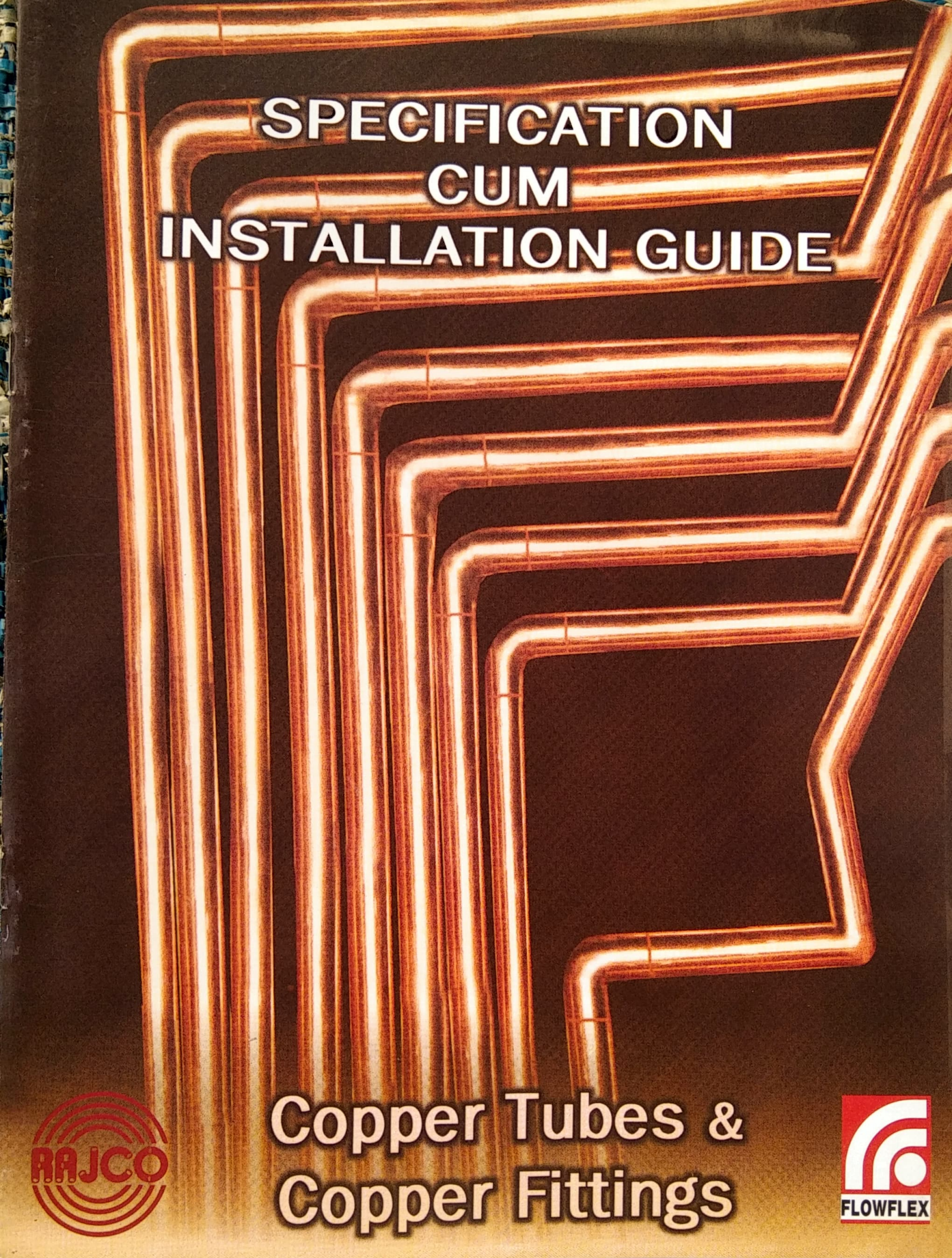
SPECIFICATION CUM INSTALLATION GUIDE



Copper Tubes & Copper Fittings

RAJCO

FLOWFLEX

Specification Cum Installation Guide For Rajco Copper Tubes & Flowflex Fittings For Plumbing, Water, Gas & Sanitation

APPLICABLE STANDARDS

A) COPPER TUBES :

i) BS 2871 Part I : Copper Tubes for water, gas & sanitation.
ii) BS EN 1057 : Seamless, round copper tubes for water and gas in sanitary and heating applications.
iii) ASTM B 88 : Seamless Copper water tube.
iv) ASTM E 243 / EN 1971 Electromagnetic (Eddy Current) examination of copper and copper alloy tubes.

