FLUID CONTROLS®

DOUBLE FERRULE TUBE FITTINGS INSTALLATION MANUAL



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SECTION 1

FLUID CONTROLS®
DOUBLE FERRULE TUBE FITTINGS

OVERVIEW

- What is a Double Ferrule Tube Fitting
- Product Range
- Intermix / Interchange with other brands
- Design Assessments / Certifications



Established in 1974, Fluid Controls® offers clients a complete range of instrumentation erection hardware, ranging from instrumentation fittings, valves, manifolds and air headers to DIN pipe clamps, SAE flanges and condensate pots. We also offer clients close coupled instrument hook-ups which are a convenient way of eliminating impulse piping by using sandwich construction valves. As part of our special product range, Fluid Controls® has developed high pressure needle valves, a range of gas valves for turbine applications and block and bleed valves.

Fluid Controls® is a premier supplier to onshore and off-shore oil and gas installations, process and power plants and railways in India. We have over 25 years of manufacturing experience for overseas clients and export 30% of our turnover to clients in the USA, Europe, Middle East and South East Asia. In India, we are approved by all leading clients, including ONGC (offshore/onshore), NTPC, NPCIL, BHEL, GAIL, SAIL, RINL.

Headquartered in Mumbai, the group has manufacturing facilities in Pune and Goa. At our Pune facility, we have a state of the art R&D centre which offers clients customized solutions based on analytical formulations, 2D and 3D Modelling and Finite Element Analysis.

We are systems certified with ISO 9001:2015, ISO 14001, ISO 18001, and PED. Our product performance certifications include ASTM F1387-99 (2012), ISO 19879 (ISO 8434), NGV, American Bureau of Shipping (PDA), MSS-SP-99, Ball Valve certification as per API 607 and Fugitive Emission certification for valves.







What is a Double Ferrule Tube Fitting

The Fluid Controls® Double Ferrule Tube Fitting is a four piece fitting consisting of the Nut, the Back Ferrule, the Front Ferrule and the Body. When installed, it becomes a five piece connection with the addition of the tubing and provides a solid leak-free joint.

The secret behind the success of the Fluid Controls® Double Ferrule Tube Fitting lies in the two ferrule design which is a combination of geometry and metallurgy. All the action in the fitting is by an axial movement along the tube (instead of a rotary motion) to create the joint. This axial movement prevents any torque transmittal from the fitting to the tubing. Since there is no initial strain on the tubing, the making of the joint does not weaken the tubing.

Exhaustive tests have proven that the tubing will yield before a Fluid Controls ® Double Ferrule joint starts leaking.



Standards & Performance

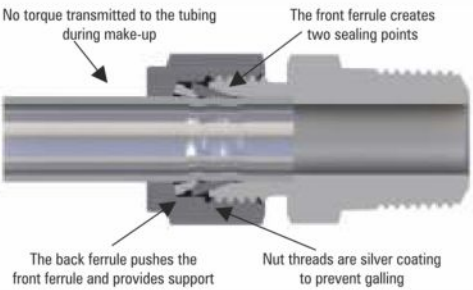
Design Standards

Unlike ANSI, SAE, DIN fittings, There are no design standards for double ferrule fittings. Fluid Controls® double ferrule fittings have been designed in-house by our dynamic R&D team

Performance Standards

ASTM F1387-99 (reapproved 2012) specifies the performance standards to which double ferrule fittings perform. Fluid Controls® is certified for compliance to the Mandatory and Supplementary requirements of this standard

Multiple Sealing Points :
A Leak Proof Joint



Product Range



Front & Back Ferrule
Fractional & Metric Tube



Coupling Cap
Fractional & Metric Tube



Tube End Closure
Fractional & Metric Tube



Bulkhead Union
Fractional & Metric Tube



Bulkhead Reducing Union
Fractional & Metric Tube



Union Elbow
Fractional & Metric Tube



Cross
Fractional & Metric Tubes



Male Connector
Fractional & Metric Tube to
NPT thread & ISO tapered pipe thread



Male Connector
Fractional & Metric Tube to
ISO parallel thread - Rp



Male Elbow
Fractional & Metric Tube to
NPT thread & ISO tapered pipe thread



45 Dgree Male Elbow
Fractional & Metric Tube to
NPT parallel thread



45 Deg. Positionable Male Elbow
Fractional & Metric Tube to
NPT parallel thread



Positionable Male Run Tee
Fractional & Metric Tube to ISO
parallel thread SAE / MS straight thread



Positionable Male Branch Tee
Fractional & Metric Tube to ISO
parallel thread SAE /MS straight thread



Female Connector
Fractional & Metric Tube to
NPT thread & ISO tapered pipe thread



Female Run Tee
Fractional & Metric Tube to NPT thread



Female Branch Tee
Fractional & Metric Tube to NPT thread



Butt Weld Pipe Connector
Fractional & Metric Tube to pipe



Reducing Union Tee
Fractional & Metric Tube



Bulk Head Male Connector
Fractional & Metric Tube to NPT thread



Male Branch Tee
Fractional & Metric Tube to NPT thread

Product Range



Fitting End Closure
Fractional & Metric Tube



Union
Fractional & Metric Tube



Reducer
Fractional & Metric Tube



Bulkhead Elbow
Fractional & Metric Tube



Union Tee
Fractional & Metric Tube



Bulkhead Reducer
Fractional & Metric Tube



Male Connector
Fractional & Metric Tube to
ISO parallel thread - Rs



O Seal Male Connector
Fractional & Metric Tube to
ISO parallel thread & straight thread-UNF



Male Adapter
Fractional & Metric Tube to
NPT thread & ISO tapered pipe thread



Positionable Male Elbow
Fractional & Metric Tube to
ISO parallel thread
SAE / MS straight thread



Male Run Tee
Fractional & Metric Tube to NPT thread



Male Adapter
Fractional & Metric Tube to
ISO parallel thread



Female Manometer Connector
Fractional & Metric Tube to
ISO parallel thread (gauge)



Bulkhead Female Connector
Fractional & Metric Tube to NPT thread



O Seal Male Adapter
Fractional Tube to
Male Straight Thread



Butt Weld Pipe Elbow
Fractional Tube to pipe



Socket Weld Tube Connector
Fractional & Metric Tube to Tube



Reducing Union
Fractional & Metric Tube



Socket Weld Tube Elbow
Fractional & Metric Tube to tube



Female Adapter
Fractional & Metric Tube to
NPT thread & ISO tapered pipe thread



Female Manometer Adapter
Fractional & Metric Tube to
ISO parallel thread (gauge)

Intermix and Interchange with Other Brands

Fluid Controls® Double Ferrule Tube Fittings are engineered to close tolerances and each Fluid Controls® Fitting components is designed to work in conjunction with the other.

