MEDICAL SPECIFICATION FOR IS STANDARD (RECOMMENDATION BY MANDEV TUBES PVT.LTD.)

1 SCOPE

This standard covers the requirements of solid drawn (seamless) copper tubes for medical grade copper tubes- for Medical Gas Pipe Line purposes.

This standard specifies the requirements, sampling, test methods and conditions of delivery for copper tubes.

It is applicable to seamless round copper tubes having an outside diameter from 6mm up to and including 219mm for pipeline system for distributing the following medical gases intended to be used at operating pressures up to 2000 kPa;

- Oxygen, nitrous oxide, nitrogen, helium, carbon dioxide, xenon;
- Medical air;
- Specific mixtures of these above mentioned gases;
- Air for driving surgical tools;
- Anaesthetic gases and vapours.

2 REFERENCE

The Indian standards listed at annex A are necessary adjuncts to this standard.

3. TERMINOLOGY

3.1 For the purpose of this standard the following definitions as given in IS 3288 (PART 3) – 1986 (Reaffirmed 2006) shall apply.

3.1.1 Seamless Tube (Solid Drawn Tube)

Tube produce from a tube shell by drawing.

3.1.2 Tube Shell

A hollow cylinder produced by extrusion, rotary piercing, or subsequent drawing into tube.

3.2 In addition to above following definitions shall also apply.

3.2.1 Eccentricity

$$\text{Eccentricity} = \frac{t\,(\text{Max}) - t\,(\text{Min})}{t\,(\text{Average})}$$

3.2.2 Mean outside Diameter

The outside diameter shall confirm to the requirement given in table 1 & Table 2

3.2.3 Mean Wall Thickness

The outside diameter shall confirm to the requirement given in table 1 & Table 3.

3.2.4 Ovality

$$\text{Ovality} = \frac{D\,(\text{Max}) - D\,(\text{Min})}{D\,(\text{Average})}$$

Where

D is outside diameter of the tube.

Note – Before bending for a bent tube.

3.2.5 Out of Roundness

Out of roundness = D (Max) – D (Min)

3.2.6 Pipe/Tube

A hollow wrought product of uniform cross section with only one enclosed void along its whole length and with a uniform wall thickness

3.2.7 Pipe line Joints

For straight tube -coupling, expanded joints (Capillary Joints) & mechanical joints can be used. [SOURCE: HTM -02 (13.17) , ISO 7396-1 (11.3) & NFPA 99].

3.2.8 Brazing

Jointing process using filler metal with a liquids temperature above 450 C. (SOURCE: ISO 857 – 2:2005)

4 SUPPLY OF MATERIAL

General requirements relating to the supply of material shall be as laid down in IS 1387:1993.

5 GRADES

This standard covers DHP GRADE (DEOXIDIZED HIGH PHOSPHORUS) of copper tubes.

6 MANUFACTURE

6.1 The tube shall be manufactured from tube shell by drawing.

6.2 The tubes shall be supplied either in soft annealed, Light drawn & Hard drawn condition.

6.3 The tube shall be cut to size in straight length, duly drafted and sealed at both ends.

6.4 Tube shall not be manufactured from used tubes.

7 FREEDOM FROM DEFECTS

The tubes shall be clean, smooth, and free from cracks, seams, slivers, scales and other harmful defects.

8 DIMENSION AND TOLERANCE

8.1 DIMENSIONS

The tubes shall be designated by the outside diameter and the wall thickness. Diameter and wall thickness shall confirm to the requirements given in table 1 .

8.2 Tolerance

8.2.1 Outside Diameter & wall thickness

The relevant tolerance on mean outside diameter & wall thickness are given in table 2 and table 3.

8.2.2 Length Tolerance

The lengths shall be equal to or greater than those ordered.

9 CHEMICAL COMPOSITION

The chemical composition shall confirm to the following requirements:

Cu +Ag min. 99.90 %;

Phosphorus 0.015 – 0.040%

This copper grade is designated Cu-DHP.

Table 1 -Nominal Outside diameters and wall thickness

Dimensions in millimetres

Nominal outside diameter	Nominal Wall thickness								
D	0,7	0,8	0,9	1,0	1,2	1,5	2,0	2,5	3,0
6	-	-	-	X	-	-	-	-	-
8	-	R	-	R	-	-	-	-	-
10	-	R	-	R	-	-	-	-	-
12	-	X	-	R	-	-	-	-	-
14	-	-	-	X	-	-	-	-	-
15	R	-	-	R	X	-	-	-	-
16	-	-	-	X	-	-	-	-	-
18	-	-	-	R	X	-	-	-	-
22	-	-	R	R	X	R	-	-	-
28	-	-	R	R	X	R	-	-	-
35	-	-	-	X	R	R	X	-	-
42	-	-	-	X	R	R	X	-	-
54	-	-	-	X	R	R	R	-	-
64	-	-	-	-	-	-	R	-	-
66,7	-	-	-	-	R	-	R	-	-
70	-	-	-	-	-	-	X	-	-
76,1	-	-	-	-	-	R	R	-	-
80	-	-	-	-	-	-	X	-	-
88,9	-	-	-	-	-	-	R	-	-
104	-	-	-	-	-	-	X	-	-
108	-	-	-	-	-	R	-	R	-
133	-	-	-	-	-	-	-	-	X
159	-	-	-	-	-	-	R	-	R
219	-	-	-	-	-	-	-	-	R

R Indicates the IS recommended dimensions.

