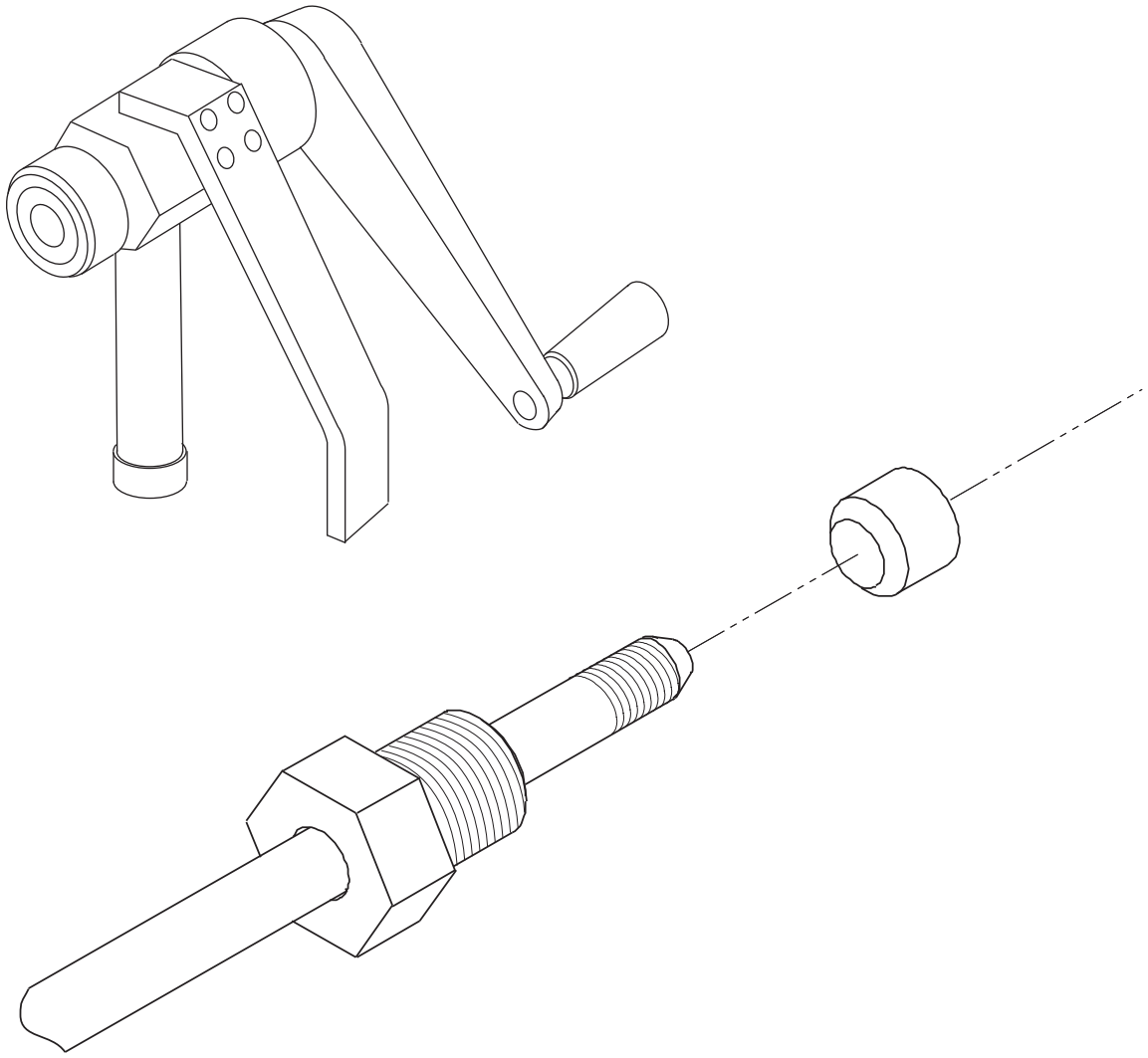
Instruction Manual

Forming Stainless Steel Tubing

Special Tool Usage



Publication information

Revision A February 2003
Revision B January 2004
Revision C February 2009
Revision D August 2009
Revision E November 2016

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Forming Stainless Steel Tubing

Equipment manufactured by Jet Edge uses 60,000 psi (4125 bar) rated stainless steel tubing for ultra-high pressure (UHP) water lines. Sizes used are U.S. standard 1/4 in, 3/8 in, and 9/16 in diameter. Jet Edge also uses 100,000 psi (6895 bar) rated stainless steel tubing in the sizes 1/4 in and 3/8 in.

