

BRITISH STANDARD 2871 : Part 1 : 1971

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**SPECIFICATION FOR
COPPER AND
COPPER ALLOYS
TUBES**

**Part 1. Copper tubes for water, gas and
sanitation**

BRITISH STANDARDS INSTITUTION

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sanitation**

BS 2871 : Part 1 : 1971

Incorporating amendments issued May 1974 (AMD 1422)
and November 1976 (AMD 2203)

BRITISH STANDARDS INSTITUTION

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The Institution desires to call attention to the fact that this British Standard does not purport to include all the necessary provisions of a contract.

A complete list of British Standards, numbering over 9 000, fully indexed and with a note of the contents of each, will be found in the BSI Catalogue which may be purchased from BSI Sales Department. The Catalogue may be consulted in many public libraries and similar institutions.

This standard makes reference to the following British Standards:

- BS 18. Methods for tensile testing of metals. Part 1. Non-ferrous metals.
- BS 864. Capillary and compression tube fittings of copper and copper alloys. Part 2. Metric units.
- BS 1172. Phosphorus deoxidized non-arsenical copper for general purposes.
- BS 1174. Phosphorus deoxidized arsenical copper.
- BS 1957. Presentation of numerical values (fineness of expression; rounding of numbers).
- BS 3889. Methods for non-destructive testing of pipes and tubes. Part 2B. Eddy current testing of non-ferrous tubes.

British Standards are revised, when necessary, by the issue either of amendment slips or of revised editions. It is important that users of British Standards should ascertain that they are in possession of the latest amendments or editions.

The following BSI references relate to the work on this standard:
Committee reference NFE/17 Draft for comment 70/21913

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CO-OPERATING ORGANIZATIONS

The Non-ferrous Metals Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments, and scientific and industrial organizations:

Aluminium Federation
 Association of Bronze and Brass Founders
 Association of Consulting Engineers, Incorporated
 Board of Trade
 British Bronze and Brass Ingot Manufacturers' Association
 *British Electrical and Allied Manufacturers' Association
 British Lead Manufacturers' Association
 *British Non-ferrous Metals Federation
 *British Non-ferrous Metals Research Association
 *Copper Development Association
 Crown Agents for Oversea Governments and Administrations
 Electric Cable Makers' Confederation
 Institute of British Foundrymen
 Institute of Metals
 *Institution of Mechanical Engineers
 Institution of Mining and Metallurgy
 Institution of Production Engineers
 Institution of Structural Engineers
 Lead Development Association
 Light Metal Founders' Association
 London Metal Exchange
 Magnesium Industry Council
 *Ministry of Defence (Army Dept)
 *Ministry of Defence (Navy Dept)
 National Brassfoundry Association
 *Non-ferrous Metal Stockists
 Post Office
 Royal Institute of British Architects
 Society of Motor Manufacturers and Traders Limited
 Tin Research Institute
 Zinc Development Association
 Individual manufacturers

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:

British Waterworks Association
 Copper Tube Fittings Manufacturers' Association
 Department of the Environment
 Department of Trade and Industry
 Electricity Supply Industry in England and Wales
 Engineering Equipment Users' Association
 Gas Council
 Institute of Plumbing
 Institution of Gas Engineers
 National Federation of Plumbers and Domestic Heating Engineers

BRITISH STANDARD SPECIFICATION FOR
COPPER AND COPPER ALLOYS
TUBES

Part 1. Copper tubes for water, gas and sanitation

FOREWORD

This British Standard is the first revision in metric terms of one of a series for copper and copper alloy in various wrought forms, the preparation of which was authorized by the Non-ferrous Metals Industry Standards Committee. Others in the series are:

BS 2870. Rolled copper and copper alloys, sheet, strip and foil.

BS 2872. Copper and copper alloys. Forging stock and forgings.

BS 2873. Copper and copper alloys. Wire.

BS 2874. Copper and copper alloys. Rods and sections (other than forging stock).

BS 2875. Copper and copper alloys. Plate.

In preparing this metric revision of BS 2871 it was decided to produce it in three parts, thereby eliminating the large section of particular applications which forms Part 3 of the 1957 edition. Further reduction in size has been effected by the tabulation of mechanical properties and test requirements.

This Part 1 provides for copper tubes primarily for water, and also for gas and sanitation applications, suitable for connection by capillary or compression fittings (metric sizes), or other appropriate methods, and covers requirements similar to those previously covered by the following individual standards, which have now been withdrawn. *As added Nov., 1976*

BS 659. Light gauge copper tubes (light drawn).