B) COPPER FITTINGS :

i) BS 864 PART 2 : Capillary and compression tube fittings of copper and copper alloys.
ii) EN 1254 : Copper and Copper Alloy Plumbing fittings
Part 1- Fittings with ends for capillary soldering or capillary brazing to copper tubes.
Part 2 : Fittings with compression ends for use with copper tubes.
Part 5 : Fittings with short ends for capillary brazing to copper tubes.

C) SOLDER WIRE / BRAZING ALLOYS :

i) BS EN 29453 : Soft Solder alloys- Chemical Compositions and forms.
ii) BS 1723 : Brazing

D) FLUX :

I) As per ANSI / NSF6 or equivalent

NOTE : All ASTM specifications (American) specify tubes & fittings in inches (Imperial sizes) whereas the British or the European standards specify fittings in mm (Metric sizes). Except for USA & Canada, the world over uses pipes & fittings in mm (Metric) sizes and hence, we in India use & specify fittings as per British & European standards.

COPPER TUBES

Copper Tubes are specified in the BS 2871 / EN 1057 in three wall thicknesses designated under Table X, Y &Z. As per the specification the wall thicknesses recommended & the calculated working & burst pressures are given below :

TABLE 1

TABLE X

Tube Size	OUTER DIAMETER		THICKNESS	INNER DIAMETER	CALCULATED BURST PRESSURE		MAXIMUM WORKING PRESSURE	
	Maximum	Minimum						
(mm)	(mm)	(mm)	(mm)	(mm)	(bar)	(PSI)	(bar)	(PSI)
15	15.045	14.965	0.7	13.6	240	3480.0	58	841.0
22	22.055	21.975	0.9	20.2	215	3117.5	51	739.5
28	28.055	27.975	0.9	26.2	165	2392.5	40	580.0
35	35.07	34.99	1.2	32.6	175	2537.5	42	609.0
42	42.07	41.99	1.2	39.6	145	2102.5	35	507.5
54	54.07	53.99	1.2	51.6	110	1595	27	391.5
67	66.75	66.60	1.2	64.6	105	1522.5	20	290
76.1	76.30	76.15	1.5	73.1	100	1450	24	348
108	108.25	108.00	1.5	105	70	1015	17	246.5

TABLE 2

TABLE Y

Tube Size	OUTER DIAMETER		THICKNESS	INNER DIAMETER	CALCULATED BURST PRESSURE		MAXIMUM WORKING PRESSURE	
	Maximum	Minimum						
(mm)	(mm)	(mm)	(mm)	(mm)	(bar)	(PSI)	(bar)	(PSI)
15	15.045	14.965	1.0	13.0	360	5220.0	87	1262.5
22	22.055	21.975	1.2	19.6	290	4205.0	69	1000.5
28	28.055	27.975	1.2	25.6	230	3335.0	55	797.5

TABLE 2

TABLE Y

Tube Size	OUTER DIAMETER		THICKNESS	INNER DIAMETER	CALCULATED BURST PRESSURE		MAXIMUM WORKING PRESSURE	
	Maximum	Minimum						
35	35.07	34.99	1.5	32.0	225	3262.5	54	783.0
42	42.07	41.99	1.5	39.0	190	2755.0	45	652.5
54	54.07	53.99	2.0	50.0	195	2827.5	47	681.5
67	66.75	66.60	2.0	63.0	157	2276.5	37	536.5
76.1	76.30	76.15	2.0	72.10	140	2030	33	478.5
108	108.25	108.00	2.5	103.0	120	1740	29	420.5