The unique design of each component ensures that Fluid Controls® Double Ferrule Tube Fittings provide leak proof seals which provide high performance for pressure, vibration, temperature, vacuum, gas and other applications.

Fluid Controls® does not recommend intermix and/or interchange of components with those of other brand/manufacturers.



Design Assessments and Certifications*

ASTM F1387-99 (2012) for "Standard Specification for Performance of Piping and Tubing Mechanically Attached Fittings"

- **ASTM F1387-99 (2012) Mandatory Tests :**
  Performance Test, Examination of Specimen, Pneumatic Proof Test, Hydrostatic Proof Test, Impulse test, Flexure Fatigue Test, Tensile Test, Burst Test, Repeat Assembly Test, Rotary Flexure Test

- **ASTM F1387-99 (2012) Supplementary Tests :**
  Thermal Cycling Test, Stress Corrosion Test, Vibration Test, Fire Test, Elevated Temperature Test, Torsion Test

American Bureau of Shipping

Certificate of Design Assessment (PDA) for Tube Fittings

Certification for CNG Application

- ANSI NGV 3.1-2012 CSA 12.3-2012 Fuel System Components for Compressed Natural Gas Powered Vehicles
- ECE R110
- ISO 15500

Helium Leak Test to 10-11 Std.cc/Sec

BS EN 61373 : Vibration Test

ISO 19879 : Vibration Test

ISO 19879 : Cyclic Endurance (Impulse) Test with Vibration

IEC 60068-2-52 : Salt Mist Test

*Certificate Copies Available on Request

SECTION 2

FLUID CONTROLS®
DOUBLE FERRULE TUBE FITTINGS

INSTALLATION GUIDE

- Overview
- Safety Instructions
- Installation up to Sizes 1" / 25mm
- Installation for Sizes 1" / 25mm and above
- Gap Inspection and Gauges
- Re-assembly of Double Ferrule Tube Fittings
- Pre-Swaging & Tools for Sizes Up To 1" / 25mm

Overview

Fluid Controls® Double Ferrule Tube Fittings are easy to install. They are reusable several times and can withstand heavy impulse, vibration vacuum and pressure systems.

The installation procedure should be carefully followed to ensure optimal performance of the system.

Installation Process : A Snapshot

- Fluid Controls® Double Ferrule Tube Fittings up to 1" / 25mm can be installed by hand
- Sizes above 1" / 25mm should be installed using the Fluid Controls® Hydraulic Swaging Unit (HSU)
- Fluid Controls® recommends that, for ease of installation, the HSU be used for sizes above ½" and 12mm as well

Note : For Installation of double ferrule fittings on non-metallic tubing, a special insert is required which will be made from the same material as the fitting. It is essential to use the insert for proper installation and to ensure a leak-free joint. Fluid Controls® provides these inserts for brass and stainless steel fitting installations on non-metallic tubing. Please contact us for more information or and insert supplies.

Safety Instructions & Symbols

When the system is pressurized, do not tighten or loosen any part of the fitting. Ensure the system is depressurized before attempting to do so.

Pressure-temperature specification as stated in the Fluid Controls® catalogue must not be exceeded.

When the tube is bent, ensure that the portion of the tube between the tube bend and fitting is sufficiently straight. This guarantees a leaf-proof joint.

When assembling the Fluid Controls® Double Ferrule Tube Fitting, hold the fitting body with a wrench. Use a separate wrench for tightening the nut. The same procedure should be used for disassembling the fitting.

When assembling a Fluid Controls® Double Ferrule Tube Fitting to soft and pliable plastic tubing, ensure that a tube insert is used along with the fitting.

Taper threads should be torqued in accordance with industry standards. When retightening a Fluid Controls® fitting, note that additional tightening may be required.



WARNING,EYE PROTECTION : Safety glasses must be worn when setting up and operating the Swaging Machine.



CAUTION TAMPER : Do not tamper with or alter any components of the machine.



CAUTION DAMAGE : Symbol that identify condition or practices that could result in damage to the equipment or other property.



WARNING, FLUID LEAKAGE : Do not use machine and return the machine to your authorized Fluid Controls® representative if any signs of excessive fluid leakage or a malfunction occurs.



WARNING : Identifies conditions or practices that could result in personal injury or loss of life.



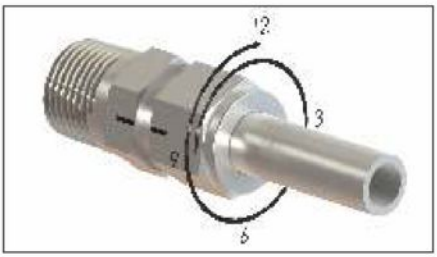
WARNING /CAUTION : Do not use the hand pump after the indicator knob releases. Failure to stop pumping after the indicator knob releases may affect fitting performance

Fluid Controls® Double Ferrule Tube Fittings up to 1" / 25mm*

Step 1
Insert the tubing into the Fluid Controls® Double Ferrule Tube Fitting and make sure the tubing rests firmly on the shoulder of the fitting. Tighten the nut so that tube will not rotate by hand or move axially in the fitting and achieve snug tight position of nut.



Step 2
Before tightening the nut, scribe the nut at the 9 o'clock position.



Step 3
While holding the fitting body steady with a backup wrench, tighten the nut one-and-one-quarter turns.
To do this, view the mark and make one complete revolution. Then continue to the 12 o'clock position.**



Note :
* Manual swaging can be done for all sizes up to 1" / 25mm. However Fluid Controls® recommends that pre-swaging be done by the Fluid Controls® Hydraulic Swaging Unit for sizes above ½" and 12mm.
** 1/8", 3/16", 3 mm and 4 mm sizes only require to be tightened 3/4th of a turn i.e. to the 6 o'Clock position.

CAUTION: Do not turn the fitting instead of the nut. It might cause scratches on the sealing surface and could cause leakages

Fluid Controls® Double Ferrule Tube Fittings over 1" / 25mm

The Fluid Controls® Hydraulic Swaging Unit (HSU) pre-swages 1/2 inch to 2 inch. and 12 mm to 42 mm Fluid Controls® ferrules onto carbon steel and stainless steel tubing.

By using the HSU, make-up torque is significantly reduced. It also prevents thread damage, galling and deformation of components.