BS 1386. Copper tubes to be buried underground.

BS 3931. Hard-drawn thin wall copper tubes.

Since these tubes are intended to be suitable for use with fittings they are standardized on the basis of outside diameter. The sizes quoted have been agreed by the appropriate ISO Technical Committee and will be specified in ISO/R 274, 'Copper alloy tubes', which is being revised at present. The tolerances on outside diameter in ISO/R 274 are greater than those specified in this standard and adhered to for many years in the appropriate British Standards. Tighter tolerances on outside diameter have therefore been specified in this standard, thereby producing better fitting joints.

In order to ensure there is no difficulty in assembling tubes and fittings taking full advantage of the greater ISO tolerances, the maximum permitted outside diameter is the same, consequently the minimum outside diameter is slightly larger in this standard.

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The opportunity has been taken to relate the pressure suitability of the tubes to their actual strength and not to the relatively low available domestic water pressures previously quoted.

As amended Nov., 1976 To avoid confusion with the tables of sizes previously given in individual standards, completely different letters (i.e. W, X, Y and Z) have been quoted herein.

Throughout this standard and the others in the series a unified system of symbols has been used to designate the alloy and suffix letters have been used to indicate the temper or condition of heat treatment in which the materials are available.

NOTE. Attention is drawn to certification facilities offered by BSI; see the back cover of this standard.

SPECIFICATION

1. SCOPE

This Part of this British Standard specifies requirements for copper tubes in the following four different conditions:

As amended Nov., 1976

(1) Annealed copper tubes supplied in coils, suitable for connection by means of compression fittings and capillary fittings for use in micro-bore or mini-bore heating systems, designated Table W.

(2) Half hard copper tubes supplied in straight lengths, suitable for connection by means of compression fittings and capillary fittings or by silver brazing or by suitable methods of welding, designated Table X.

(3) Half hard copper tubes in straight lengths and annealed copper tubes in coils suitable for burying underground and for connection by means of compression fittings and capillary fittings or by silver brazing or by bronze or autogenous welding, designated Table Y.

(4) Hard drawn copper tubes supplied in straight lengths suitable for connection by means of capillary fittings or non-manipulative type compression fittings (Type A specified in BS 864, Part 2), designated Table Z. (These tubes are not recommended for bending.)

As amended Nov., 1976

Maximum working pressures at temperatures up to 65 °C*, calculated in accordance with the following formula, are stated in Tables W, X, Y and Z:

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

where

P = pressure (bar)

F = stress (N/mm²)

* Copper tubes are suitable in some circumstances for use up to a maximum temperature of 200 °C, but for pressure calculation purposes a stress value appropriate to the particular temperature should be used.

t = thickness (mm)

D = Outside diameter (mm)

For H Condition, $F = 72.5 \text{ N/mm}^2$

For $\frac{1}{2}$ H Condition, $F = 60 \text{ N/mm}^2$

For O Condition, $F = 46 \text{ N/mm}^2$

If tubes in the H and $\frac{1}{2}$ H condition are annealed then the stress value quoted above for the O condition should be used in the calculation of the working pressures.

NOTE. The titles of the British Standards referred to in this standard are listed on page 2.

2. GENERAL

The tubes shall comply with the general requirements set out in the following clauses and with the appropriate requirements stated in Table 1 and Tables W, X, Y or Z.

*As amended
Nov., 1976*

3. INFORMATION TO BE SUPPLIED BY THE PURCHASER

The purchaser shall state on his enquiry and order the following information:

- (1) The table of tubes required (W, X, Y or Z).
- (2) If Table Y is selected, the condition of the material.
- (3) Whether mechanical tests are required.
- (4) Whether a certificate of compliance is required.
- (5) Whether it is the intention of the purchaser to inspect the material at the supplier's works.
- (6) If Table W is selected, the thickness required.

*As amended
Nov., 1976*

*As added
Nov., 1976*

4. FREEDOM FROM DEFECTS

The tubes shall be round, clean, smooth and free from harmful defects and from deleterious films in the bore.

5. CHEMICAL COMPOSITION

The chemical composition of the tubes shall comply with the requirements of BS 1172 (C.106) or BS 1174 (C.107).