TABLE 3

TABLE Z

Tube Size	OUTER DIAMETER		THICKNESS	INNER DIAMETER	CALCULATED BURST PRESSURE		MAXIMUM WORKING PRESSURE	
	Maximum	Minimum						
(mm)	(mm)	(mm)	(mm)	(mm)	(bar)	(PSI)	(bar)	(PSI)
15	15.045	14.965	0.5	14.0	260	3770.0	50	725.0
22	22.055	21.975	0.6	20.8	215	3117.5	41	594.5
28	28.055	27.975	0,6	26.8	165	2392.5	32	464.0
35	35.07	34.99	0.7	33.6	155	2247.5	30	435.0
42	42.07	41.99	0.8	40.4	145	2102.5	28	406.0
54	54.07	53.99	0.9	52.2	130	1885.0	25	362.5
67	66.75	66.60	1.0	65.0	120	1740.0	20	290.0
76.1	76.30	76.15	1.2	73.7	80	1160.0	19	275.5
108	108.25	108.00	1.2	105.6	75	1087.5	17	246.5

MAXIMUM WORKING PRESSURES

The maximum working pressures at temperatures up to 65° C are calculated using the following formula :

$$P = \frac{20Ft}{D-t}$$

Where P = maximum working pressure (bar) F = design stress (N/mm²)
T = minimum wall thickness (mm) D = maximum outside diameter (mm)

Tubes installed underground, laid under floors or in other inaccessible places must be able to withstand twice the maximum working pressure.

The values of F used in the above formula depend upon the condition of the tube and are given below :

TABLE 4

Condition	F(N/mm²)
Annealed O, R220	46
Half-hard ½H, R250	60
Hard H, R290	72.5

(0.1N/mm² = 1Bar = 14.5PSI)

DESIGN STRESS VALUES FOR 65° C

Tubes in the Half Hard (½H) and Hard (H) condition locally annealed during fabrication for e.g. during hot bending, silver brazing or the attachment of welded fittings, should have the working pressure calculated from the design stress F in the annealed condition. Certain large diameter and/ or thick walled copper tube may be subjected to over annealing during fabrication. This may result in the design strength being below that quoted for the annealed condition. If in doubt in these circumstances the customer should seek advice from Rajco.

Design stress value (F) for copper tubes operating at temperatures in excess of 110°C up to a maximum of 200°C are given in BS 1306 and typical values for tube in the annealed condition are given below :

TABLE 5

Temperature °C	110	150	175	200
Max. admissable stress for annealed, R220, condition, N/mm²	40	34	26	18

Design stress value for working temperatures in excess of 65° C.
Values for intermediate temperatures may be interpolated as required.

Flow Rate

Assuming good design practice and installation the maximum recommended flow velocities of oxygenated water at different tempeartures are as follows:

TABLE 6

Maximum recommended flow velocities

Degree C	10	50	70	90
Flow m/s	2.0	1.5	1.3	1.0

Flow velocities should be between 0.5m per second, below which any suspended matter may settle out, and the maximum values given in the table, above which erosion/corrosion and/or cavitation may occur. conditions.

In deoxygenated hot water flow velocity is restricted only by system constraints.

The size of the tube should therefore be selected according to the conditions.

En 1057 Calls For Various Tests To Be Conducted On Copper Tubes/Fittings Some Important Test Are Listed Below

COPPER TUBES

1) CHEMICAL COMPOSITION :

Copper Tubes are designated under alloy C 106 also called DHP (Deoxidised High Residual Phosphorized Grade).
The requirement is as follows :
Min. Copper including Silver % - 99.9 %
Phosphorus % - 0.015 to 0.040%

2) DIMENSIONAL TOLERANCES :

Dimensional tolerance to confirm to the EN 1057. It must be noted that the dimensional tolerance on copper tubes as specified for the outside diameter is very important so that the annular gap between the tube & the fitting is within a designated dimensional tolerance to ensure correct & proper capillary action during the process of soldering or brazing.
Please refer to Table 1, 2 & 3 for dimensional tolerance on outside diameter. Dimensional tolerance for wall thickness is given below :

TABLE 6

Tolerances on wall thickness

Nominal outside	Tolerances on wall thickness e[1)]	
diameter (mm)	e < 1mm(%)	e≥ 1mm (%)
< 18	10	13
≥ 18	10	15

1) Including deviation from concentricity
2) ± 10% for R250 (half hard) tubes of 35mm, 42mm and 54 mm diameter with a wall thickness of 1.2mm
NOTE : Concentricity (uniformity of wall thickness is Contralled by the tolerance on the wall thickness)