X Indicates other IS dimensions

Table 2 - Tolerances on outside diameter

Dimensions in millimetres

Nominal outside diameter		**Tolerance on nominal diameter**		
D		applicable to mean diameter	applicable to any diameter [a]	
Over	up to end including	Soft annealed material conditions	Hard Drawn material condition	Light Drawn hard material condition
6 [b]	18	± 0,04	± 0,04	± 0,09
18	28	± 0,05	± 0,06	± 0,10
28	54	± 0,06	± 0,07	± 0,11
54	76,1	± 0,07	± 0,10	± 0,15
76,1	88,9	± 0,07	± 0,15	± 0,20
88,9	108	± 0,07	± 0,20	± 0,30
108	159	± 0,2	± 0,70	± 1,0
159	219	± 0,60	± 1,50	± 2,00

NOTE 1 Tolerances for tubes in Soft Annealed material condition are applicable only to mean diameter.
NOTE 2 In case of dispute, to improve the accuracy when determining the mean diameter, the tube may be re- rounded before measurement.
NOTE 3 Tolerance for tubes with a nominal outside diameter higher than 108 mm in material condition soft annealed are not specified.

a Including deviation from circular form
b Including 6.

Table 3- Tolerance on wall thickness

Nominal outside diameter	Tolerance on wall thickness e[a]	
d mm	e < 1 mm %	e≥ 1 mm %
< 18	± 10	± 13
≥ 18	± 10	± 15[b]

NOTE Concentricity (uniformity of wall thickness) is controlled by tolerance on wall thickness.

a Including deviation from concentricity.

b ± 10% for Light Drawn tubes of 35mm, 42mm and 54mm diameter with a wall thickness of 1, 2mm.

10 PHYSICAL PROPERTIES

10.1 Mechanical Properties

10.1.1 Tensile Test

A piece of tube selected for test, suitably plugged or flattened sufficiently at the ends for gripped or strip cut from a tube, shall be tested in accordance with IS 2655:1964 and shall confirm to the requirements of tensile properties as given in table 4.

Table 4 - Mechanical properties

Material condition	Nominal outside diameter		Tensile strength	Elongation
	d		R_m	A
	mm		Mpa	%
	min.	max.	min.	min.
Soft annealed	6	108	220	40
Light drawn[a]	6	66,7	250	30
	66,7	219		20
Hard drawn[a]	6	219	290	3

NOTE NOTE 1 1 Mpa is equivalent ti 1 N/mm2.
NOTE 2 Brittle fracture prevention: Copper, having a face-centred cubic crystal structure, does not suffer a transition from ductile to brittle failure like some other materials.
NOTE 3 Tolerances for tubes with a nominal outside diameter higher than 108 mm in material condition soft annealed are not specified.

a Straight lengths only.

10.2 Flattening Test

10.2.1 The flattening test shall be carried out as per IS 2328:1983 on test pieces selected from any part of the tubes in soft annealed condition. The light drawn tubes shall be soft annealed before testing.

10.2.2 The test piece shall not crack when close flattened until the interior surfaces of the tube meet as shown in Fig.1.

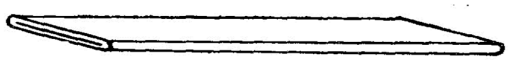

FIG. 1 FLATTENING TEST

10.3 Drift Expanding Test

10.3.1 The drift expanding test shall be carried out as per IS 2335:1985 on tubes in soft annealed condition. The light drawn tubes shall be soft annealed before testing.

10.3.2 The tube shall be capable of undergoing drifting by means of a taper drift having an included angle of 60 Degree as shown in Fig. 2, without showing either crack or flaw until the outside diameter of the expanded end measures at least 40% more than the original diameter of the tube. The test piece shall be examined with eyes having normal vision with or without spectacles.

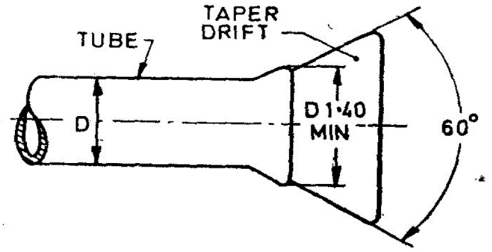

FIG. 2 DRIFT EXPANDING TEST

10.4 Non Destructive Test

10.4.1 Eddy Current Test

Each tube shall be subjected to the Eddy – current test in accordance with IS 11612:1984. Tubes shall be tested in as drawn condition prior to the final annealing or heat treatment, unless otherwise agreed upon by the supplier and the purchaser. Drill holes size as per mention in table 5.

Table 5 Diameter of Drilled Holes

all dimensions in millimetres

Outside Diameter of Tube		Diameter of Drilled Holes
Over (1)	Up to and Including (2)	(3)
3	6	0.50
6	19	0.65
19	25	0.80
25	32	0.95
32	38	1.05
38	44	1.15
44	50	1.30

11 RESIDUE TEST OR CLEANLINESS TEST

11.1 The inside of tube with sealed ends shall be sufficiently clean so that when the interior of tube is washed with trichloroethylene, carbon tetrachloride or any other suitable organic solvent, the residue remaining after evaporation of the solvent shall not exceed 0.038g/m2 of the interior surface.

11.2 The perform the test , a determined quantity of the solvent shall be taken through a tube into a flask, which is, in turn attached to an aspirator or vacuum pump. The solvent then transferred to a weighed container (crucible, evaporating dish or beaker). The solvent in the container shall be evaporated to dryness on a low temperature hot plate or sand bath. Overheating of the container should be avoided to prevent charring of the residue. The container shall then be dried in an oven at 100-110 degree c for 10 minutes, cooled in a desiccator and weighed. A blank determination shall be run on the same determined quantity of solvent and the gain in weight for the blank shall be subtracted from the weight of the residue sample.