Note *Jet Edge equipment is rated for continuous operation at 36ksi, 55ksi, and 75 ksi; Jet Edge equipment can produce higher pressures for each rating. Tubing for Jet Edge equipment is rated for 40ksi, 60ksi, and 100ksi.*

All tubing on Jet Edge equipment is available by replacement part number. Refer to the parts lists and assembly drawings in the product manual for the specific machine. To maintain the warranty and ensure proper operation, Jet Edge recommends that customers obtain replacement tubing by part number.

In some cases, unique plumbing requirements for special systems or accessories are required. For example, in some mobile applications UHP tubing may be preferred to flexible hose. Tubing stock is available in bulk length. Preparing the tubing requires specialized tools to assure proper installation.

Contents

⚠ WARNING

Jet Edge equipment can produce water pressures up to 90,000 psi (6200 bar). Lower-rated tubing can fracture and possibly cause personal injury.

Never use tubing rated below operating pressure. Tubing supplied by Jet Edge meets all standards for Jet Edge equipment.

Note *Study all instructions before starting any procedure. If uncertain about any procedure, contact the Jet Edge Service Department.*

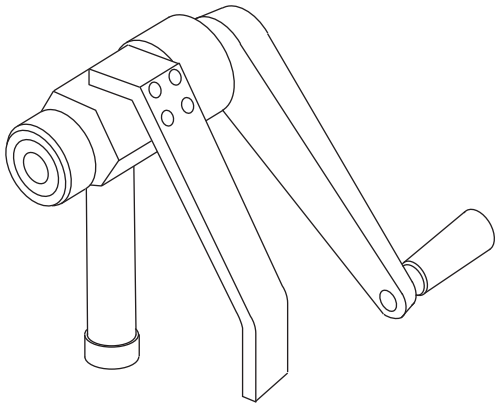
Lubricating threads

Use Precision Lube (part number 25750) on all threads. This compound is recommended instead of MoS_2 or similar lubricants because it is specially formulated to prevent galling of stainless steel threads and fittings.

Tools

Jet Edge offers a tubing tool kit from Autoclave Engineering.

- The older style is identified by a handle made of round steel rod
- The newer style is identified by a handle made of cast metal.



Old style

The old style coning tool (part number 26160-xxx) requires different replacement collets and blades, and a separate tool is required for each tubing size. Replacement parts for older style coning and threading tools:

Old Style Coning Tool Parts

Tubing Size	Replacement Blades	Replacement Die
1/4 Inch	26201-250	26207-250
3/8 Inch	26201-375	26207-375
9/16 Inch	26201-562	26207-562

New style

The new style coning tool (part number 102522-xxx) can be used for all sizes by changing the collet and blades for the desired size. The same threading tool can be used for all sizes by changing the die and guide bushing to the desired size.

New Style Coning Tool Parts

Description	1/4 Inch Coning Tool*	3/8 Inch Coning Tool†	9/16 Inch Coning Tool‡
Coning tool	102522-250	102522-375	102522-562
Replacement blades	102887	102888	26201-562
Replacement collet	102884	102885	102886
Left-hand threading tool	26164-250	26164-375	26164-562
Replacement die	26207-250	26207-375	26207-562
Guide bushing	28683-250	28683-375	28683-562
Reamer	26165-250	26165-375	26165-562
Tubing bender	46212	46214	46218

* 1/4 inch (0.250 in) Diameter tubing: Bulk tubing (part number 25309)

† 3/8 inch (0.375 in) Diameter tubing: Bulk tubing (part number 25127)