3) MECHANICAL (PHYSICAL) PROPERTIES ARE DESIGNATED IN EN 1057 TO BE AS FOLLOWS

TABLE 8

Mechanical Properties

Material Temper		Outside Diameter in mm		Tensile Strength MPa	Elongation %	Hardness (only indicative) HV 5
Designated in Accordance with EN 1173	Common term used	Min.	Max.	Min.	Min.	
R220	Annealed	6	54	220	40	(40 to 70)
R250	Halfhard	6	67	250	30	(75 to 100)
		6	159		20	
R290	Hard	6	267	290	3	(min. 100)

4) FREEDOM FROM DEFECTS :

SURFACE QUALITY :

The outer diameter & inner surface of the tube shall be clean & smooth. An attack on copper tube can occur causing pitting corrosion when a thin film of carbon is formed within the bore of the tube during the manufacturing process. Concern over deleterious film in the bore has prompted the newly adopted EN1057 to call for a carbon film & carbon content test, concerning the measurement of the residual & potential carbon in a copper tube bore. Rajco Copper Tubes meet this criteria.

5) NON DESTRUCTIVE TEST :

Keeping in view the impracticality of conducting 100% hydrostatic or pneumatic pressure tests the EN 1057 has now called for an Eddy Current Test in accordance with EN1971 in lieu of hydrostatic or pneumatic test. Eddy current test is a computer aided test, where in the tube passes through a probe & an electro magnetic field is created around the peri-pheri of the tube to detect any flaw or blow hole which may not be visible to the naked eye.

6) BENDING :

Half hard copper tubes and soft annealed copper tubes must undergo a bending test without formation of wrinkles on the inner bend. Bending is an expansion of the outside surface of the bent tube & a contraction of the inner surface of the tube. The formation of wrinkles on the inner surface shows either the fact that the physical properties of the tube are not in order or the bending mechanism i.e the bending tool has got a gap more than the diameter of the tube, which allows the tube to get raised while conducting the bending operation from the former, allowing wrinkle formation to take place on the inner surface.

COPPER FITTINGS

Copper fittings are specified in EN1254 Part 1 as stated above. There aer 2 types of capillary fittings :

a) **Integral Solder Ring Fittings (Inbuilt): (Designated as 'FP')**
This range of fittings contains solder inside the recess/cavity of the fittings itself i.e. there is no need to provide solder from outside.

b) **End Feed Fittings : (Designated as 'NF')**
This range of fittings does not contain Integral Solder, but you have to end-feed solder / brazing rod i.e you have provide solder / brazing rod from outside.

1) DIMENSIONAL TOLERANCE

TABLE 9

Dimensional tolerance as specified on nominal diameter to be as follows :

Nominal Diameter	Tolerances on the mean diameter [1] with respect to the nominal diameter		Resulting diametrical difference	
D	Outside diameter of male end (mm)	Inside diameter of socket (mm)	Max. (mm)	Min. (mm)
15 mm	+ 0.04	+ 0.15	0,20	0.02
	- 0.05	- 0.06		
22 to 28 mm	+ 0.05	+ 0.18	0.24	0.02
	- 0.06	- 0.07		
35 to 54 mm	+ 0.06	+ 0.23	0.30	0.03
	- 0.07	- 0.09		
67 to 108 mm	+ 0.07	+ 0.33	0.41	0.03
	- 0.08	- 0.10		

[1] Arithmetical mean of two diameters at right angles in a cross section taken anywhere on the length of the socket or the male end.

TABLE 10

The minimum wall thickness of a fitting shall be in accordance as given below :

Nominal Diameter (mm) D	Minimum wall thickness (mm)		
	Wrought coppers	Wrought copper alloys	Cast copper and copper alloys
15	0.7	1.2	1.2
22	0.9	1.4	1.5
28	0.9	1.5	1.8
35	1.0	1.6	1.8
42	1.1	1.8	2.0
54	1.2	1.9	2.3
67	1.4	2.0	2.4
76.1	1.6	2.6	2.8
108	2.1	3.3	3.5

2) CARBON IN BORE

The internal surface of copper capillary fittings for soldering or brazing shall not contain any detrimental film nor present a carbon level high enough to allow the formation of such a film during installation. The maximum total carbon level on internal surfaces shall not exceed 1.0 mg/dm² when tested in accordance with the specification.