6. MANUFACTURE

The tubes shall be solid drawn. The ends shall be cut clean and square with the axis of the tube. In no case shall tubes be re-drawn from used tubes.

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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

*As amended
Nov., 1976*

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 W, 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.

*As amended
Nov., 1976*

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

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.

10. MECHANICAL TESTS (INCLUDING PREPARATION OF TEST PIECES)

10.1 Tensile test. Tensile tests shall be made on test samples of tube selected in accordance with Clause 9 and tested in full section or on longitudinal strips cut from any part of the tube. The tests shall be made in accordance with BS 18, Part 1, and the values obtained shall comply with the appropriate requirements given in Table 1.

10.2 Drifting test. For tubes designated Table X and Table Y the tubes as supplied, without annealing, shall be expanded as shown in Fig. 1 by means of a taper drift having an included angle of 45° , until the outside diameter of the expanded end exceeds the original outside diameter by the amount specified in Table 1. The tube shall not crack when subjected to this test.

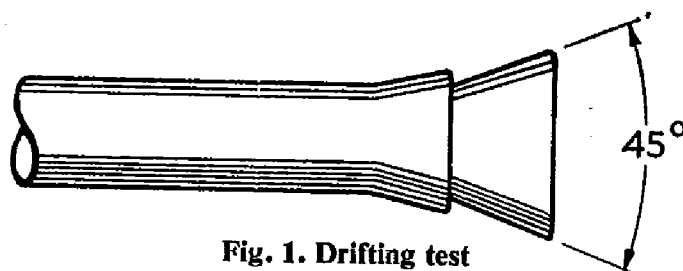


Fig. 1. Drifting test

11. NON-DESTRUCTIVE TEST

The manufacturer shall satisfy himself that each tube will withstand the minimum test pressure specified in Table 1 as appropriate to the size of tube, without leakage, by means of a hydrostatic or pneumatic test or an eddy current test in accordance with BS 3889, Part 2B.

NOTE. These methods of test are intended to determine the soundness of the tube wall and are not to be regarded as an indication of the strength or safe working pressure.

12. RETESTS

Should any of the test pieces first selected by the purchaser or his representative fail to pass any of the prescribed tests, two further samples from the same batch shall be selected for testing, one of which shall be from the tube from which the original test sample was taken, unless that tube has been withdrawn by the supplier.

Should the test pieces from both these additional samples pass, the batch represented by the test samples shall be deemed to comply with this standard. Should the test pieces from either of these additional samples fail, the batch represented by the test samples shall be deemed not to comply with this standard.

13. CERTIFICATE OF COMPLIANCE

The supplier shall, if required, and stated on the order, certify that the tube complies with the requirements of this standard.

*As amended
Nov., 1976*

14. INSPECTION

The purchaser shall notify the supplier when placing the order if it is his intention to inspect the material at the supplier's works. The supplier shall afford the purchaser all reasonable facilities to satisfy himself that the material is in accordance with the standard. For this purpose the purchaser or his representa-

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tive may, by prior arrangement, attend to inspect the material, to select and identify the test samples for testing and to witness the tests being made.

The purchaser shall be at liberty to take samples from the material selected in accordance with Clause 9 and have them analysed. The results shall be communicated to the supplier if they are not in accordance with either of the compositions given in Clause 5.

15. INDEPENDENT TEST

Should there be a dispute about the compliance of the material with either the composition or the test requirements of this standard, the purchaser and the supplier shall have the right to have tests made by a mutually acceptable testing authority.

The results obtained by the independent testing authority shall be accepted as final.

16. FACILITIES FOR TESTING

For making tests on samples selected in accordance with Clause 9 the supplier shall provide and prepare the necessary test pieces and supply labour and appliances for such testing as may be carried out on his premises in accordance with this standard. Unless otherwise agreed, material for testing shall remain the property of the supplier. Failing facilities at his own works for making the prescribed tests, the supplier shall make the necessary arrangements for making the tests elsewhere.

17. MARKING

For tubes from 15 mm diameter up to and including 42 mm diameter, the manufacturer shall permanently mark each tube at intervals of not more than 500 mm with the number of this British Standard, i.e. BS 2871, the table designation and his identification mark.

For all tubes above 42 mm diameter the manufacturer shall mark each tube at one end with the number of this British Standard, i.e. BS 2871, the table designation and his identification mark.