11.3 In performing the test, care shall be exercised to clean the outside surface of the end of the sample to be immersed in the solvent. The sample shall be prepared in such a manner as to prevent the inclusion in the residue of copper chips or dust resulting from the cutting of the sample.

12 SAMPLING AND CRITERIA FOR CONFORMITY

12.0 Unless otherwise agreed to between the purchaser and the supplier, the following procedure of sampling and criteria for conformity should be followed for acceptance of a lot.

12.1 Lot

In any consignment tubes of the same grade size, thickness and temper shall be grouped together to constitute a lot of 300 tubes or 1000 kg (whichever is higher) or part thereof.

12.2 Dimensional Tolerances

From each lot, ten tubes shall be selected at random and tested for length outside diameter and wall thickness. No failure shall occur if the lot is to be accepted under this clause.

12.3 Chemical composition, Mechanical properties, Flattening test and drift expanding test

From the lot found acceptable for dimensions one test shall be conducted for each of chemical composition, mechanical properties, flattening test and drift expanding test requirements given in the specification. The lot shall be accepted if the samples tested meet all the requirements of these tests.

12.4 Each tube shall be tested for Eddy current test, unless otherwise agreed upon by the supplier and the purchaser.

12.5 Retest

12.5.1 Chemical Composition

If a test result of chemical analysis fails to satisfy the requirements for any of the elements. Two more tests for that element shall be done on the same sample in order to confirm that the analysis has been done properly. If both the test results satisfy the relevant requirements the lot shall be considered as conforming to the specification; otherwise not.

12.5.2 Mechanical Properties, Flattening Test and drift expanding Test

If the test results on any sample tested for mechanical test (tensile test), flattening test, drift expanding test, fail to satisfy the requirements for any of these tests given in the specification, two more sample shall be tested for that test. If both the test results satisfy the relevant requirement, the lot shall be considered as confirming to specification; otherwise not.

12.5.3 Residue Test

The procedure for retest shall be as agreed to between supplier and purchaser.

13 PACKING

The tubes shall be suitably covered with a polyethylene sheet and packed to avoid movements and rubbing. The tube ends shall be protected by proper inserts to avoid damage during handling and transit. Each package shall be of convenient weight for ease of handling and shall not exceed 1000 kg (gross) . The bottom of the packing case shall be rigid to enable the tubes to maintain straightness.

14 MARKING

14.1 Boxes/packages containing tubes shall be suitably marked with the following details:

a) Lot Number;

b) Grade;

c) Temper;

d) Size (diameter,thickness and length);

e) Number of tubes in the box/package;

f) Date of manufacture; and

g) Name and address of manufacturer.

14.2 BIS Certification Marking

14.2.1 The tubes may also be marked with the standard mark.

14.2.2 The use of the standard mark is governed by the provisions of the Bureau of Indian standards Act,1986 and the Rules and regulation made thereunder. The details of conditios under which the licence for the use of standard Mark may be granted to manufacturers or producers may be obtained from the Bureau Of Indian Standards.

15 TEST CERTIFICATE

The manufacturer/ supplier should provide test certificate for each consignment giving information like grade, lot number , temper , size, thickness and corresponding chemical composition and physical properties.

ANNEX A

LIST OF REFERED INDIAN STANDARD

IS NO.	TITLE	IS NO.	TITLE
440:1964	Methods for chemical analysis Of copper (revised)	2655:1964	Method of tensile testing of copper and copper alloy tubes
1387:1993	General requirements for the Supply of metallurgical metarial (second revision)	3288 (PART 3) 1986	Glossary of terms relating to copper and copper alloy: Part 3 Wrought forms
2328:1983	Method for falttening test on Metallic tubes (first revision)	11612:1984	Code of practice for Eddy Current testing of non - Ferrous seamless pipes and Tubes (first revision)
2335:1985	Method for drift expanding test For metallic tables (first revision)		

References:

1) ASTM B 819- 2019-- SEAMLESS COPPER TUBE FOR MEDICAL GAS SYSTEM

https://drive.google.com/file/d/1pBTk86cS-YtGREFUViZav2X5eoCJo5Pp/view?usp=sharing

2) BS 2871 : PART 1 : 1971-- COPPER TUBES FOR WATER GAS AND SANITATION

https://drive.google.com/file/d/1-pa1mcIpMEejqqHN19vbfNFPKye0h5AK/view?usp=sharing

3) EN 1057 : 2006 + A1: 2010 --SEAMLESS, ROUND COPPER TUBES FOR WATER AND GAS IN SANITARY AND HEATING APPLICATIONS

https://drive.google.com/file/d/1-pa1mcIpMEejqqHN19vbfNFPKye0h5AK/view?usp=sharing

4) BS EN 13348 : 2016-- SEAMLESS, ROUND COPPER TUBES FOR MEDICAL GASES OR VACUUM

https://drive.google.com/file/d/1IPUr_LXsfvFygA2jBDoHbL0t5HTnzw24/view?usp=sharing

5) RECOMMENDATION BY MANDEV-- SEAMLESS, ROUND COPPER TUBES FOR MEDICAL GASES PIPELINE APPLICATION

https://drive.google.com/file/d/1h9CsJOTaSmPDrAff260M1Dy-N1nxYJ_k/view?usp=sharing

