SOLID DRAWN COPPER TUBES - HALF HARD

1.0 GENERAL:

This specification governs the quality requirements of solid drawn copper tubes.

2.0 APPLICATION:

For general engineering purpose.

3.0 CONDITION OF DELIVERY:

The tubes shall be in half hard condition (Stress relieved) and shall be cut square, cleaned and deburred.

The tubes shall be supplied in half - hard condition through out their length and suitable for expansion and bell mouthing at both ends.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

Assistance has been taken from BSEN: 1057.

5.0 DIMENSIONS AND TOLERANCES:

5.1 Sizes:

The tubes shall be supplied to the dimensions specified in BHEL order.

5.2 Tolerances:

The tolerance on outside diameter, wall thickness, and length shall comply with the following.

5.2.1 Tolerance on outside Diameter:

Table 1: Tolerance on outside diameter

Nominal outside diameter, d		Tolerance on nominal diameter (Values in mm)	
over	up to and including	Applicable to mean diameter	Applicable to any diameter *
≥ 6	18	± 0.04	± 0.09
18	28	± 0.05	± 0.10

28	54	± 0.06	± 0.11
54	76.1	± 0.07	± 0.15
76.1	88.9	± 0.07	± 0.20
88.9	108	± 0.07	± 0.30
108	159	± 0.2	± 0.40
159	267	± 0.6	-
* Including deviation from circular form			

5.2.2 Tolerances 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 below:

Table 2: Tolerance on wall thickness

Nominal outside diameter, d	Tolerance on wall thickness **e** *	
	e < 1 mm %	e ≥ 1 mm %
< 18	± 10	± 13
≥ 18	± 10	± 15 **

***** Including deviation from concentricity

****** ± 10 % for half - hard tubes of 35 mm, 42 mm and 54 mm diameter with wall thickness of 1.2 mm.

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

5.2.3 Tolerances on specified length of tubes:

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

6.0 FREEDOM FROM DEFECTS:

The tubes shall be leak tight and shall have no detrimental defects.

6.1 Surface quality:

The outer and inner surface of the tubes shall be clean and smooth.

The inner surface shall not contain any detrimental film nor present a carbon level high enough to allow the formation of such film during installation. When tested in accordance with 10.4 and 10.5 as appropriate the tube shall conform to the appropriate requirements given in table 3.

Table 3: Quantitative and qualitative specification for carbon residues

Nominal outside diameter d mm		Residual Carbon[1)]	Potential Carbon[1)]	Total Carbon [1)]	Carbon Film test
From Up to and Including	10 54	0.20	-	-	Yes
Over	54	0.20	-	-	Yes

Table 4: Testing of drift expanding

Nominal outside diameter d mm		Technological test
Over	Up to and including	Drift expanding test
6 *	18	M
18	54	A
54	267	-

* Including 6
M- Mandatory
A- As agreed upon by BHEL and the supplier

6.4 Drift expanding:

No crack, break or tearing of the metal shall be visible to the unaided eye when tubes of sizes and tempers given in table 4 are tested in accordance with 10.6.

7.0 CHEMICAL COMPOSITION:

The chemical composition of the material when analysed as per IS: 440 or any other established instrumental / chemical method shall be as follows:

Copper (Incl. Silver) : 99.90%, minimum.

$0.015\ \% \leq$ Phosphorus ≤ 0.040

8. 0 MECHANICAL PROPERTIES:

When tested in accordance with IS: 1608 tensile strength and elongation shall conform to the requirements given below:

Tensile strength : 250 MPa, min.

Hardness Vickers (HV5) : 75 – 100

Elongation (for 6 to 66.7 mm dia. tube and either e < 1mm or $d/e^2 > 24$) $\geq$ 30%
(for 6 to 159 mm dia. tube or e $\geq$ 1mm and also $d/e^2 \leq 24$) $\geq$ 20%

Where

d is the nominal outside diameter in millimetres;
e is the nominal wall thickness in millimetres.

9.0 SAMPLING:

For the purpose of quality assurance during production, the number of sampling units to be taken at random shall be as follows:

Sampling Rate		
Tube weight per meter kg/m	Quantity for one sampling unit at predicted monthly metreage *	
	< 100 000m kg	≥ 100 000m kg
≤ 0.25	1 500	3 000
> 0.25	2 500	5 000
* at least one sampling unit shall be taken per production batch.		

These sampling rates shall apply when testing for dimensional controls; control of other mandatory properties shall be carried out on each second sampling unit.

For the verification of the composition, results may be used from analyses carried out at an earlier stage of manufacturing of product, e.g. at the casting or billets inward stage.

10.0 TEST MERHODS:

10.1 Analysis

For composition, analysis shall be carried out on the test samples obtained in accordance with clause 9. The analytical methods shall be chemical or spectrographic in accordance with appropriate national / international standards. In cases of dispute the reference method shall be by chemical analysis.

10.2 Tensile test

The tensile test shall be carried out in accordance with EN 10002 -1 / IS: 1608 on test pieces prepared from the samples obtained in accordance with clause 9.