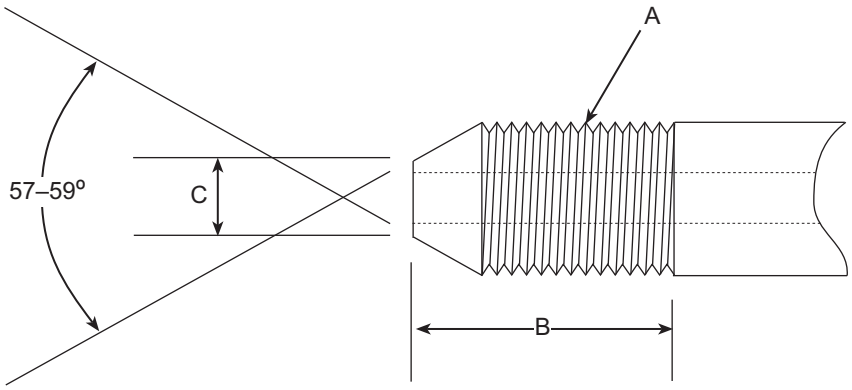
‡ 9/16 inch (0.562 in) Diameter tubing: Bulk tubing (part number 25308)

Coning and Threading

Preparation of tubing ends before bending is generally preferred. In cases where a bend is near the end of the tubing the coning and threading must be done first, or the tubing end will not be long enough to insert in the tools.

Tubing Geometry

Tubing Size (OD x ID)	A	B	C
0.250 x 0.083 inch	1/4–28 UNF L.H.	5/8 inch	1/8 inch
0.375 x 0.125 inch	3/8–24 UNF L.H.	3/4 inch	7/32 inch
0.562 x 0.188 inch	9/16–16 UNF L.H.	1 inch	9/32 inch

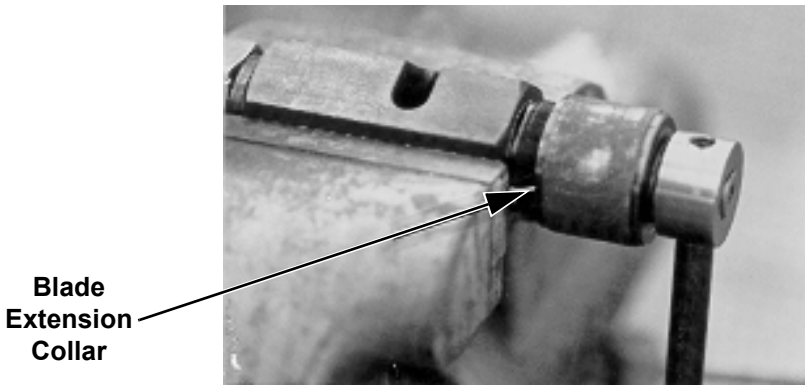


Required equipment

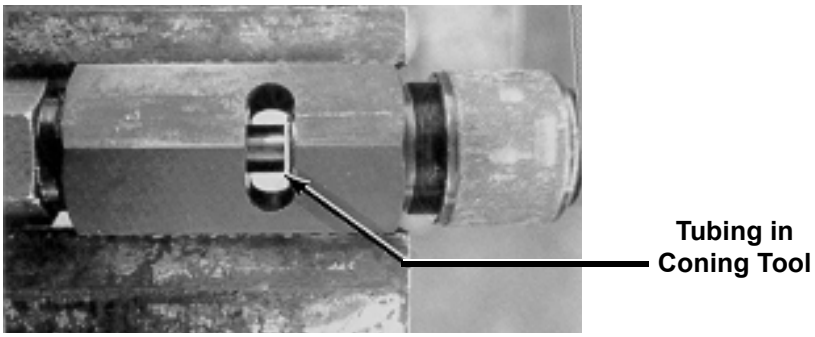
- See “Tools” on page 4, select tubing tools by tubing size
- Medium weight cutting oil
- Degreaser
- Low-pressure air source

Procedure

1. Carefully measure the tubing to be replaced. Cut the new tubing to the required length, adding 1/4 inch for metal removal during finishing. File or grind burrs from cut ends.
2. Spin the blade extension collar of the coning tool outward until the blades are retracted into the housing.



3. Clamp the coning tool in a vise.
4. Insert the tubing through the collet nut until the end of the tubing is approximately 1/16” from the blades, then tighten the nut securely to hold the tubing in place.



⚠ CAUTION

Do not turn the cutting handle counterclockwise; the blades can be damaged.