Table 2 - Tolerances on outside diameter

Dimensions in millimetres

Nominal outside diameter		Tolerance on nominal diameter		
D		applicable to mean diameter	applicable to any diameter [a]	
Over	up to end including	Soft annealed material conditions	Hard Drawn material condition	Light Drawn hard material condition
6 [b]	18	± 0,04	± 0,04	± 0,09
18	28	± 0,05	± 0,06	± 0,10
28	54	± 0,06	± 0,07	± 0,11
54	76,1	± 0,07	± 0,10	± 0,15
76,1	88,9	± 0,07	± 0,15	± 0,20
88,9	108	± 0,07	± 0,20	± 0,30
108	159	± 0,2	± 0,70	± 1,0
159	219	± 0,60	± 1,50	± 2,00

NOTE 1 Tolerances for tubes in Soft Annealed material condition are applicable only to mean diameter.
NOTE 2 In case of dispute, to improve the accuracy when determining the mean diameter, the tube may be re- rounded before measurement.
NOTE 3 Tolerance for tubes with a nominal outside diameter higher than 108 mm in material condition soft annealed are not specified.

a Including deviation from circular form
b Including 6.

Table 3- Tolerance on wall thickness

Nominal outside diameter	Tolerance on wall thickness e[a]	
d mm	e < 1 mm %	e≥ 1 mm %
< 18	± 10	± 13
≥ 18	± 10	± 15[b]

NOTE Concentricity (uniformity of wall thickness) is controlled by tolerance on wall thickness.

a Including deviation from concentricity.

b ± 10% for Light Drawn tubes of 35mm, 42mm and 54mm diameter with a wall thickness of 1, 2mm.

Table 3 — Tolerances on outside diameter

Dimensions in millimetres

Nominal outside diameter d		Tolerances on nominal diameter		
		applicable to mean diameter	applicable to any diameter[a]	
over	up to and including	all material conditions	R290 (hard) material condition	R250 (half hard) material condition
6[b]	18	± 0,04	± 0,04	± 0,09
18	28	± 0,05	± 0,06	± 0,10
28	54	± 0,06	± 0,07	± 0,11
54	76,1	± 0,07	± 0,10	± 0,15
76,1	88,9	± 0,07	± 0,15	± 0,20
88,9	108	± 0,07	± 0,20	± 0,30
108	159	± 0,2	± 0,70	± 1,0
159	219	± 0,60	± 1,50	± 2,00

NOTE 1 Tolerances for tubes in R220 (annealed) material condition are applicable only to mean diameter.

NOTE 2 In case of dispute, to improve the accuracy when determining the mean diameter, the tube may be re-rounded before measurement.

NOTE 3 Tolerances for tubes with a nominal outside diameter higher than 108 mm in material condition R220 (annealed) are not specified.

[a] Including deviation from circular form.

[b] Including 6.

6.3.4 Tolerance on wall thickness

The tolerance on wall thickness expressed in percentage of the nominal thickness, as measured at any point, shall conform to the requirements given in Table 4.

Table 4 — Tolerance on wall thickness

Nominal outside diameter d mm	Tolerance on wall thickness e[a]	
	$e < 1$ mm %	$e \geq 1$ mm %
< 18	± 10	± 13
≥ 18	± 10	± 15[b]

NOTE Concentricity (uniformity of wall thickness) is controlled by tolerance on wall thickness.

[a] Including deviation from concentricity.

[b] ± 10 % for R250 (half hard) tubes of 35 mm, 42 mm and 54 mm diameter with a wall thickness of 1,2 mm.

6.3.5 Tolerance on length

The lengths shall be equal to or greater than those ordered.

Table 4 — Tolerances on outside diameter

Values in millimetres

Nominal outside diameter d		Tolerances on nominal diameter		
		applicable to mean diameter	applicable to any diameter [a]	
over	up to and including	all material conditions	R290 (hard) material condition	R250 (half hard) material condition
6 [b]	18	± 0,04	± 0,04	± 0,09
18	28	± 0,05	± 0,06	± 0,10
28	54	± 0,06	± 0,07	± 0,11
54	76,1	± 0,07	± 0,10	± 0,15
76,1	88,9	± 0,07	± 0,15	± 0,20
88,9	108	± 0,07	± 0,20	± 0,30
108	159	± 0,2	± 0,7	± 0,4
159	267	± 0,6	± 1,5	—

NOTE 1 Tolerances for tubes in R220 (annealed) material condition are applicable only to mean diameter.

NOTE 2 In case of dispute, to improve the accuracy when determining the mean diameter, the tube may be re-rounded before measurement.

[a] Including deviation from circular form

[b] Including 6

7.3.4 Tolerances on wall thickness

The tolerances on wall thickness expressed in percentage of the nominal thickness as measured at any point shall conform to the requirements given in Table 5.

Table 5 — Tolerances on wall thickness

Nominal outside diameter d mm	Tolerances on wall thickness e [a]	
	e < 1 mm %	$e \geq 1$ mm %
< 18	± 10	± 13
≥ 18	± 10	± 15 [b]

NOTE Concentricity (uniformity of wall thickness) is controlled by tolerance on wall thickness.

[a] Including deviation from concentricity

[b] ± 10 % for R250 (half hard) tubes of 35 mm, 42 mm and 54 mm diameters with a wall thickness of 1,2 mm

7.3.5 Tolerances on length

The lengths shall be equal to or greater than those ordered.

7. CONDITION

The tubes shall be supplied in one of the following conditions as specified in Table 1:

H As drawn
½H Half hard
O Annealed

8. DIMENSIONS AND TOLERANCES

8.1 Diameter. The mean outside diameter of the tube shall not vary from the specified outside diameter by more than the amount of the tolerances specified in Table X, Y or Z. The mean outside diameter is half the sum of two diameters at right angles on one cross section of the tube.