3) RESISTANCE TO DEZINCIFICATION

Components which are manufactured from alloys containing more than 10% zinc (including brass) and which are required to be resistant to dezincification, shall be capable of meeting the acceptance criteria for resistance to dezincification. When tested in accordance with the specification, the depth of dezincification, in any direction, shall be for grade (A) : maximum 200 pm for grade (B) : mean not to exceed 200 µm and maximum 400 µm.

4) RESISTANCE TO STRESS CORROSION

The fitting shall be resistant to stress corrosion. When tested in accordance with EN 1254, components manufactured from copper alloys shall show no evidence of cracking.

5) PRESSURE TEST

When required, the bodies of fittings with as-cast microstructure, after machining, shall be pressure tested by the manufacturer. At the option of the manufacturer, they shall be submitted to a hydrostatic or to a pneumatic pressure test or to any other pressure test of equivalent performance. The reference method of test shall be either by the application of an internal pneumatic pressure of a minimum of 5 bar with the fitting entirely immersed in water, or an internal hydrostatic pressure test of a minimum of 1.5 times maximum pressure given in Table 6 of EN 1254 or the relevant size range, and at ambient temperature.

TABLE 11

Materials approved for capillary fittings

Metal or alloy	BS number	Designation
Copper	BS 6017	Cu-ETP or C101*
		Cu-DHP pr C106*
	BS 2871	C106*
		C107*
Dezincification Resistant	BS 2872	CZ 132*
Brass Alloy		
Gunmetal castings	BS 1400	LG 1*
		LG 2*

* These metals and alloys are dezincification immune or resistant as per the requirement of EN 1254.

NOTE : It must be stressed that even gun metal casted fittings are not acceptable if they are ordinarily sand casted due to a merged, uneven & distorted grain structure. It is important for all gun metal fittings to be shell moulded or pressure diecasted to give a co-axial and a uniform grain structure.

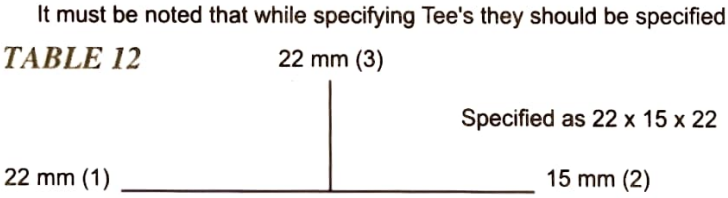
6) THREADING

All threaded fittings will have BSP threads. All male threads will be tapered & all female threads will be parallel. This is a necessity so that a lock-in occurs in between the male & the female fitting before reaching the stop.

7) SPECIFYING FITTINGS

It must be noted that while specifying Tee's they should be specified in the following order as shown as numbers 1, 2 & 3.

TABLE 12



SOLDER WIRE

Legislation has resulted in a ban on the use of lead containing solders in both new and repaired potable water systems. All integral solder ring fittings contain lead-free solder. In the case of end feed fittings the onus is on the specifier and installer to ensure that lead-free, tin-copper or tin-silver solders, as specified in BS EN 29453 (Formally BS 219) are used exclusively in potable water installations.

FLUX

I) Flux should be Non-Acidic, Lead Free.

ii) The Flux should be supplied in paste form packed in small tin container of 500 gms or small packaging & should have compatibility to use with solder wire (Lead free & as per BS 219 or equivalent)

iii) The Flux should be water soluble & should be used in recommended quantity. Excess use of Flux is not recommended.