It is essential to use the HSU for sizes 1" / 25mm and above.

Fluid Controls® strongly recommends that pre-swaging be done by the Hydraulic Swaging Unit for sizes above ½" and 12mm

Please refer to the section on *Fluid Controls® Hydraulic Swaging Unit* for detailed instructions on using the Fluid Controls® HSU



Fluid Controls® Double Ferrule Tube Fittings over 1" / 25mm

1 Pre-Swage the assembly using the Hydraulic Swaging Unit. When completed, remove the pre-swaged assembly from the HSU.

2 For Double Ferrule Tube Fittings over 1 in. or 25 mm it is recommended that lubricant must be applied during final installing. If packet of lubricant is provided with fitting, apply lubricant on fitting body threads. Apply a similar amount of lubricant to the rear surface of the back ferrule.


Fig.1

Installing Pre-Swaged Assembly into Fitting Body

3. Install the pre-swaged assembly into the fitting body. Turn the nut onto the fitting body until it is finger-tight.

4. Scribe the nut at the 9 o'clock position, While holding the fitting body steady with a wrench, tighten the nut one half turn.

5 The swaging operation is complete.

6. To ensure that the fitting has been sufficiently tightened, please use the Fluid Controls® Gap Inspection Gauge (Refer to section on Gap Gauges)


Fig.2

Fitting the Pre-Swaged Assembly into Fitting Body

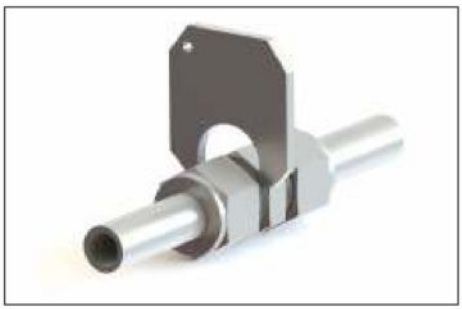
Gap Inspection

Fluid Controls® Gap Inspection Gauges ensure that the swaging operation is correctly done. This is particularly important for manual swaging operations and when fitting are installed in difficult or inaccessible locations .

Only use the Gap Inspection Gauge on the first installation of the fitting

If the Gap Inspection Gauge does not insert between the nut and the body hex, the fitting has been sufficiently tightened.

If the Inspection Gauge fits between the nut and the body hex, the fitting has NOT been sufficiently tightened. In this case, tighten the nut until the Gap Inspection Gauge does not fit between the nut and the body hex.



No Go Sufficiently tightened



Go Insufficiently tightened

CAUTION: If you are Re-Assembling or Pre-Swaging, please do not use the Gap Inspection Gauge.

Re-assembly

Fluid Controls® Double Ferrule Tube Fittings are designed to be assembled and re-assembled numerous times. The same reliable, leak-proof sealing can be obtained every time the connection is made.

Step 1
Before disassembling the fitting, mark the tube at the back of the nut and mark a line along the nut and fitting body flats. These marks will help to ensure that you return the nut to the previously pulled-up position.

Step 2
Insert the tubing with Pre-Swaged ferrules into the fitting body until the front ferrule sits against the fitting body. Apply lubricant to the body threads and the rear surface of the back ferrule, if required.

Step 3
Rotate the nut with a wrench to the previously pulled-up position, as indicated by the marks on the tube and flats.

Step 4
At this point, there will be significant rise in resistance to tighten the nut. Further tighten the nut slightly.



CAUTION :
- Please ensure the tubing system is depressurized before disconnecting the Fluid Controls® fitting for reassembly
- The Gap Inspection Gauge is accurate ONLY for initial fitting pull-up. When the fitting is re-assembled, do not use the Gap Inspection Gauge.

Pre-Swaging & Tools Upto 1" / 25mm

When Fluid Controls® Double Ferrule Fittings are to be installed in cramped quarters or overhead, it may be advisable to use a Fluid Controls® Pre-Setting Tool to pre-swage the ferrules onto the tubing in an open ground area.

Step 1
Insert the Fluid Controls® nut and ferrules into the Pre-Setting Tool. Insert the tubing through the ferrules until it bottoms out in the pre-swaging tool.



Step 2
Tighten the nut so that tube will not rotate by hand or move axially in the fitting to achieve snug tight position of nut.



Step 3
Before tightening the Fluid Controls® nut, scribe the nut at the 9 o'clock position.

Step 4
Hold the Pre-Setting Tool in a vise. Tighten the nut one-and-one-quarter turns. Watch the scribe mark and make one complete revolution. Then continue turning to the 12 o'clock position.



Step 5
Remove the nut & pre-swaged ferrules from the Pre-Setting Tool. Connect the assembly into the fitting body according to the re-assembly procedure.



SECTION 3

FLUID CONTROLS ®
DOUBLE FERRULE TUBE FITTINGS

GUIDE TO USING THE HYDRAULIC SWAGING UNIT (HSU)

- Overview
- Parts & Identification
- Setup of HSU
- Operating the HSU
- Installing the Pre-Swaged Assembly
- Restrictions on Use of the HSU
- Troubleshooting
- Storage Guidelines

Fluid Controls® Hydraulic Swaging Unit (HSM - 1A)

The Fluid Controls® Hydraulic Swaging Unit pre-swages ferrule sizes above 1/2 inch upto 2 inch and above 12 mm upto 42 mm. This pre-swaging is for carbon steel and stainless steel tubing.