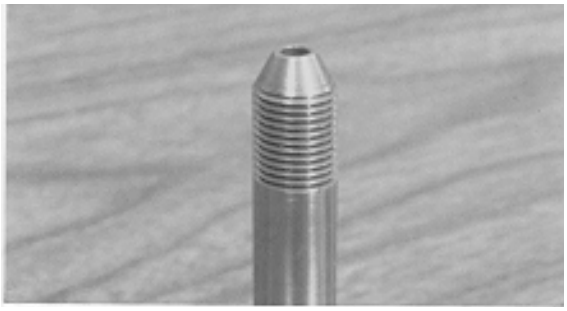
Turn the handle clockwise only.

5. Rotate the handle in a clockwise direction. Apply cutting oil liberally during coning. Stainless steel heats rapidly, which reduces blade service life.
6. Rotate the blade extension collar toward the tubing as material is cut away.
7. Inspect after several turns. The tip is properly coned when the end plane is clean and flat.
8. Remove the tubing from the tool and clamp it in the vise.

9. The collar for the gland nut requires left-hand thread. Select the appropriate threading tool for the tubing size being used from the tools table (see "Tools" on page 4).
10. Slide the tool over the tubing, making sure the die is in firm contact against the end surface.
11. Rotate the threading tool counterclockwise in short arcs to cut the thread. Back the tool off slightly each quarter turn to clear metal shavings from the die. Apply cutting oil liberally while forming the thread.
12. Thread the tubing to the recommended length (refer to the chart provided).

Note *Do not thread more than required to install the collar. Extra threading removes more metal than necessary and weakens the tubing.*

13. Unthread and remove the tool.
14. Verify that a clean, full thread is formed. A dull die can produce weak or partial threads.



Coned and Threaded Tubing

⚠ CAUTION

Metal shavings will damage machine components and destroy the orifice in the tool.

The tubing must be clean of all debris before connection.

15. Use a reamer to chamfer the tubing bore slightly. Ensure that all metal shavings are cleared away.
16. Remove metal particles with a wire brush and clean the threads with degreaser. Wipe dry.
17. Blow low-pressure air through the tubing from the opposite end to remove oil, degreaser, and metal shavings.

Bend Tubing

Precise fitting of tubing is critical to safe and efficient operation of the equipment. If tubing is not properly radiused during bending the inner bore may be constricted (kinked). Kinking weakens the tubing walls, restricts water flow, and creates back pressure. Components down-line from the restriction do not receive full water volume, and the tubing may fracture at the bend point.

Freehand bending of UHP tubing is strongly discouraged. Jet Edge tools are specifically designed to safely bend the tubing to the minimum recommended radius. UHP tubing should always be covered with flexible metal shielding (conduit) to protect personnel in case of tubing fractures.

Recommended Minimum Bend Radius

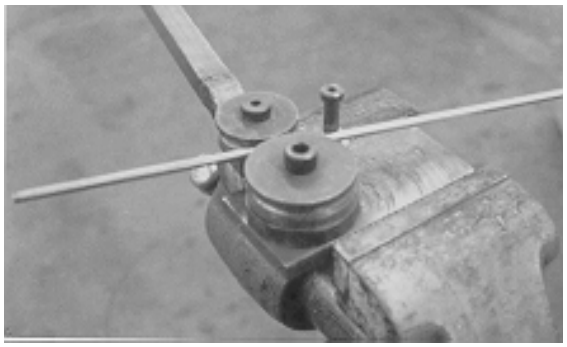
Tubing	Thread	Minimum Radius
1/4 Inch	5/8 Inch	1.25 Inch
3/8 Inch	3/4 Inch	1.75 Inch
9/16 Inch	1 Inch	2.62 Inch

Required equipment

- See “Tools” on page 4, select tubing tools by tubing size

Procedure

1. Clamp the base of the bending tool in a vise.
2. Determine where the center of the bend radius should be and mark the tubing with grease pencil or chalk.
3. Insert the tubing into the tool between the mandrel wheels and the vertical stud so the mark is approximately between the wheels.