CONTACT WITH OTHER METALS (GALVANIC CORROSION)

Whenever two dissimilar metals are in contact, in an electrolyte containing dissolved oxygen, the assembly constitutes a galvanic (Corosion) cell in which the more noble metal is the anode, which tends to dissolve (corrode). A consequence of this is that the more noble metal is cathodically protected by the less noble (base) metal. For example galvanised (i.e. zinc coated) steel is protected by the preferential corrosion of the zinc coating and does not show significant rusting until the dissolution of the zinc coating is virtually complete. In pipework, the jointing of copper to iron or steel should be avoided as far as possible, otherwise the iron or steel component will corrode preferentially. The corrosion of steel tanks commonly connected to copper pipes is reduced by the insertion of electrically, insulating washers and also by the relative size of the exposed surfaces, in this case a large anode and a small cathode. A steel pipe attached to a pipe tank or cylinder will corrode at a significantly greater rate since the relationship is one of a large cathode and a small anode.

Similarly, iron or steel should not be installed downstream of copper in a circuit otherwise rapid corrosion of the iron or steel will occur. However no undue corrosion damage will be experienced if the iron or steel is upstream of the copper. The conductivity of the water (electrolyte) also influences the rate of corrosion in that the higher the conductivity of the water, the greater will be the rate of any corrosion It should be stressed that galvanic corrosion does not occur in the absence of an electrolyte i.e. in a dry environment so that the use of steel clips on a copper pipe will cause no problem, the steel clips may corrode preferentially however if the environment is prone to condensation e.g. a cold water pipe in a steamy (humid) atmosphere such as a kitchen.
The presence of dissolved oxygen in the water is a major factor in galvanic corrosion within systems.

(I) HOW TO SPECIFY RAJCO COPPER PIPES FOR PLUMBING

Copper tubes conforming to EN 1057 in 10' length & thickness as per table X, Y or Z. Dimension must be strictly as per EN 1057 & Chemical composition of copper pipes to be as follows :

Copper % = 99.9 % min
Phosphorus % = 0.015% to 0.040 %

Copper tubes as per Table X & Table Y must be capable of bending at 90° / 135° radius without breakage or wrinkles on the inside surface. The tubes shall be totally cylindrical and of uniform thickness free from flaw, pin holes, cracks and other skin defects. The maximum working & burst pressure of tubes shall be as EN 1057. All tubes shall be eddy current tested to ensure the tubes are free from any internal blow holes/ flaw or eccentricity. Tubes from manufacturers who do not have eddy current testing facility will not be accepted. The buyer/user reserves the right to inspect the facility of the manufacturer to ensure that Eddy current testing facility is prevalent and being done. Carbon film & carbon content test must be conducted on copper tubes as per En1057.

Approved Make RAJCO METAL INDUSTRIES PVT.LTD.

(II) HOW TO SPECIFY CAPILLARY FITTINGS

Fittings made of Dezincification Resistant materials i.e. Copper, DZR Brass (Alloy CZ132) or Gun Metal conforming to BS 864 / EN 1254. Ordinary or Duplex Brass fittings are not allowed to be used. Dimensions of fittings must confirm to EN 1254 Part II & EN 1057 to ensure proper jointing. The distance between the socket and neck of the fitting should be sufficient to allow proper capillary action & flow of lead free solder. Threads on all fittings must be BSP threads and all male threads must be tapered & female ends parallel. Fittings must have BS 864 or EN 1254 imprinted on the fitting itself.

Approved make FLOWFLEX COMPONENTS LTD. UK, fittings.

a) FOR SOLDER RING FITTINGS

All plain end of fittings must be provided with enough amount of lead free solder in the neck of the fitting itself to ensure proper capillary action. The solder must be soft solder & lead free with melting temperature of approx. 230° C & must be capable of melting with an ordinary blow lamp and on melting must be sufficient to form a complete leakproof joint to cover the annular space in between the tube and fitting from the socket of the fitting to the outside of the fitting. Solder must confirm to BS 219/ BS EN 29453 specification.

b) FOR END FEED FITTINGS

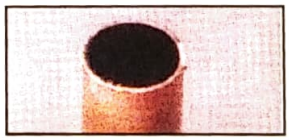
The fittings must be capable of End feeding. Solder wire to be used with these fittings must be soft solder capable of melting at approx. 230°C & must confirm to BS 219/ EN BS 29453. Solder Wire must be absolutely lead free . Copper Tin or Silver Tin solder is acceptable only.

INSTALLATION GUIDE

A step-by-step guide showing how to make the perfect joint

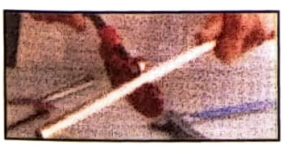
Step 1

Make sure that you have the correct size fittings and tube.