8.2 Thickness. The thickness of the tube shall be that specified in Table X, Y or Z as appropriate to the diameter of the tube and shall not vary from that specified by more than : 10 %

9. SELECTION OF TEST SAMPLES

When tests are specifically called for by the purchaser, tubes of any one size, thickness and diameter, shall be grouped in batches of 300 tubes or 1300 kg whichever is the greater weight, and the purchaser or his representative shall take one tube at random from each batch, and any part of a batch remaining, for testing.

When the size of the order does not permit batching in the above quantities, one tube of each size, thickness and diameter shall be selected for testing.

TABLE X. DIMENSIONS AND WORKING PRESSURES FOR HALF HARD, LIGHT GAUGE COPPER TUBES

1	2	3	4	5
Size of tube	Outside diameter,		Nominal thickness	Maximum working pressures*
	maximum	minimum		
mm	mm	mm	mm	bar†
6	6·045	5·965	0·6	133
8	8·045	7·965	0·6	97
10	10·045	9·965	0·6	77
12	12·045	11·965	0·6	63
15	15·045	14·965	0·7	58
18	18·045	17·965	0·8	56
22	22·055	21·975	0·9	51
28	28·055	27·975	0·9	40
35	35·07	34·99	1·2	42
42	42·07	41·99	1·2	35
54	54·07	53·99	1·2	27
76·1	76·30	76·15	1·5	24
108	108·25	108·00	1·5	17
133	133·50	133·25	1·5	14
159	159·50	159·25	2·0	15

* Based on material in ½H condition (see Clause 1) at 65 °C.
† 1 bar = 0·1 N/mm² = 10^5 N/m².

TABLE Y. DIMENSIONS AND WORKING PRESSURES FOR HALF HARD AND ANNEALED COPPER TUBES

1	2	3	4	5	6
Size of tube	Outside diameter		Nominal thickness	Maximum working pressures 1/2H condition*	Maximum working pressures O condition†
	maximum	minimum			
mm	mm	mm	mm	bar‡	bar‡
6	6·045	5·965	0·8	188	144
8	8·045	7·965	0·8	136	105
10	10·045	9·965	0·8	106	82
12	12·045	11·965	0·8	87	67
15	15·045	14·965	1·0	87	67
18	18·045	17·965	1·0	72	55
22	22·055	21·975	1·2	69	57
28	28·055	27·975	1·2	55	42
35	35·07	34·99	1·5	54	41
42	42·07	41·99	1·5	45	34
54	54·07	53·99	2·0	47	36
76·1	76·30	76·15	2·0	33	25
108	108·25	108·00	2·5	29	22

* Based on material in ½H condition (see Clause 1) at 65 °C.
† Based on material in O condition (see Clause 1) at 65 °C.
‡ 1 bar = 0·1 N/mm² = 10^5 N/m².

TABLE Z. DIMENSIONS AND WORKING PRESSURES FOR HARD DRAWN THIN WALL COPPER TUBES

1	2	3	4	5
Size of tube	Outside diameter		Nominal thickness	Maximum working pressures*
	maximum	minimum		
mm	mm	mm	mm	bar†
6	6·045	5·965	0·5	113
8	8·045	7·965	0·5	98
10	10·045	9·965	0·5	78
12	12·045	11·965	0·5	64
15	15·045	14·965	0·5	50
18	18·045	17·965	0·6	50
22	22·055	21·975	0·6	41
28	28·055	27·975	0·6	32
35	35·07	34·99	0·7	30
42	42·07	41·99	0·8	28
54	54·07	53·99	0·9	25
76·1	76·30	76·15	1·2	19
108	108·25	108·00	1·2	17
133	133·50	133·25	1·5	16
159	159·50	159·25	1·5	15

* Based on material in H condition (see Clause 1) at 65 °C.
† 1 bar = 0·1 N/mm² = 10^5 N/m².

Canadian Standards Association (CSA) Z 305.1/Z 7396.1, Nonflammable Medical Gas Piping Systems[7]

3. Terminology

3.1 For definitions of terms related to copper and copper alloys, refer to Terminology B846.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *lengths*—straight pieces of the product.

3.2.2 *standard*—uniform lengths established as commercial standards.

3.2.3 *tube, copper water*—a seamless copper tube conforming to the particular dimensions commercially known as Copper Water Tube and designated as Types K and L (see Table 1).

3.2.4 *tube, seamless*—a tube produced with a continuous periphery in all stages of the operations.

4. Ordering Information

4.1 Orders for material under this specification shall include the following information:

4.1.1 Specification B819–00.

4.1.2 Nominal or standard size (Column 1 of Table 1) and whether Type K or L (Sections 3 and 10),

4.1.3 Temper (Sections 7 and 8),

4.1.4 Length (see 10.5),

4.1.5 Quantity (pieces) of each size and type,

4.2 The following options are available and should be specified at the time of placing the order when required.

4.2.1 Whether tension test determinations are required (Section 8),

4.2.2 Whether the tube shall be charged with dry, oil-free nitrogen during capping, closing, or plugging (see 11.8),

4.2.3 Certification, if required (see Section 20), and

4.2.4 Mill Test Report, if required, (see Section 21).

4.2.5 In addition, when material is purchased for agencies of the U.S. government, it shall conform to the Supplementary Requirements as defined herein when specified in the contract or purchase order.