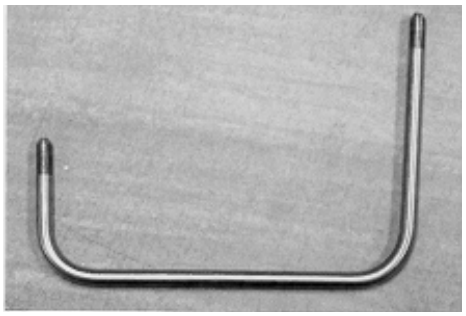
Tubing in Bending Tool

⚠ CAUTION

If tubing is bent incorrectly, it cannot be straightened or re-bent.

Observe the bending operation carefully. Proceed slowly and ensure the tubing is bent to the proper radius.

4. Rotate the handle on its pivot until the tubing is bent to the desired radius. Form the curve using short strokes of the lever. Adjust the tubing as required to put the bend in the proper location.
5. If a large radius is desired, bend only partially, then slide the tubing further through the mandrel wheels. Add to the arc in short segments until the desired curvature is achieved.
6. Remove the tubing from the tool and check for proper angle and run. Repeat for each bend as required until the tubing is properly shaped for installation.



Example of Formed Tubing

7. Blow low-pressure air through the tubing to remove loose scale.

Note *Scale in the tubing bore may peel off and be expelled during the first few hours of operation. This is normal and should be expected.*

Installation

For proper machine performance, UHP tubing gland nuts should be torqued when connecting tubing after repairs have been performed:

Note *It is the experience at Jet Edge that for the 55ksi connections the lower end of the torque range is ideal, for the 75ksi connections the upper end of the torque range is ideal.*

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UHP Connector Torque Specifications*

Connection Type	Tubing Size	Thread Size	Torque
"M" Type (hose swivel nut and adapter, 36ksi)	A9	9/16-18	25–30 lb•ft
	A12	3/4-16	40–50 lb•ft
	A14	7/8-12	50–60 lb•ft
High Pressure (autoclave type, 55ksi connections)	1/4 inch	9/16-18	10–15 lb•ft
	3/8 inch	3/4-16	20–35 lb•ft
	9/16 inch	1-1/8-12	65–105 lb•ft
High Pressure (autoclave type, 75ksi connections)	1/4 inch	9/16-18	10–20 lb•ft
	3/8 inch	3/4-16	25–40 lb•ft

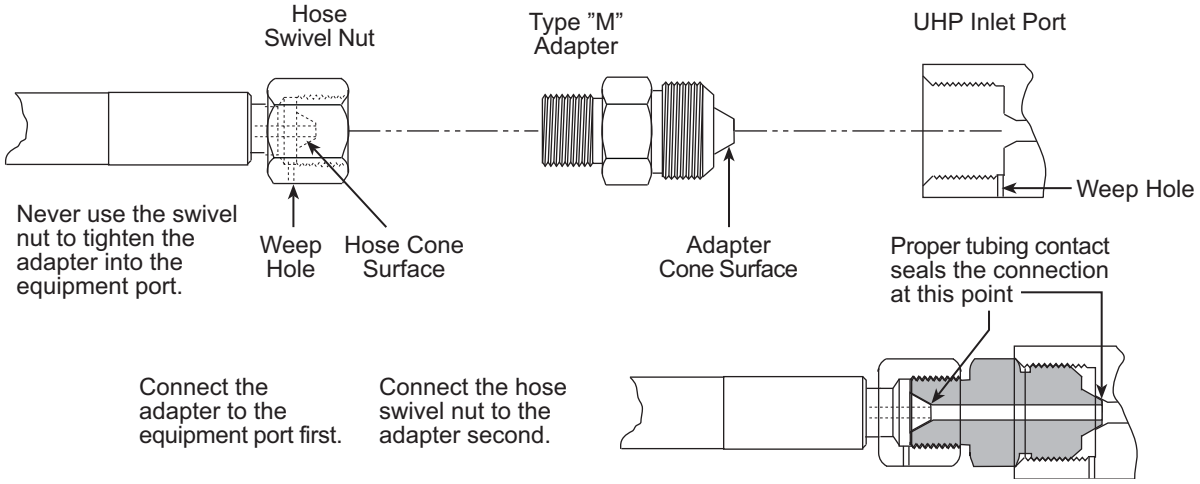
* The torque specifications apply for connectors purchased from Jet Edge.