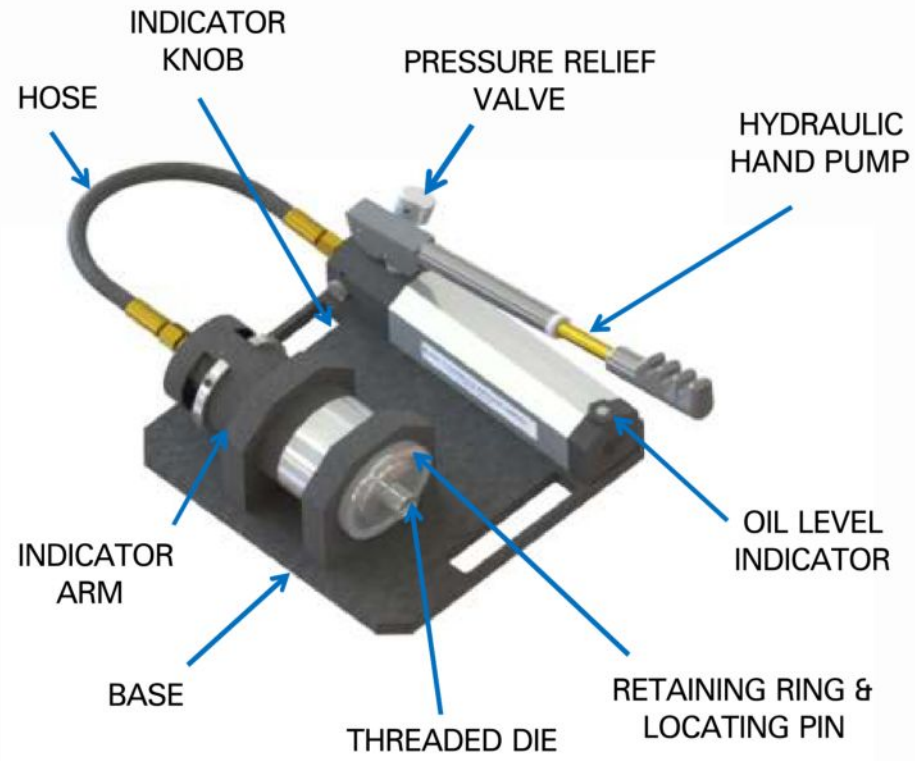
SALIENT FEATURES:

- Rigid design for shop floor use
- Unique feature of double locking arrangement:
  - — Tightening to Snug-fit: tube stops rotating after initial tightening and
  - — Installation Post Snug-fit i.e. 3/4 turn rotation

  This combined feature ensures swaging with less effort
- Snug-Fit and Post-Snug-Fit feature aids in better installation and reduces operator error.
- Light weight and portable.
- Available for fractional and metric Fluid Controls® Double Ferrule Fitting sizes above ½" or 12mm OD
- One year warranty with free training for first time buyers



Parts and Identification



SAFETY GUIDELINES:

This is a hydraulic operated unit. Follow the safety instructions of Hydraulic Pump before operating this unit. Fluid Controls® is not responsible for any damage to product/property or human during operation.

Fluid Controls® is not responsible for any personal injury or damage resulting from unsafe product use, lack of product maintenance, or incorrect product and/or system operation. Wear Personal Protective Equipment (PPE) when operating or working near the HSM.

Setup and Operating Procedure

Swaging Die Setup

1. Select the appropriate hydraulic swaging die (HSD)
2. Insert the HSD into the Die Holding Chuck by aligning the key slot provided on the die. Using the screw provided, lock out the HSD into the chuck
3. Using the provided circlip, lock out the HSD into the chuck

Operating Procedure





1. Place the Fluid Controls® Nut and ferrules on the tubing** in the right direction and sequence i.e. Front Ferrule first, then Back Ferrule and then the Nut
2. Hand-tighten the Nut onto the HSD so that the tube bottoms out
3. Press the Snug and Swage knob
4. Close the Operation Valve gently until it locks out i.e. the valve handle stops rotating
5. Start pumping the handle gently, until the first Pip-out sound is heard from the Snug and Swage knob. This means Snug Fit is achieved i.e. the tube stops rotating
6. Keep pumping the handle gently till the second Pip-out comes out of the Snug and Swage knob. This means the ¾ turn swaging has occurred
7. Gently open the Operation Valve
8. Completely untighten the Nut from the HSD, and take out the assembly with both the ferrules swaged on the tube
9. This assembly is now ready to be used at the appropriate location to ensure a leak-free joint









* Tube end preparation shall be done appropriately, please refer to the Fluid Controls® catalogue for tube preparation details

Installing the Pre-Swaged Assembly

1. Remove the pre-swaged assembly from the Hydraulic Swaging Unit

2. For Double Ferrule Tube Fittings over 1 inch or 25 mm it is recommended that lubricant must be applied during final installing. If pocket of lubricant is provided with fitting, apply lubricant on fitting body threads. Apply a similar amount of lubricant to the rear surface of the back ferrule.

3. Install the pre-swaged assembly into the fitting body. Turn the nut onto the fitting body until it is finger-tight

4. Scribe the nut at the 9 o'clock position, While holding the fitting body steady with a wrench, tighten the nut one half turn

5. The swaging operation is complete

6. To ensure that the fitting has been sufficiently tightened, please us the Fluid Controls® Gap Inspection Gauge (Refer to section on Gap Gauges)



Fig.1

Installing Pre-Swaged Assembly into Fitting Body



Fig.2

Fitting the Pre-Swaged Assembly into Fitting Body

Troubleshooting

1. If after the swaging operation, the tubing is hard to remove from the die, gently rock the tubing back and forth to dis-engage it

2. If the oil level decreases, the swaging unit would not work properly. Please check the oil level using a pressure gauge

3. If oil leaks out of the hydraulic cylinder, please contact Fluid Controls® at services@fluidcontrols.com immediately

Storage Guidelines

1. Clean all components after every usage

2. Unscrew the die from the chuck before storing

3. Store all the components in the case provided

4. We recommend that the storage case with machine be kept in a horizontal position when not in use

SECTION 4

FLUID CONTROLS®
DOUBLE FERRULE TUBE FITTINGS

GUIDE TO TUBING

- Tube Selection
- Tube Handling
- Tube Preparation
- Tubing Installation
- Tubing Data Chart : Stainless Steel Fractional
- Tubing Data Chart : Stainless Steel Metric
- Tubing Data Chart : Carbon Steel Fractional & Metric
- Tubing Data Chart : Copper Fractional & Metric
- Tubing Data Chart : Monel Fractional & Metric
- Ordering Information

Tube Selection

Proper selection, handling and installation of tubing is essential to reliable tubing systems.

Guide to Tube Selection

- Tubes shall be reasonably straight
- Tubes shall be annealed
- Tubes shall have no ovality
- Tubes shall have smooth ends free from burrs
- Tube surface finish is required to be smooth and free from any scratches, axial or circumferential which will allow leakage paths along the joints
- Tubes must always be softer than the fitting material by using the suggested hardness of the tubes. Best results are obtained where the stainless steel tubing hardness is in the range of RB 70-74.
- For tubing hardness exceeding RB 90, special fittings need to be ordered

Tubing for Gas Service

For the greatest safety factor against surface defects in any gas system it is recommended that the wall thickness employed be not less than that shown in the table

Tube O.D	Suggested Minimum Wall Thickness	Tube O.D	Suggested Minimum Wall Thickness
1/16"	.028"	3/4"	.062"
1/8"	.028"	7/8"(20mm)	.073"
1/4"(6mm)	.028"	1"(25mm)	.083"
5/16"(8mm)	.035"	1-1/4"	.104"
3/8"(10mm)	.035"	1-1/2"	.125"
1/2"(12mm)	.041"	2"	.167"
5/8"(16mm)	.052"		

Light gases such as helium, hydrogen, nitrogen have very small molecules which can escape through even the minutest leak path created by surface defect on the tubing. As the tube OD increases, so does the likelihood of a scratch or other surface defect interfering with proper sealing.