5. Materials and Manufacture

5.1 *Material*—The materials of manufacture shall be a cast billet of Copper Alloy UNS C12200 of such purity and soundness as to be suitable for processing into the products prescribed herein.

5.2 *Manufacture*—The product shall be manufactured by such hot working necessary to convert the billet to a tubular shape and cold worked to the finished size.

6. Chemical Composition

6.1 The material shall conform to the following chemical requirements of Copper UNS No. C12200:

Copper (incl silver), %	99.9 minimum
Phosphorous, %	0.015 to 0.040

6.2 These specification limits do not preclude the presence of other elements. Limits for unnamed elements may be established by agreement between the manufacturer or supplier and the purchaser.

7. Temper

7.1 Seamless copper tube for medical gas systems shall be furnished in the H55 (Light Drawn) temper or H58 (Drawn General Purpose) temper, as defined in Classification B601.

[7] Available from Canadian Standards Association (CSA), 178 Rexdale Blvd., Toronto, ON M9W 1R3, Canada, http://www.csagroup.org.

TABLE 1 Dimensions, Mass, and Tolerances in Diameter and Wall Thickness for Nominal or Standard Copper Water Tube Sizes
(All tolerances are plus and minus except as otherwise indicated)

Nominal or Standard Size, in.	Outside Diameter, in. (mm)		Average Outside Diameter[A] Tolerances, in. (mm)		Wall Thickness and Tolerances, in.								Theoretical Mass, lb/ft (kg/m)			
					Type K				Type L				Type K		Type L	
					Wall Thickness		Wall Tolerance		Thickness		Tolerance					
⅛	0.250	(6.35)	0.001	(0.025)	0.030	(0.762)	0.003	(0.08)	0.025	(0.635)	0.0025	(0.06)	0.080	(0.119)	0.068	(0.102)
¼	0.375	(9.52)	0.001	(0.025)	0.035	(0.889)	0.0035	(0.089)	0.030	(0.762)	0.003	(0.076)	0.145	(0.216)	0.126	(0.187)
⅜	0.500	(12.7)	0.001	(0.025)	0.049	(1.24)	0.005	(0.13)	0.035	(0.889)	0.004	(0.10)	0.269	(0.400)	0.198	(0.295)
½	0.625	(15.9)	0.001	(0.025)	0.049	(1.24)	0.005	(0.13)	0.040	(1.02)	0.004	(0.10)	0.344	(0.512)	0.285	(0.424)
⅝	0.750	(19.1)	0.001	(0.025)	0.049	(1.24)	0.005	(0.13)	0.042	(1.07)	0.004	(0.10)	0.418	(0.622)	0.362	(0.539)
¾	0.875	(22.3)	0.001	(0.025)	0.065	(1.65)	0.006	(0.15)	0.045	(1.14)	0.004	(0.10)	0.641	(0.954)	0.455	(0.677)
1	1.125	(28.6)	0.0015	(0.038)	0.065	(1.65)	0.006	(0.15)	0.050	(1.27)	0.005	(0.13)	0.839	(1.25)	0.655	(0.975)
1¼	1.375	(34.9)	0.0015	(0.038)	0.065	(1.65)	0.006	(0.15)	0.055	(1.40)	0.006	(0.15)	1.040	(1.55)	0.884	(1.32)
1½	1.625	(41.3)	0.002	(0.051)	0.072	(1.83)	0.007	(0.18)	0.060	(1.52)	0.006	(0.15)	1.360	(2.02)	1.140	(1.70)
2	2.125	(54.0)	0.002	(0.051)	0.083	(2.11)	0.008	(0.20)	0.070	(1.78)	0.007	(0.18)	2.060	(3.07)	1.750	(2.60)
2½	2.625	(66.7)	0.002	(0.051)	0.095	(2.41)	0.010	(0.25)	0.080	(2.03)	0.008	(0.20)	2.930	(4.36)	2.480	(3.69)
3	3.125	(79.4)	0.002	(0.510)	0.109	(2.77)	0.011	(0.28)	0.090	(2.29)	0.009	(0.23)	4.000	(5.95)	3.330	(4.96)
3½	3.625	(92.1)	0.002	(0.051)	0.120	(3.05)	0.012	(0.30)	0.100	(2.54)	0.010	(0.25)	5.120	(7.62)	4.290	(6.38)
4	4.125	(105)	0.002	(0.051)	0.134	(3.40)	0.013	(0.33)	0.110	(2.79)	0.011	(0.28)	6.510	(9.69)	5.380	(8.01)
5	5.125	(130)	0.002	(0.051)	0.160	(4.06)	0.016	(0.41)	0.125	(3.18)	0.012	(0.30)	9.670	(14.4)	7.610	(11.3)
6	6.125	(156)	0.002	(0.051)	0.192	(4.88)	0.019	(0.48)	0.140	(3.56)	0.014	(0.36)	13.900	(20.7)	10.200	(15.2)
8	8.125	(206)	+0.002 −0.006	(0.051) (0.150)	0.271	(6.88)	0.027	(0.69)	0.200	(5.08)	0.020	(0.51)	25.900	(38.5)	19.300	(28.7)

[A] The average outside diameter of a tube is the average of the maximum and minimum outside diameter, as determined at any one cross section of the tube.