18. THE ROUNDING OF NUMBERS RULE

Values between the limits of composition and mechanical properties shown (NOT dimensional tolerances) are subject to the application of the 'rounding' rule in accordance with BS 1957. Under this rule the determined values are 'rounded' to the last place of figures stated as limits.

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The following examples illustrate the application of the rounding rule:

Specification limits		Extreme values which round to specification limits	
min.	max.	min.	max.
—	0.050	—	0.0505
0.2	0.6	0.15	0.65
6	9	5.5	9.4
6.0	9.0	5.95	9.05
7	10	6.6	10.5
7.5	10.5	7.46	10.54

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TABLE 1. MECHANICAL PROPERTIES AND TEST REQUIREMENTS FOR COPPER TUBES

As amended
Nov., 1976

	Specified size of tube		Condition	Tensile strength minimum	Elongation on 5.65 $\sqrt{S_0}$ minimum	Drifting test minimum	*Minimum hydraulic pressure	*Minimum pneumatic pressure
	Over	Up to and including						
Table W	mm	mm	O	N/mm ² 210	%	30	bar† 35	bar† 4
	—	10						
Table X	—	54	½H†	250	30	30	35	4
	54	108	½H†	250	30	30	25	4
	108	159	½H†	250	30	30	15	4
Table Y	—	35	O	210	40	30	35	4
	35	108	O	210	40	30	25	4
	—	35	½H†	250	30	30	50	4
	35	108	½H†	250	30	30	25	4
Table Z	—	54	H	380	—	—	35	4
	54	108	H	310	—	—	25	4
	108	159	H	310	—	—	15	4

* One of these tests or an eddy current test to be selected by the manufacturer (see Clause 11).

† Hardness HV5 = 80–100 (for information only).

‡ 1 bar = 0.1 N/mm² = 10⁵ N/m².

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As added
Nov., 1976

**TABLE W. DIMENSIONS AND WORKING PRESSURES FOR
ANNEALED COPPER TUBES FOR USE IN
MICRO-BORE OR MINI-BORE HEATING SYSTEMS**

1	2	3	4	5	6	7
Size of tube	Outside diameter		Preferred thickness	Other recommended thickness	Maximum working pressures	
	maximum	minimum			for preferred thickness	for other recommended thickness
mm	mm	mm	mm	mm	bar*	bar*
6	6.045	5.965	0.6	0.8	90	144
8	8.045	7.965	0.6	0.8	66	105
10	10.045	9.965	0.7	0.8	62	82

* 1 bar = 0.1 N/mm² = 10⁵ N/m²

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

*As amended
Nov., 1976*

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
67 L	66.75	66.60	1.2	20
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

*As added
May 1974*

* Based on material in $\frac{1}{2}$ H condition (see Clause 1) at 65 °C.

† 1 bar = 0.1 N/mm² = 10⁵ N/m².

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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
67	66.75	66.60	2.0	37	28
76.1	76.30	76.15	2.0	33	25
108	108.25	108.00	2.5	29	22

*As added
May 1974*

* Based on material in 1/2H 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 = 10⁵ N/m².

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TABLE Z. DIMENSIONS AND WORKING PRESSURES FOR
HARD DRAWN 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
67	66.75	66.60	1.0	20
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

*As added
May 1974*

* Based on material in H condition (see Clause 1) at 65 °C.

† 1 bar = 0.1 N/mm² = 10⁵ N/m².

BRITISH STANDARDS INSTITUTION

The British Standards Institution was founded in 1901 and incorporated by Royal Charter in 1929.

The principal objects of the Institution as set out in the charter are to co-ordinate the efforts of producers and users for the improvement, standardization and simplification of engineering and industrial materials; to simplify production and distribution; to eliminate the waste of time and material involved in the production of an unnecessary variety of patterns and sizes of articles for one and the same purpose; to set up standards of quality and dimensions, and to promote the general adoption of British Standards.

In carrying out its work the Institution endeavours to ensure adequate representation of all viewpoints. Before embarking on any project it must be satisfied that there is a strong body of opinion in favour of proceeding and that there is a recognized need to be met.

The Institution is a non-profit-making concern. It is financed by subscriptions from firms, trade associations, professional institutions and other bodies interested in its work, by a Government grant and by the sale of its publications. The demands on the services of the Institution are steadily increasing and can only be met if continuing and increased financial support is provided.

Membership of the Institution is open to British subjects, companies, technical and trade associations, and local and public authorities.

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