The most successful connection for gas service will occur if all the installation instructions are carefully followed and the heavier permissible wall thickness of tubing are selected. A heavy wall thickness resist ferrule action more than a thin wall thickness allowing the ferrules to coin out minor surface in perfection. A thin wall tube will collapse offering little resistance to ferrule action during preparation of joints. This reduces the chances of coining out surface defects essential for gas service.

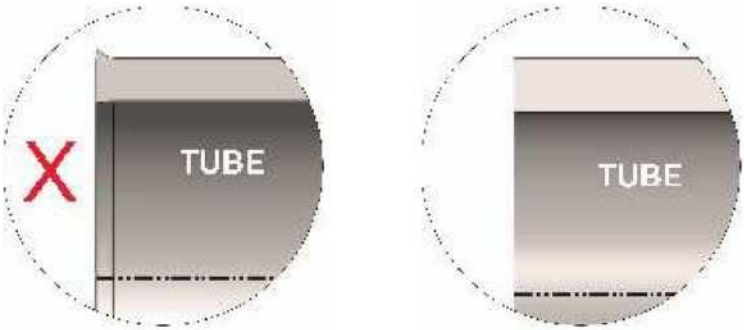
Tube Handling

Proper handling of tubing is essential to reliable tubing systems.

- Tubing should never be dragged out of a tubing rack.
- Tubing should never be dragged across cement, asphalt, gravel or any other surface which could scratch the surface and recreate the leakage parts.
- Tube cutters or hacksaws should always be sharp, and you should not try to take too deep a cut with each turn of the cutter or with each back and forth motion of the saw blade.
- Tube ends should always be deburred.

Tube Preparation

1. Tube Cutting :
   Use the appropriate 'Tube Cutter' to cut the tube and secure a 90° Tube end. If not; the tubing could become damaged.



2. **Tube Deburring :**
   Remove the internal / external burrs from the tubing by using a Deburring tool.



External

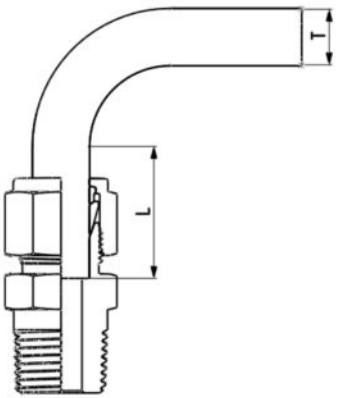


Internal

CAUTION : After Deburring, remove all debris. Do not put fingers inside cutting tool or near cutting edges.

Tube Installation

When fittings are to be installed near tube bends, there has be adequate distance between the fitting installation and the tube. This is to ensure that the tube properly bottoms out in the Fluid Controls fitting



Fractional, in.	
T Tube OD	L
1/16	1/2
1/8	23/32
3/16	3/4
1/4	13/16
5/16	7/8
3/8	15/16
1/2	1 3/16
5/8	1 1/4
3/4	1 1/4
7/8	1 5/16
1	1 1/2
1 1/4	2
1 1/2	2 13/32
2	3 1/4

Metric, mm	
T Tube OD	L
3	19
6	21
8	23
10	25
12	31
14	32
32	32
15	32
16	32
18	32
20	34
22	34
28	46
32	50
38	54
42	75
50	80

TUBING DATA CHARTS

Stainless Steel : Fractional

Tubing Selection

- Annealed 304 or 316 Stainless Steel tubing to ASTM A 269 or A 213 or equivalent based on ultimate tensile strength of 75,000 psi and suitable for temperatures 20°C to 100°C.
- The hardness of these tubes is not to exceed RB 80 and optimal hardness is in the range RB 70 – 74
- Tubes to be suitable for bending and flaring and should be free of surface defects and imperfections

Recommended Wall Thickness (WT) for Tube OD's

All tube have a range of wall thicknesses. When considering the WT to be used for a size, we also have to make sure that the ferrule will swage onto the tube. If the tube is too thick, the ferrule cannot swage.

The implication of this is that for every tube size, there are recommended WT's. We do not recommend using tubes of WT other than these. The ASTM F1387 testing we have conducted has been based on these wall thicknesses. The wall thicknesses we recommend are generally accepted by industry and other manufacturers.

Recommended Wall Thickness for SS tubes (1/4" to 1") :

TUBE OD (INCH)	Tube Wall Thickness SS304/316 HRB <80					
	0.028	0.035	0.049	0.065	0.083	0.095
1/4	Y	Y				
3/8	Y	Y				
1/2		Y	Y			
5/8			Y	Y		
3/4			Y	Y		
1				Y	Y	

FRACTIONAL STAINLESS STEEL SEAMLESS TUBING

Allowable working pressures are calculated from an S value of 20000 psi for ASTM A269 tubing at -20 to 100°F(-28 to 37°C), as listed in ASME B31.3.

TUBE OD (INCH)	TUBE WALL THICKNESS (INCHES)															
	0.010	0.012	0.014	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.12	0.134	0.156	0.188
	WORKING PRESSURE (PSIG)															
1/16	6068	7466	8937	10484	13835											
1/8	2857	3471	4100	4744	6079	8953	11721	18118								
3/16	1865	2258	2657	3062	3891	5630	7246	10777								
1/4	1382	1671	1963	2258	2859	4104	5242	7667	10714							
5/16						3227	4104	5949	8216	10998						
3/8						2824	3585	5175	7111	9458						
1/2						2085	2638	3780	5146	6769						
5/8						1651	2085	2976	4031	5270	6128					
3/4						1366	1723	2453	3312	4313	5001	5827				
7/8						1164	1468	2086	2810	3650	4224	4911				
1						1014	1278	1813	2440	3163	3656	4243	4713			
1 1/8						897	1131	1604	2155	2790	3221	3734	4144			
1 1/4							1014	1437	1930	2495	2879	3334	3697	4167	4921	
1 1/2								1189	1595	2059	2374	2745	3040	3421	4031	4943
2									1183	1525	1755	2027	2242	2519	2960	3614

Notes :
The RB 80 maximum hardness is a suggestion and not a restriction against the use of Fluid Controls Double Ferrule Fitting in stainless steel to increase the performance of the fitting. However, if the tubing hardness exceeds RB 90, special fittings need to be ordered.