Flexible metal conduit (safety shielding)

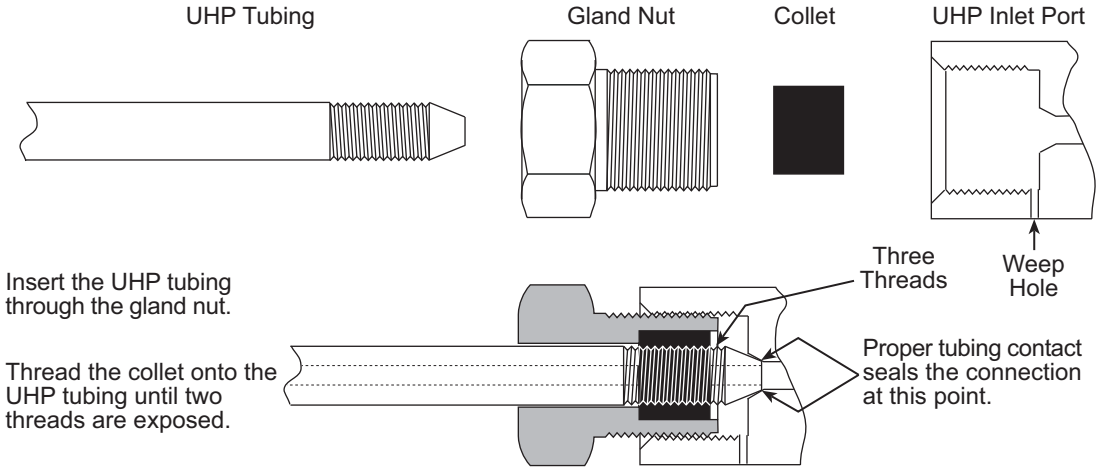
Tubing	Part Number
1/4 Inch	28600
3/8 Inch	25671
9/16 Inch	28601