After cutting the tube, you will notice some rough edges around the outside and inside of the tube. This is called burr and should be removed with a file or sharp blade.

Step 2



Prepare the end of the tube by cutting to the correct length with a tube cutter or fine bladed hacksaw.

The ends of the tube must be cut square to the axis and be especially careful not be damage the ends of the tube.

Step 3

Clean the outside surface of the tube that will eventually go into the socket of the fitting, along with the inside surface of the fitting.

To do this use Scotch Brite cleaning pads, fine sandpaper or steel wool Scotch Brite is best for this purpose.

Step 4

Apply water soluble flux to the tube and fitting by smearing a thin film of FLOWFLEX Flux around the outer ends of the tube that have been cleaned and to the inside of the cleaned socket of the fitting. This is best done with a small brush to avoid applying too much and to prevent contact with the skin.

Remember that flux is an essential element to successful soft solder capillary jointing. It prevents copper from oxidising and chemically cleansthe surface during the heating operation, so ensuring that the moltentin copper solder bonds both tube and fitting.

Step 5

Insert the tube into the fitting and ***push***

Step 6

Wipe off any excess flux with a clean

A) For Integral Solder Ring Fittings (Inbuilt)

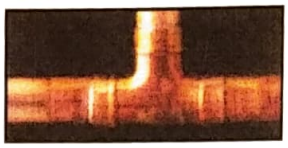
Step 7 (A)

Apply heat to the assembled joints to be made using a conventional blow Lamp torch or similar appliance that emits a flame that is clean, blue and soot-free.

Once a complete ring of solder has appeared around the mouth of the fitting, turn off the heat.

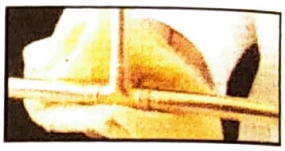
The complete silver coloured ring of solder is proof of a sound joint.

Step 8 (A)



Allow the joint to cool

Step 9 (A)



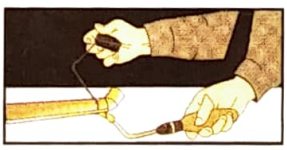
Wipe off any excess flux and residues.

B) For Endfeed Fittings

Step 7 (B)

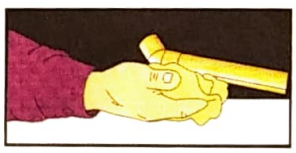
Apply the flame to the fitting to heat tube and solder cup of fitting until solder melts when placed at the joint of tube and fitting.

Step 8 (B)



Remove the flame and feed solder into the joint at one or two points. until a ring of solder appears at the end of the fitting. The correct amount of solder is approximately equal to 1 1/2 the diameter of the fitting 3/4" long solder for 15mm fitting, etc.

Step 9 (B)



Remove excess flux with a wiping

The Copper Plumbing System

Rajco Metal Industries manufacture copper tube to the quality requirements of numerous specifications and the company's products are accepted throughout India & exported to various countries.

A comprehensive product range is available in a wide variety of sizes and all copper tube is ideal for hot and cold water services and gas and steam applications including for Medical Gas applications. Table X half hard condition to BS 2871: Part 1 : 1971/BS : EN 1057 is a general purpose tube for above-ground services, i.e. hot and cold water, sanitation, gas and engineering applications. Half hard temper is available in straight lengths.

Smaller sizes of copper tube can be bent easily using appropriate bending springs or tube bending machines, however, tube above 22mm diameter should only be bent using ^ bending machine. In all instances when bending, Rajco's instructions and recommendations should be adhered to. Hard condition copper tube is not designed to be bent in any way.

Both FLOWFLEX and RAJCO METAL INDUSTRIES have an established reputation for manufacturing excellence.

FLOWFLEX RAJCO

Rajco Metal Industries Pvt. Ltd.

Opp. Acme Industrial Estate, Sewri Bunder Rd. Sewri (East), Mumbai - 400 015. India Tel. : 91-22 2416 6706, 2418 1856, 2412 1804,
Fax : 91-22 2416 6426 E-mail : rajco@rajcogroup.com