Stainless Steel : Metric

Tubing Selection

- Annealed 304 or 316 Stainless Steel tubing to ASTM A 269 or A 213 or equivalent based on ultimate strength of 75,000 psi and suitable for temperatures 20°C to 100°C.
- The hardness of these tubes is not to exceed RB 80 and optimal hardness is in the range RB 70 – 74
- Tubes to be suitable for bending and flaring and should be free of surface defects and imperfections

Recommended Wall Thickness (WT) for Tube OD's

All tube have a range of wall thicknesses. When considering the WT to be used for a size, we also have to make sure that the ferrule will swage onto the tube. If the tube is too thick, the ferrule cannot swage.

The implication of this is that for every tube size, there are recommended WT's. We do not recommend using tubes of WT other than these. The ASTM F1387 testing we have conducted has been based on these wall thicknesses. The wall thicknesses we recommend are generally accepted by industry and other manufacturers.

Recommended Wall Thickness for SS tubes (3mm to 30mm) :

TUBE OD (mm)	Tube Wall Thickness SS304/316 HRB <80								
	0.8	1	1.2	1.5	1.8	2	2.2	2.5	2.83
3	Y	Y							
6		Y	Y						
8		Y	Y						
10		Y	Y						
12			Y	Y					
14			Y	Y					
15			Y	Y					
16			Y	Y					
18				Y	Y				
20					Y	Y			
22					Y	Y			
25							Y	Y	
28							Y	Y	
30							Y	Y	

METRIC STAINLESS STEEL SEAMLESS TUBING

Allowable working pressure are calculated from an S value of 20000 psi for EN ISO 1127 tubing
(D4, T4 tolerance for 3 to 12 mm; D4, T3 tolerance for 14 to 50 mm) at -20 to 100°F(-28 to 37°C), as listed in ASME B31.3

TUBE OD (INCH)	TUBE WALL THICKNESS (MM)													
	0.8	1	1.2	1.5	1.8	2	2.2	2.5	2.8	3	3.5	4	4.5	5
	WORKING PRESSURE (PSIG)													
03	10063	14035	18569											
4	7248	9927	12869											
6	4645	6258	7970	10742	13793	16003	18187	21750	25705					
8	3415	4568	5770	7678	9720	11164	12563	14785	17172	18863				
10	2699	3595	4521	5972	7502	8570	9593	11197	12890	14072				
12	2231	2963	3715	4885	6108	6953	7758	9010	10316	11220				
14	1900	2519	3153	4133	5150	5849	6512	7536	8599	9329				
15	1769	2343	2931	3837	4775	5418	6027	6966	7937	8603				
16	1654	2190	2738	3581	4451	5047	5610	6477	7371	7982				
18	1464	1937	2419	3158	3919	4438	4927	5678	6449	6975				
20	1313	1736	2166	2824	3500	3960	4392	5054	5732	6193				
22	1190	1572	1960	2553	3160	3572	3960	4551	5155	5566	6620	7714	8851	10034
25	1042	1376	1715	2231	2758	3115	3450	3960	4479	4831	5732	6662	7625	8620
28	927	1223	1524	1981	2446	2761	3056	3504	3960	4268	5054	5863	6696	7555
30	863	1139	1418	1843	2275	2566	2839	3254	3675	3960	4684	5428	6193	6980
32						2397	2651	3037	3429	3693	4365	5054	5761	6486
38						2001	2212	2531	2854	3071	3623	4186	4762	5349
42						1802	1991	2277	2566	2761	3254	3756	4268	4789
50						1503	1659	1896	2136	2296	2702	3115	3534	3960

Copper : Fractional & Metric

Tubing Selection

- Annealed, soft, seamless copper tubing to ASTM B 75 or ASTM B 88 based on an ultimate tensile strength of 30,000 psi and for a temperature in the range of 20°C to 80°C
- Maximum hardness of the tube not to exceed RB 50. Tubes preferably in the range RB 40-45.
- Copper tubing to be used only with Copper, Brass and Copper Alloy Fittings

Recommended wall thickness for Copper Fractional Tubes (1/4" to 1 1/2")

TUBE OD (INCH)	TUBE WALL THICKNESS (INCHES)							
	0.035	0.049	0.065	0.083	0.095	0.109	0.12	0.134
1/4	Y	Y						
3/8	Y	Y						
1/2		Y	Y					
5/8		Y	Y					
3/4			Y	Y				
1				Y	Y			
1 1/4				Y	Y			
1 1/2					Y	Y		

Recommended wall thickness for Copper Metric Tubes (6mm to 38mm)

TUBE OD (INCH)	TUBE WALL THICKNESS (INCHES)							
	1	1.2	1.5	1.8	2	2.5	2.8	2.8
6	Y	Y						
8	Y	Y	Y					
10		Y	Y					
12		Y	Y					
15			Y	Y				
18				Y	Y			
22					Y	Y		
28						Y	Y	
38							Y	Y

FRACTIONAL COPPER SEAMLESS TUBING

Allowable working pressures are calculated from an S value of 6000 psi for ASTM B75 & ASTM B88 tubing at -20 to 100°F (-28 to 37°C), as listed in ASME B31.3

TUBE OD (INCH)	TUBE WALL THICKNESS (INCHES)															
	0.010	0.012	0.014	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.12	0.134	0.156	0.188
	WORKING PRESSURE (PSIG)															
1/16	1638	2109	2608	3137	3993											
1/8	781	994	1212	1436	1784	2789	3772	6105	9598							
3/16	578	716	856	999	1219	1795	2328	3600	5245	7491						
1/4	426	528	631	735	894	1307	1681	2550	3624	5006						
5/16						1026	1314	1973	2767	3758						
3/8							1078	1608	2237	3006						
1/2							791	1172	1615	2146						
5/8								921	1263	1667	1956					
3/4								748	1026	1342	1572	1850				
7/8								634	869	1134	1326	1556				
1								550	753	981	1146	1343	1486			
1 1/8									664	864	1008	1180	1305	1483		
1 1/4									593	771	900	1052	1163	1320	1574	
1 1/2										635	740	864	954	1082	1287	1594
2										473	548	637	701	793	941	1161