UHP Water Connections

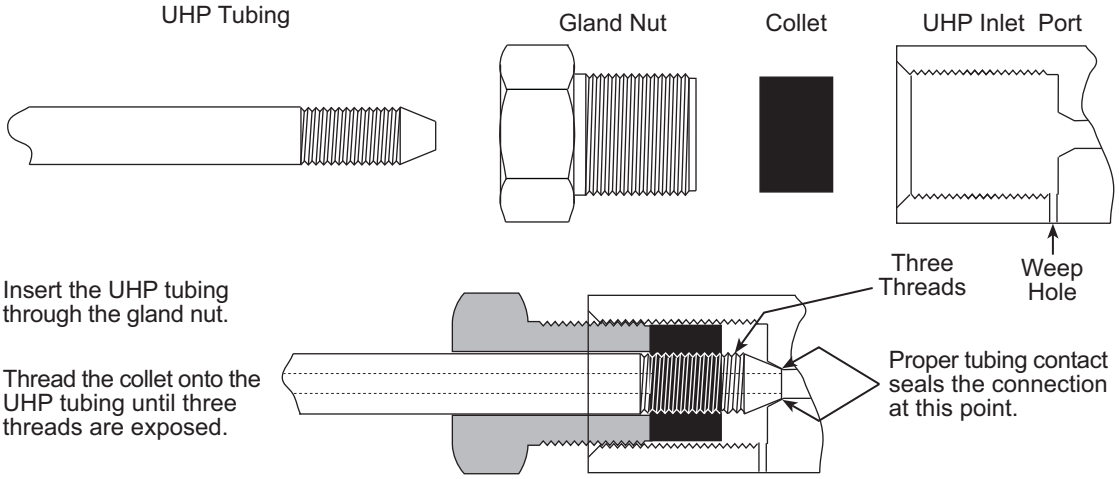
36k Connection



55k Connection



75k Connection



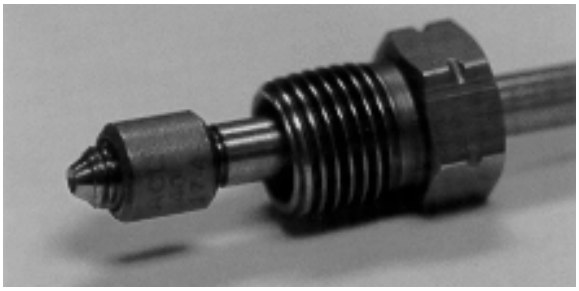
Gland Nut – Collet Connection

Required Equipment

- Precision Lube P/N 25750
- Gland nut & collar assembly

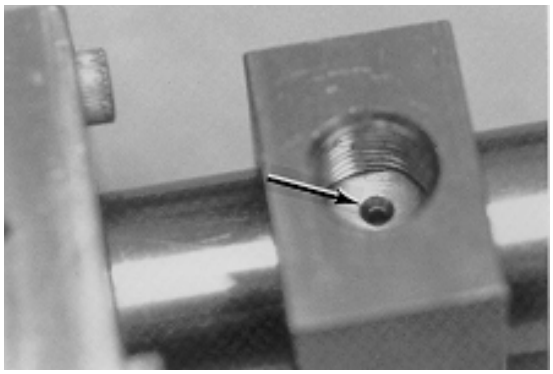
Procedure

1. Slide flexible shielding over the tubing. Slide the gland nut over the tubing, threaded end outward.
2. Apply Precision Lube to the tubing threads. Thread the collet onto the tubing until two full threads of the tubing end are exposed.



Finished Tubing End

Note *When connecting tubing, ensure the tapered tip of the tubing seats properly within the inlet of the component or fitting.*



Tubing Inlet Alignment

3. Apply Precision Lube to the gland nut threads. Insert the tubing into the component it is to be connected to and tighten the gland nut securely. To ensure proper connection, use a suitably sized crow foot and torque wrench to tighten the gland.
4. On tubing runs greater than six feet (two meters) clamp the tubing to a bulkhead or other rigid support. Vibration caused by water pulsations can fracture the tubing, especially at connection points.
5. Disconnect the water delivery line from the tool. Start the intensifier at low water pressure (not more than 5000 psi/345 bar). Permit water to flow through the system for several minutes to clean the lines. Clear as much debris as possible before connecting the water tool.
6. Turn the UHP pump off.

Troubleshoot Leaking Connections

Leakage at the Type “M” adapter to the equipment port weep hole

A. Reduce the UHP water to zero pressure.

B. Loosen the hose swivel nut.

C. Tighten the adapter nut to the equipment port.

D. Re-tighten the swivel nut.

E. Torque the connections according to the table “UHP Connector Torque Specifications” on page 10.

Leakage at the swivel nut weep hole

A. Reduce the UHP water to zero pressure.

B. Unscrew the hose swivel nut.and check the hose cone surface and the mating surface in the adapter.

   If either surface is damaged, replace the part.

   If the surfaces are not damaged, re-connect the swivel nut to the adapter.

C. Torque the connection according to the table “UHP Connector Torque Specifications” on page 10.

Leakage at the autoclave connection to the equipment port weep hole

A. Reduce the UHP water to zero pressure.

B. Unscrew the gland nut.

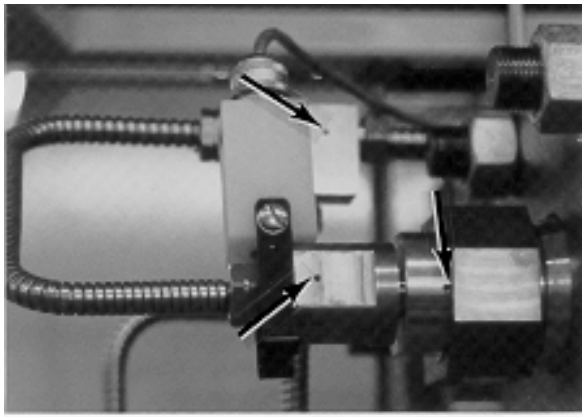
C. Check that the collet is threaded onto the tube nipple far enough to have at least two threads exposed.

D. Re-tighten the gland nut.

E. Torque the connections according to the table “UHP Connector Torque Specifications” on page 10.

Inspection

1. Connect the water tool and restart the machine at low pressure. Gradually increase flow in 1000 psi (70 bar) stages to full working pressure.
2. Inspect the fittings at each pressure increment. Verify no leakage at connection points. Correct any discrepancies immediately.
3. Inspect components that have weep holes. Water seepage from a weep hole often indicates that the gland is not securely tightened, or the tubing is not properly inserted into the connection point.