CHEMICAL , MECHANICAL , TESTING & SAMPLING PARAMETER OF SPECIFICATION

SR NO	PARAMETER	AS PER ASTM B 819 (2019)	AS PER BS 2871 :PART 1 :1971	AS PER EN 1057:2006 +A1:2010	AS PER BS EN 13348:2016	RECOMMENDATION BY MANDEV
		SEAMLESS COPPER TUBE FOR MEDICAL GAS SYSTEM	COPPER TUBES FOR WATER ,GAS AND SANITATION	SEAMLESS, ROUND COPPER TUBES FOR WATER AND GAS IN SANITARY AND HEATING APPLICATIONS	SEAMLESS, ROUND COPPER TUBES FOR MEDICAL GASES OR VACUUM	SEAMLESS, ROUND COPPER TUBES FOR MEDICAL GASES PIPE LINE APPLICATION
		RESULT	RESULT	RESULT	RESULT	RESULT
1	**Grade Mentioned**	COPPER UNS NO. C 12200	BS 1172 (C 106) PR BS 1174 (C107)	Cu - DHP or CW024A	Cu - DHP or CW024A	Cu - DHP
2	**GRADE**	COPPER UNS NO. C 12200	Cu - DHP C 12200	Cu - DHP or CW024A	Cu - DHP or CW024A	Cu - DHP
	Copper + Ag (%)	99.90%	99.90%	99.90%	99.90%	99.90%
	Phosphorous (%)	0.015%≤ P ≤ 0.040%	0.015%≤ P ≤ 0.040%	0.015%≤ P ≤ 0.040%	0.015%≤ P ≤ 0.040%	0.015%≤ P ≤ 0.040%
3	**TEMPER**	NOT MENTIONED	Annealed (Soft)	Annealed (Soft)	Annealed (Soft)	Annealed (Soft)
4	MECHANICAL PROPERTIES*					
	Hardness (HV 5)	NOT MENTIONED	NOT MENTIONED	40 to 70	40 to 70	NOT MENTION
	Tensile Strength (N/mm2 Or Mpa)	NOT MENTIONED	210 Mpa min	220 Mpa min	220 Mpa min	220 Mpa min
	Elongation (%)	NOT MENTIONED	40 % Min	40% Min.	40% Min.	40% Min.
5	**EXPANSION TEST/ DRIFTING TEST/ FLARING**	NOT MENTIONED	30% of the diameter	1) 6 mm to 18 mm Mandatory 2) 18 mm to 54 mm To be agreed upon by the purchaser and the supplier 3) 54 mm to 267 mm Not applicable	1) 6 mm to 18 mm Mandatory 2) 18 mm to 54 mm To be agreed upon by the purchaser and the supplier 3) 54 mm to 219 mm Not applicable	Mandatory
6	**TEMPER**	LIGHT DRAWN (H 55) & DRAWN GENERAL PURPOSE (H 58)	Half Hard	Half Hard	Half Hard	Light Drawn
	MECHANICAL PROPERTIES*					
	Hardness (Hv 5)	70 - 110 (H 55) & 70 Min (H 58)	Not Mentioned	75 to 100	75 to 100	Not Mention
	Tensile Strength (MPa)	250 - 325 Mpa (H 55) & 250 Min (H 58)	250 min	250 min	250 min	250 min
	Elongation (%)	NOT MENTIONED	30% Min			
	6 mm - 66.7 mm			30% min	30% min	30% min
	66.7 mm to 219 mm			66.7 mm to 159 mm - 20% min	20% min	20% min
7	**EXPANSION TEST/ DRIFTING TEST/ FLARING**	NOT MENTIONED	30% of the diameter	1) 6 mm to 18 mm Mandatory 2) 18 mm to 54 mm To be agreed upon by the purchaser and the supplier 3) 54 mm to 267 mm Not applicable	1) 6 mm to 18 mm Mandatory 2) 18 mm to 54 mm To be agreed upon by the purchaser and the supplier 3) 54 mm to 219 mm Not applicable	The light drawn tubes shall be soft annealed before testing.
8	**TEMPER**	NOT MENTIONED	Hard	Hard	Hard	Hard Drawn
	MECHANICAL PROPERTIES*					
	Hardness (Hv 5)	NOT MENTIONED	Not Mentioned	100 Min	100 Min	Not Mentioned (Refer Note 2)
	Tensile Strength (MPa)	NOT MENTIONED	Up to 54 mm - 380 Mpa min 54 mm to 159 mm - 310 Mpa min	290 min	290 min	290 min
	Elongation (%)	NOT MENTIONED	Not Applicable	3 min	3 min	3 min
9	**EXPANSION TEST/ DRIFTING TEST/ FLARING**	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