METRIC COPPER SEAMLESS TUBING

TUBE OD (INCH)	TUBE WALL THICKNESS (MM)													
	0.8	1	1.2	1.5	1.8	2	2.2	2.5	2.8	3	3.5	4	4.5	5
	WORKING PRESSURE (PSIG)													
3	3478	4756	6225											
4	2553	3317	4247											
6	1612	2063	2593	3453	4368	5054	5752	6959	8314					
8	1176	1495	1864	2450	3056	3500	3941	4684	5486	6059				
10	924	1171	1454	1897	2349	2675	2996	3528	4092	4487				
12	760	961	1190	1547	1906	2164	2415	2828	3261	3562				
14	645	815	1007	1305	1603	1816	2022	2360	2710	2952				
15	599	757	935	1210	1485	1680	1870	2179	2499	2719				
16	560	706	872	1128	1383	1564	1739	2024	2318	2520				
18	494	615	761	985	1207	1364	1508	1753	2006	2179				
20	441	550	680	879	1076	1215	1342	1558	1780	1932				
22	399	497	614	794	971	1095	1209	1402	1600	1735	2060	2419	2757	3147
25	349	434	536	692	846	954	1052	1219	1389	1504	1782	2087	2372	2700
28						844	930	1076	1225	1326	1568	1833	2079	2362
30						784	864	999	1137	1230	1452	1696	1922	2180
32						731	806	932	1060	1146	1353	1578	1787	2025
38						609	671	775	880	951	1121	1305	1475	1668
42						549	603	696	791	854	1006	1170	1321	1492
50						460	505	581	657	709	833	968	1092	1231

Carbon Steel : Fractional and Metric

Tubing Selection

- Soft, annealed carbon steel hydraulic tubing to ASTM A179, DIN 2391 or equivalent based on ultimate tensile strength of 47,000 psi and for metal temperatures not to exceed 20°C to 100°C.
- For higher temperature service, reducing factors for elevate temperature operation as specified in table 302.3 1A and 304.1.2 of the code for pressure piping in ANSI B31.3 should be applied.
- The hardness of the tube is recommended at RB 72 or less.
- The tubes should be suitable for bending and flaring and free of all surface defects and imperfections.

Recommended wall thickness for Carbon Steel Fractional Tubes (1/4" to 1 1/2")

TUBE OD (INCH)	TUBE WALL THICKNESS (INCHES)							
	0.035	0.049	0.065	0.083	0.095	0.109	0.12	0.134
1/4	Y	Y						
3/8	Y	Y						
1/2		Y	Y					
5/8		Y	Y					
3/4			Y	Y				
1				Y	Y			
1 1/4				Y	Y			
1 1/2					Y	Y		

Recommended wall thickness for Carbon Steel Metric Tubes (6mm to 38mm)

TUBE OD (INCH)	TUBE WALL THICKNESS (INCHES)							
	1	1.2	1.5	1.8	2	2.5	2.8	2.8
6	Y	Y						
8	Y	Y	Y					
10		Y	Y					
12		Y	Y					
15			Y	Y				
18				Y	Y			
22					Y	Y		
28						Y	Y	
38							Y	Y

FRACTIONAL CARBON STEEL SEAMLESS TUBING

Allowable working pressures are calculated from an S value of 15700 psi for ASTM A179 tubing at -20 to 100°F (-28 to 37°C), as listed in ASME B31.3. For working pressure in accordance with ASMEB31.1, multiply by 0.85

TUBE OD (INCH)	TUBE WALL THICKNESS (INCHES)													
	0.010	0.012	0.014	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.12	0.134
	WORKING PRESSURE (PSIG)													
1/16	5359	6615	7944	9352	12436									
1/8	2582	3143	3719	4311	5546	8238	10873	17131	26513					
3/16	1667	2057	2424	2798	3565	5187	6710	10092	14623					
1/4	1262	1527	1796	2069	2625	3783	4849	7150	10092	13882				
5/16						2975	3795	5535	7704	10409				
3/8						2451	3117	4514	6228	8324				
1/2						1811	2294	3296	4501	5942				
5/8						1435	1814	2594	3523	4618	5380			
3/4						1187	1499	2138	2893	3776	4385	5119		
7/8						1012	1277	1818	2453	3193	3700	4308		
1							1109	1577	2125	2759	3193	3711	4126	
1 1/8								1395	1877	2434	2813	3265	3626	
1 1/4								1250	1681	2176	2513	2914	3234	3648
1 1/2								1034	1389	1796	2071	2398	2658	2994
2									1029	1328	1529	1767	1956	2199

METRIC CARBON STEEL SEAMLESS TUBING

Allowable working pressures are based on equations from ASME B31.3 for DIN 2391 tubing, using a stress value of 16300 psi. For working pressure in accordance with ASMEB31.1, multiply by 0.85

TUBE OD (MM)	TUBE WALL THICKNESS (MM)								
	0.8	1	1.2	1.5	1.8	2	2.2	2.5	2.8
	WORKING PRESSURE (PSIG)								
3	9091	12398	16189						
4	6490	8681	11094						
6	4124	5424	6805	9043	11510	13299	15219	18378	21925
8	3021	3942	4905	6433	8070	9228	10444	12052	14126
10	2382	3095	3833	4990	6211	7063	7948	9102	10564
12	1965	2547	3145	4075	5047	5720	6414	7495	8628
14	1757	2250	2665	3443	4250	4805	5375	6258	7176
15	1634	2092	2559	3195	3939	4449	4972	5780	6618
16	1528	1954	2389	3060	3670	4142	4625	5370	6141
18	1351	1727	2109	2696	3300	3713	4059	4703	5367
20	1211	1546	1887	2409	2945	3310	3616	4183	4765
22	1097	1400	1707	2178	2659	2986	3318	3766	4285
25	960	1225	1493	1902	2320	2603	2890	3327	3722
28	1089	1327	1689	2057	2307	2559	2943	3335	3553
30		1014	1235	1571	1913	2144	2378	2733	3095
32						1960	2177	2506	2840
38						1636	1816	2088	2364
42						1452	1613	1856	2103
50						1211	1344	1546	1750

Monel 400 : Fractional and Metric

Tubing Selection

- Fully annealed Monel 400 seamless tubing conforming ASTM B165 or equivalent and based on ultimate tensile strength of 70,000 psi and for use with temperatures 20°C to 90°C.
- Hardness of the tube must be RB 75 maximum and optimal hardness is in the range RB 68-72.
- These tubes should be suitable for blending and flaring and free from all surface defects and imperfections

Recommended wall thickness for Monel Fractional Tubes (1/4" to 1 1/2")