Weep Holes

Part Numbers for Tubing and Accessories

This section lists thepart number for various 60 ksi and 100 ksi tubing components.

- 1/4 inch (0.250 in) Diameter tubing: Bulk tubing (part number 25309)
- 3/8 inch (0.375 in) Diameter tubing: Bulk tubing (part number 25127)
- 9/16 inch (0.562 in) Diameter tubing: Bulk tubing (part number 25308)

60 ksi Components

Part Number	Description
26261	Adaptor, 3/8 female x 1/4 female
26218	Adaptor, 3/8 male x 1/4 female
25891	Adaptor, 3/8 to 5 mm hose
28848	Adaptor, 3/8 to 8 mm hose
26257	Adaptor, 9/16 female x 3/8 female
29265	Adaptor, 9/16 female x 3/8 male
25304	Adaptor, 9/16 male x 1/4 female
26225	Adaptor, 9/16 male x 3/8 female
25249	Adaptor, 9/16 to 5 mm hose
28847	Adaptor, 9/16 to 8 mm hose
26243	Bulkhead coupling, 1/4
25667	Bulkhead coupling, 3/8
25303	Bulkhead coupling, 9/16
25571	Coupling, hose to hose, 5 mm
29517	Coupling, hose to hose, 8 mm
29516	Coupling/adaptor, 5 mm hose to 8 mm hose
26249	Cross, 1/4
26256	Cross, 3/8
25310	Cross, 9/16
26239	Elbow, 1/4
26253	Elbow, 3/8
25301	Elbow, 9/16
45543	Filter Assembly, in-line UHP

60 ksi Components

Part Number	Description
27171	Filter Element, replacement for UHP filter (p/n 45543)
25307	Gland collar only, 1/4
25666	Gland collar only, 3/8
26209	Hand shutoff valve, 1/4
27044	Hand shutoff valve, 3/8
26232	Hand shutoff valve, 9/16
27630	Plug, 1/4
27629	Plug, 3/8
27631	Plug, 9/16
26259	Straight coupling, 1/4
25349	Straight coupling, 3/8
25693	Straight coupling, 9/16
26224	Tee, 1/4
25669	Tee, 3/8
25302	Tee, 9/16
30621	Water hose for portable tools, 36K rating, 10 feet
25315	Water hose for portable tools, 36K rating, 50 feet
30556	Water hose for portable tools, 60K rating, 26 feet
30633	Water hose for portable tools, 60K rating, 50 feet
28090	Water pressure gauge, 0 – 80,000 psi

100 ksi Components

Part Number	Description
106011	Adapter, 1/4” female to 3/8” male
105730	Bulkhead coupling, 1/4”
105731	Bulkhead coupling assy, 3/8” (includes gland and collar)
106010	Bulkhead coupling, body, 3/8” (part of 105731)
106013	Bulkhead nut, 3/8”
105790	Collar only, 1/4”

100 ksi Components

Part Number	Description
105789	Collar only, 3/8”
105728	Coupling, 1/4”
105729	Coupling, 3/8”
105726	Cross, 1/4”
105727	Cross, 3/8”
106247	Cross, 3/8”
105722	Elbow, 1/4”
105723	Elbow assy, 3/8” (includes gland and collar)
106008	Elbow, body, 3/8” (part of 105723)
105718	Gland and collar assembly, 1/4”
105719	Gland and collar assembly, 3/8”
105792	Gland only, 1/4”
105791	Gland only, 3/8”
105732	Shutoff valve, hand, 1/4”
105733	Shutoff valve, hand, 3/8”
105812	Nipple, 1/4”
105813	Nipple, 3/8”
105720	Plug, 1/4”
105721	Plug, 3/8”
105724	Tee assy, 1/4” (includes gland and collar)
105725	Tee assy, 3/8” (includes gland and collar)
106009	Tee, body, 3/8” (part of 105725)
105716	Tubing, 1/4”
105717	Tubing, 3/8”