10.3 Hardness test

When required, the Vickers hardness test shall be carried out in accordance with ISO 6507 -1 / IS: 1608.

10.4 Carbon content test:

The determination of carbon content shall be carried out on the samples obtained in accordance with clause 9 using reference method described in prEN723.

10.5 Carbon film test:

The detection and assessment of carbon film shall be carried out on the samples obtained in accordance with clause 9 using the method described in annex. A.

10.6 Drift expanding test:

When required, the drift expanding test shall be carried out in accordance with IS 2501. The outside diameter of the tube end shall be expanded by 30% using a conical mandrel having an angle of 45°.

10.7 Freedom from defects tests:

Each tube shall be subjected to one of the following tests:

- eddy current test for detection of local defects, in accordance with prEN 1971 and the requirements in B.1;
- hydrostatic test in accordance with the method in B.2;
- Pneumatic test in accordance with the method in B. 3.

The choice of method, selected from the above, is at the discretion of the manufacturer.

11.0 RETEST:

In the event that the tube sample fails to meet the test requirements, further sample shall be taken from the batch at a sampling rate four times higher than specified in sampling clause and if any of the retest samples fail to meet the specification requirements, the tube represented by the sample shall be rejected. If all the retest samples meet the requirements, the tubes represented by the samples shall be accepted.

12.0 TEST CERTIFICATES:

Unless otherwise specified on order, three copies of test certificates shall be supplied.

In addition, supplier shall sure to enclose one copy of test certificate along with dispatch documents to facilitate quick clearance of material**.**

The test certificate shall bear the following information:

BHEL order No.

AA 12016, Rev. No. 01 : Solid Drawn Copper Tubes – Half hard

Batch No.

Identification Mark / No.

Weight

Supplier's Reference and Name

Result of Chemical, Mechanical, and all other tests called for.

13.0 PACKING AND MARKING:

The material shall be suitably packed in wooden crated to prevent corrosion and damage during transit.

Each crate shall be legibly marked with the following information.

BHEL order No.

AA 12014

Batch No.

Identification Mark / No.

Weight

Supplier's reference and Name

14.0 REFERRED STANDARDS (Latest Publications Including Amendments):

(1) BS EN 1057 (2) IS 440 (3) IS: 1608 (4) IS: 2305

(5) ASTM E 24 (6) AA 0490002

Annexure A

Carbon film test

A.1 Preparation of the test piece

The sample of tube to be tested shall be cleaned on its outside surface either abrasively by filling or turning in order to remove all traces of the original surface finish, or chemically by sealing one end with an acid resistant plug and then immersing in concentrated nitric acid to pickle the outside surface, and then rinsing with deionized water and drying.

A sample, at least 25 mm long, shall be then cut from the cleaned section, using a clean saw blade and cut in half longitudinally to make two test pieces. One test piece shall be degreased by dipping in acetone.

For tube dimensions exceeding 22 mm X 1 mm a sample of comparable surface area shall be taken, the preparation of which shall correspond to the procedure described.

A. 2 Method

The degreased test piece shall be placed, with its internal surface upwards, in a small, flat bottomed white porcelain or glass dish and covered with 25% (V/V) nitric acid at ambient temperature.

The acid causes loosening of surface deposits which will float to the surface. When the acid turns blue in colour the test piece shall be removed and rinsed with deionized water to wash back into the acid any particles adhering to the test piece.

A. 3 Detection and assessment of films

The reaction of the test piece in the acid shall be observed with a microscope of X10 magnification. The initial observation will assess whether a material released by the acid is in the form of a film or particulate. If nothing is detected, or particles are found, the test is passed.

If clearly visible films are seen floating to the surface these may be of carbon or oxide.

To distinguish between carbon and oxide, the porcelain or glass dish shall be gently heated and the acid allowed to boil for about 5 min to dissolve any oxide films.

If on re-examination the films have been eliminated or only particles remain, the test passed. If there is no reduction in the film element, then it is carbon and the test is failed.

Annexure B

Freedom from defect tests

B. 1 Eddy current test

Maximum drill diameters for the reference standard tube which is defined in EN 1971 and are given table B. 1. Signals produced by reference standard tubes set the sorting limits for acceptance or rejection. Tubes containing defects which produce signals equal to or greater than the sorting limit shall be rejected.

B. 2 Hydrostatic test

The tube under test shall be connected to a source of pressurized water. Water pressure as specified in table B. 2 shall be maintained in the tube for a minimum period for 10 second without evidence of leaking. If one or more leaks are observed, the tube shall be rejected. If no leak is observed, the tube shall be accepted.

Table B.2

Nominal outside diameter d (mm)		Hydrostatic pressure (bar)
Over	Up to and including	Min.
6 *	54	35
54	108	25
108	159	15
159	267	10

* Including 6

B. 3 Pneumatic test

The tube under test shall be connected to a source of pressurized air. Air pressure at 4 bar (0.4 MPa) shall be maintained in the tube.

The tube shall be completely immersed in water for a minimum period of 10 Second and inspected for the issue of bubbles from the tube. Should any bubbles be observed then the tube shall be rejected. If no bubbles are observed then the tube shall be accepted.