10	**EDDY CURRENT TEST**	EACH TUBE SHALL BE SUBJECTED TO THE EDDY CURRENT TEST	EDDY CURRENT OR HYDROSTATIC OR PNEUMATIC TEST ARE OPTIONAL, AMONG ONE TEST IS MANDATORY	EACH TUBE SHALL BE SUBJECTED TO THE EDDY CURRENT TEST	EACH TUBE SHALL BE SUBJECTED TO THE EDDY CURRENT TEST	EACH TUBE SHALL BE SUBJECTED TO THE EDDY CURRENT TEST
11	**HYDROSTATIC TEST**	SHOULD SUBSEQUENT TESTING BY THE PURCHASER	EDDY CURRENT OR HYDROSTATIC OR PNEUMATIC TEST ARE OPTIONAL, AMONG ONE TEST IS MANDATORY	TO BE AGREED BETWEEN THE PURCHASER AND THE SUPPLIER AT THE TIME OF THE ORDER / NOT MANDATORY	TO BE AGREED BETWEEN THE PURCHASER AND THE SUPPLIER AT THE TIME OF THE ORDER / NOT MANDATORY	TO BE AGREED BETWEEN THE PURCHASER AND THE SUPPLIER AT THE TIME OF THE ORDER / NOT MANDATORY
12	**PNEUMATIC TEST**	SHOULD SUBSEQUENT TESTING BY THE PURCHASER	EDDY CURRENT OR HYDROSTATIC OR PNEUMATIC TEST ARE OPTIONAL, AMONG ONE TEST IS MANDATORY	TO BE AGREED BETWEEN THE PURCHASER AND THE SUPPLIER AT THE TIME OF THE ORDER / NOT MANDATORY	TO BE AGREED BETWEEN THE PURCHASER AND THE SUPPLIER AT THE TIME OF THE ORDER / NOT MANDATORY	TO BE AGREED BETWEEN THE PURCHASER AND THE SUPPLIER AT THE TIME OF THE ORDER / NOT MANDATORY
13	**CARBON FILM TEST**	NOT MENTIONED	Not Mentioned	NOT MANDATORY / OPTIONAL TEST OF CARBON CONTENT	NOT MENTIONED	NOT MENTIONED (Refer Note 3)
14	**CARBON CONTENT TEST**	NOT MENTIONED	Not Mentioned	MANDATORY AS PER SAMPLING CLAUSE 10 mm to 54 mm - 0.20 mg/dm2 OVER 54mm FOR HARD -1.0 mg/dm2	MANDATORY AS PER SAMPLING CLAUSE 6 mm to 133 mm - 0.20 mg/dm2 133 mm to 219 mm-0.38 mg/dm2	NOT MENTIONED (Refer Note 3)
15	**CLEANNESS REQUIREMENTS**	THE RESIDUE REMAINING UPON EVAPORATION OF THE SOLVENT SHALL NOT EXCEED 0.038G/M2	Not Mentioned	NOT MENTIONED	NOT MENTIONED	THE RESIDUE REMAINING UPON EVAPORATION OF THE SOLVENT SHALL NOT EXCEED 0.038G/M2
16	**SAMPLING**					
	CHEMICAL	One sample shall be taken for test purposes from each lot of 10000 lbs (4550 kg)	Tubes of any one size, thickness and diameter, shall be grouped in batches of 300 tubes or 1300 kg whichever is the greater weight.	Quantity for one sampling unit ≤ 0.25 kg/m or 1500 kg or 3000 kg > 0.25 kg/m or 2500 kg or 5000 kg	Not Mentioned	From a lot found acceptable for dimensions, one test shall be conducted from each of these tests
	TENSILE , HARDNESS, DRIFTING	1 to 50 number in lot - 1 sample 51 to 200 number in lot - 2 sample 201 to 1500 number in lot - 3 sample Over 1500 number in lot - 0.2% of total piece in the lot but not more than 10 sample pieces	Tubes of any one size, thickness and diameter, shall be grouped in batches of 300 tubes or 1300 kg whichever is the greater weight.	Quantity for one sampling unit ≤ 0.25 kg/m or 1500 kg or 3000 kg > 0.25 kg/m or 2500 kg or 5000 kg	Quantity for one sampling unit ≤ 0.25 kg/m or 1500 kg > 0.25 kg/m or 2500 kg	From a lot found acceptable for dimensions, one test shall be conducted from each of these tests
	HYDRAULIC TEST	Not Mentioned	Not Mentioned	Quantity for one sampling unit ≤ 0.25 kg/m or 1500 kg or 3000 kg > 0.25 kg/m or 2500 kg or 5000 kg	Not Mentioned	TO BE AGREED BETWEEN THE PURCHASER AND THE SUPPLIER AT THE TIME OF THE ORDER / NOT MANDATORY
	PNEUMATIC TEST	Not Mentioned	Not Mentioned	Quantity for one sampling unit ≤ 0.25 kg/m or 1500 kg or 3000 kg > 0.25 kg/m or 2500 kg or 5000 kg	Not Mentioned	TO BE AGREED BETWEEN THE PURCHASER AND THE SUPPLIER AT THE TIME OF THE ORDER / NOT MANDATORY
	EDDY CURRENT TESTING	Not Mentioned	Not Mentioned	Quantity for one sampling unit ≤ 0.25 kg/m or 1500 kg or 3000 kg > 0.25 kg/m or 2500 kg or 5000 kg	Not Mentioned	EACH TUBE SHALL BE SUBJECTED TO THE EDDY CURRENT TEST
	CARBON FILM TEST	Not Mentioned	Not Mentioned	Quantity for one sampling unit ≤ 0.25 kg/m or 1500 kg or 3000 kg > 0.25 kg/m or 2500 kg or 5000 kg	Not Mentioned	Not Applicable
	CARBON CONTENT TEST	Not Mentioned	Not Mentioned	Quantity for one sampling unit ≤ 0.25 kg/m or 1500 kg or 3000 kg > 0.25 kg/m or 2500 kg or 5000 kg	Not Mentioned	Not Applicable
	CLEANNESS REQUIREMENTS	Not Mentioned	Not Mentioned	Not Applicable	Not Mentioned	From a lot found acceptable for dimensions, one test shall be conducted from each of these lot.

NOTE 1: DIMENSION TOLERANCE ATTACHED FOR ASTM B 819 , BS 2871 , EN 1057 , EN 13348 & MANDEV RECOMMEDATION SPECIFICATION .

NOTE 2 : Regarding Hardness Test, BIS does not have its own particular specification defined, In their earlier different copper tube specification as well as other references specification for testing.

NOTE 3 : We recommended residue / cleanliness test . As BIS does not have its own particular specification defined, In their earlier different copper tube specification as well as other references specification for testing.