TUBE OD (INCH)	TUBE WALL THICKNESS (INCHES)							
	0.035	0.049	0.065	0.083	0.095	0.109	0.12	0.134
1/4	Y	Y						
3/8	Y	Y						
1/2		Y	Y					
5/8		Y	Y					
3/4			Y	Y				
1				Y	Y			
1 1/4				Y	Y			
1 1/2					Y	Y		

Recommended wall thickness for Monel Metric Tubes (6mm to 38mm)

TUBE OD (INCH)	TUBE WALL THICKNESS (INCHES)							
	1	1.2	1.5	1.8	2	2.5	2.8	2.8
6	Y	Y						
8	Y	Y	Y					
10		Y	Y					
12		Y	Y					
15			Y	Y				
18				Y	Y			
22					Y	Y		
28						Y	Y	
38							Y	Y

FRACTIONAL ALLOY 400 SEAMLESS TUBING

Allowable working pressures are calculated from an S value of 18700 psi for ASTM B165 tubing at -20 to 100°F (-28 to 37°C), as listed in ASME 31.3

TUBE OD (INCH)	TUBE WALL THICKNESS (MM)									
	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.12
	WORKING PRESSURE (PSIG)									
1/8	4251	5442	7999							
3/16	2784	3537	5113	6576	9764	13908				
1/4	2068	2618	3756	4795	7008	9782	13266			
5/16	1644	2077	2966	3772	5464	7543	10088			
3/8			2450	3108	4477	6137	8137			
1/2			1817	2297	3287	4468	5866			
5/8			1524	1925	2747	3721	4863	5654		
3/4			1264	1594	2269	3064	3989	4626	5389	
7/8			1078	1360	1932	2603	3381	3913	4549	
1			940	1185	1682	2263	2933	3390	3935	4371
1 1/8				1049	1489	2001	2590	2990	3466	3847
1 1/4				941	1335	1792	2318	2675	3097	3434
1 1/2					1106	1483	1915	2207	2553	2828
2						1100	1418	1632	1885	2085

METRIC ALLOY 400 SEAMLESS TUBING

Allowable working pressures are calculated from an S value of 18700 psi for ASTM B165 tubing at -20 to 100°F (-28 to 37°C), as listed in ASME B31.3

TUBE OD (MM)	TUBE WALL THICKNESS (MM)								
	0.8	1	1.2	1.5	1.8	2	2.2	2.5	2.8
	WORKING PRESSURE (PSIG)								
3	9820	12961	16471						
4	7077	9200	11496						
6	4538	5818	7164	9317	11649	13314	15078	17925	21048
8	3338	4252	5201	6692	8271	9377	10528	12345	14282
10	2638	3349	4081	5220	6410	7235	8086	9413	10806
12	2180	2762	3357	4277	5232	5889	6562	7605	8690
14	1857	2349	2851	3623	4419	4964	5521	6379	7266
15	1729	2185	2650	3365	4100	4603	5115	5903	6715
16	1617	2043	2476	3141	3824	4290	4764	5493	6242
18	1514	1912	2317	2936	3572	4004	4445	5120	5812
20	1358	1714	2075	2627	3192	3576	3965	4561	5171
22	1231	1553	1879	2377	2885	3230	3579	4112	4657
25	1079	1361	1646	2079	2521	2820	3122	3583	4052
28	960	1211	1463	1848	2238	2502	2769	3174	3586
30	895	1127	1363	1720	2082	2327	2574	2949	3331
32						2175	2405	2754	3109
38						1817	2008	2298	2591
42						1635	1806	2066	2328
50						1365	1507	1722	1939

SECTION 5

FLUID CONTROLS®
DOUBLE FERRULE TUBE FITTINGS

FLUID CONTROLS®
ORDERING INFORMATION

Hydraulic Swaging Unit (HSU)

DESCRIPTION	PART NUMBER
Hydraulic Swaging Unit	FCHSU
External Circlip For Swaging Die	ECLPSD
Plier For External Circlip	PECLPSD
Lubricant For Fittngs	LBSD

SWAGING MACHINE DIES	
TUBE OD SIZE IN INCH	PART NUMBER
5/8	10 FSDIE
3/4	12 FSDIE
7/8	14 FSDIE
1	16 FSDIE
1.1/4	20 FSDIE
1.1/2	24 FSDIE

SWAGING MACHINE DIES	
TUBE OD SIZE IN MM	PART NUMBER
14	FSDIE 14
15	FSDIE 15
18	FSDIE 18
22	FSDIE 22
25	FSDIE 25
28	FSDIE 28
38	FSDIE 38
42	FSDIE 42



Note : Sizes not included are also available. Please contact your Fluid Controls® representative

Gap Gauges



FRACTIONAL FITTINGS	
GAP GAUGE	
TUBE OD SIZE IN INCH	**PART NUMBER**
1/4	4 SGG
3/8	6 SGG
1/2	8 SGG
5/8	10 SGG
3/4	12 SGG
1	16 SGG
1.1/4	20 SGG
1.1/2	24 SGG

METRIC FITTINGS	
GAP GAUGE	
TUBE OD SIZE IN MM	**PART NUMBER**
6	SGG 6
8	SGG 8
10	SGG 10
12	SGG 12
14	SGG 14
15	SGG 15
18	SGG 18
22	SGG 22
28	SGG 28
38	SGG 38
42	SGG 42

Pre-setting Tool



FRACTIONAL FITTINGS	
PRE-SETTING TOOL	
TUBE OD SIZE IN INCH	**PART NUMBER**
1/4	4 SPT
3/8	6 SPT
1/2	8 SPT
5/8	10 SPT
3/4	12 SPT
1	16 SPT
1.1/4	20 SPT
1.1/2	24 SPT

METRIC FITTINGS	
PRE-SETTING TOOL	
TUBE OD SIZE IN MM	**PART NUMBER**
6	SPT 6
8	SPT 8
10	SPT 10
12	SPT 12
14	SPT 14
15	SPT 15
18	SPT 18
22	SPT 22
25	SPT 25
28	SPT 28
38	SPT 38
42	SPT 42

Note : Sizes not included are also available. Please contact your Fluid Controls® representative

FLUID CONTROLS PRIVATE LIMITED

CORPORATE OFFICE: J.V.Patel I.T.I Compound, B. Madhurkar Marg, Mumbai 400 013, Maharashtra, INDIA
Tel.: +91-22-43338000 I Fax: +91-22-43338001
Website: www.fluidcontrols.com Email : sales@fluidcontrols.com

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