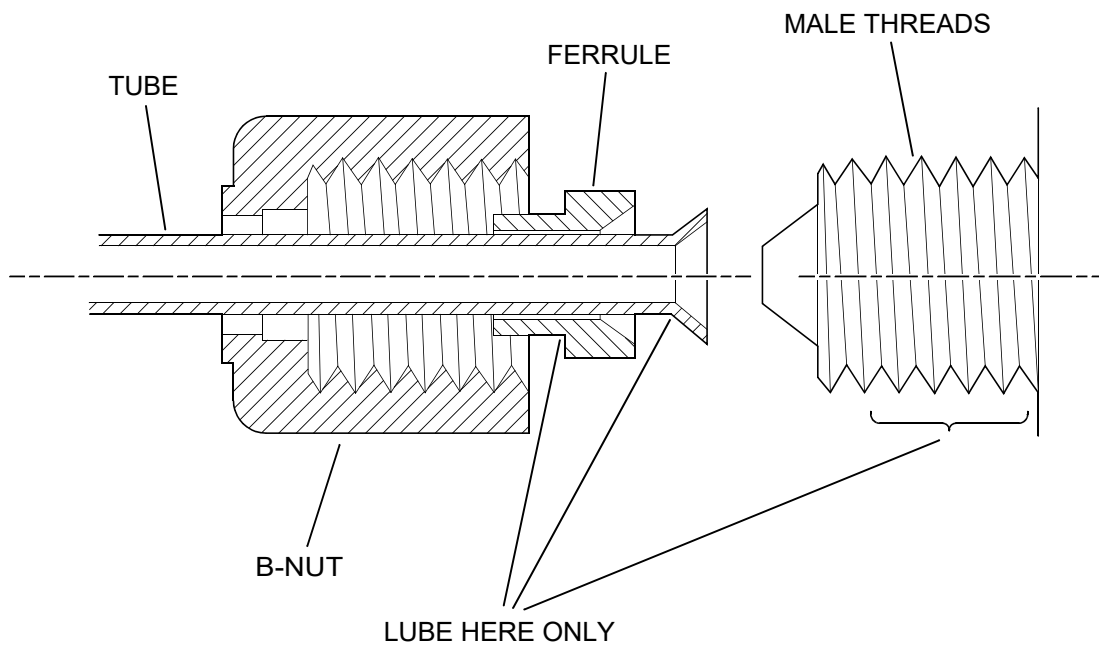
**NOTE**

Use 3M 8417 or 8418 tape on titanium tubing.

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System Identification Tapes  
Table 203

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Straight Thread Fittings  
Figure 209

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COMPOUND	SYSTEMS						
	HYDRAULIC	EMERGENCY AIR	HOT AIR 1000 °F [537.78 °C] MAXIMUM CRES ONLY	FUEL	PITOT- STATIC	ALL OTHER EXCEPT OXYGEN	OXYGEN
Rector Seal 100-W or 100 Virgin	X	X			X		
Liqui-Moly NV thread compound anti-seize	X	X		X	X	X	
VV-P-236 Petrolatum	X	X			X		
MIL-PRF-5606 Hydraulic Oil	X						
Engine Oil MIL-PRF-23699 or MIL-PRF-7808				X			
C5-A Anti- seize Thread Compound			X				
Christo-lube MCG 111 per MIL-PRF-27617							X

Thread Compound for Straight Threaded Fittings  
Table 204

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