BS EN 12449:2023

BSI Standards Publication

Copper and copper alloys — Seamless, round tubes for general purposes

bsi.

National foreword

This British Standard is the UK implementation of EN 12449:2023. It supersedes BS EN 12449:2016+A1:2019, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee NFE/34, Copper and copper alloys.

A list of organizations represented on this committee can be obtained on request to its committee manager.

Contractual and legal considerations

Published by BSI Standards Limited 2023

ISBN 978 0 539 19408 1

ICS 23.040.15; 77.120.30

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 June 2023.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12449

June 2023

ICS 23.040.15; 77.120.30

Supersedes EN 12449:2016+A1:2019

English Version

Copper and copper alloys - Seamless, round tubes for general purposes

Cuivre et alliages de cuivre - Tubes ronds sans soudure pour usages généraux

Kupfer und Kupferlegierungen - Nahtlose Rundrohre zur allgemeinen Verwendung

This European Standard was approved by CEN on 13 February 2023.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. EN 12449:2023 E

Contents

European foreword

This document (EN 12449:2023) has been prepared by Technical Committee CEN/TC 133 “Copper and copper alloys”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2023, and conflicting national standards shall be withdrawn at the latest by December 2023.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 12449:2016+A1:2019.

The main changes compared to the previous edition are listed below:

a) update of normative references;

b) addition of the material CuCr1Zr (CW106C) in Table 2 and Table 9;

c) modification of the lead content for CuZn39Pb3 (CW614N) and CuZn40Pb2 (CW617N) in Table 7;

d) correction of hardness values for CuSi3Zn2P (CW124C) of material conditions R650 and H170 in Table 9;

e) modification of 9.1 “Declaration of conformity” and 9.2 “Inspection documentation;

f) editorial amendments.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

Introduction

The European Committee for Standardization (CEN) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning the alloy CuSi3Zn2P (CW124C) given in 6.1.

CEN takes no position concerning the evidence, validity and scope of this patent right. The holder of this patent right has ensured the CEN that they are willing to negotiate licenses under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with CEN.

For CuSi3Zn2P (CW124C) information may be obtained from:

VIEGA GmbH and Co. KG
Ennester Weg 9
57439 Attendorn
GERMANY

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights other than those identified above. CEN shall not be held responsible for identifying any or all such patent rights.

CEN and CENELEC maintain online lists of patents relevant to their standards (https://www.cencenelec.eu/european-standardization/ipr-and-patents/patents/). Users are encouraged to consult the lists for the most up to date information concerning patents.

1 Scope

This document specifies the composition, property requirements and tolerances on dimensions and form for seamless round drawn copper and copper alloy tubes for general purposes supplied in the size range from 3 mm up to and including 450 mm outside diameter and from 0,3 mm up to and including 20 mm wall thickness.

The sampling procedures and the methods of test for verification of conformity to the requirements of this document are also specified.

NOTE Tubes having an outside diameter less than 80 mm and/or a wall thickness greater than 2 mm in certain alloys are most frequently used for free machining purposes which are specified in EN 12168.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1173, *Copper and copper alloys - Material condition designation*

EN 1412, *Copper and copper alloys - European numbering system*

EN 1971-1, *Copper and copper alloys - Eddy current test for measuring defects on seamless round copper and copper alloy tubes - Part 1: Test with an encircling test coil on the outer surface*

EN 1971-2, *Copper and copper alloys - Eddy current test for measuring defects on seamless round copper and copper alloy tubes - Part 2: Test with an internal probe on the inner surface*

EN 1976, *Copper and copper alloys - Cast unwrought copper products*

EN 16090, *Copper and copper alloys - Estimation of average grain size by ultrasound*

EN ISO 196, *Wrought copper and copper alloys - Detection of residual stress - Mercury(I) nitrate test (ISO 196)*

EN ISO 2624, *Copper and copper alloys - Estimation of average grain size (ISO 2624)*

EN ISO 6506-1, *Metallic materials - Brinell hardness test - Part 1: Test method (ISO 6506-1)*

EN ISO 6507-1, *Metallic materials - Vickers hardness test - Part 1: Test method (ISO 6507-1)*

EN ISO 6892-1, *Metallic materials - Tensile testing - Part 1: Method of test at room temperature (ISO 6892-1)*

EN ISO 8493, *Metallic materials - Tube - Drift-expanding test (ISO 8493)*

ISO 6957, *Copper alloys — Ammonia test for stress corrosion resistance*

ISO 80000-1:2009, *Quantities and units — Part 1: General*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
seamless round tube
hollow semi-finished product, circular in cross-section, having a uniform wall thickness, which at all stages of production has a continuous periphery

3.2
mean diameter
arithmetical mean of the maximum and minimum outside diameters through the same cross-section of the tube

[SOURCE: EN 1057:2006+A1:2010, 3.5]

3.3
deviation from circular form
difference between the maximum and minimum outside diameters measured at any one cross-section of the tube

[SOURCE: EN 1057:2006+A1:2010, 3.6]

4 Designations

4.1 Material

4.1.1 General

The material is designated either by symbol or number (see Table 1 to Table 8).

4.1.2 Symbol

The material symbol designation is based on the designation system given in ISO 1190-1.

NOTE Although material symbol designations used in this document might be the same as those in other standards using the designation system given in ISO 1190-1, the detailed composition requirements are not necessarily the same.

4.1.3 Number

The material number designation is in accordance with the system given in EN 1412.

4.2 Material condition

For the purposes of this document, the following designations, which are in accordance with the system given in EN 1173, apply for the material condition:

M material condition for the product as manufactured without specified mechanical properties;

R... material condition designated by the minimum value of tensile strength requirement for the product with mandatory tensile property requirements;

H... material condition designated by the minimum value of hardness requirement for the product with mandatory hardness requirements;

NOTE 1 Products in the H... condition can be specified to Vickers or Brinell hardness. The material condition designation H... is the same for both hardness test methods.

S (suffix) material condition for a product which is stress relieved.

NOTE 2 Products in the M, R... or H... condition can be specially processed (i.e. mechanically or thermally stress relieved) in order to lower the residual stress level to improve the resistance to stress corrosion (see 6.5.2).

Exact conversion between the material conditions designated R... and H... is not possible.

Except when the suffix S is used, material condition is designated by only one of the above designations.

4.3 Product

The product designation provides a standardized pattern of designation from which a rapid and unequivocal description of a product is conveyed in communication. It provides mutual comprehension at the international level with regard to products which meet the requirements of the relevant European Standard.

The product designation is no substitute for the full content of the document.

The product designation for products to this document shall consist of:

— denomination (Tube);

— number of this document (EN 12449);

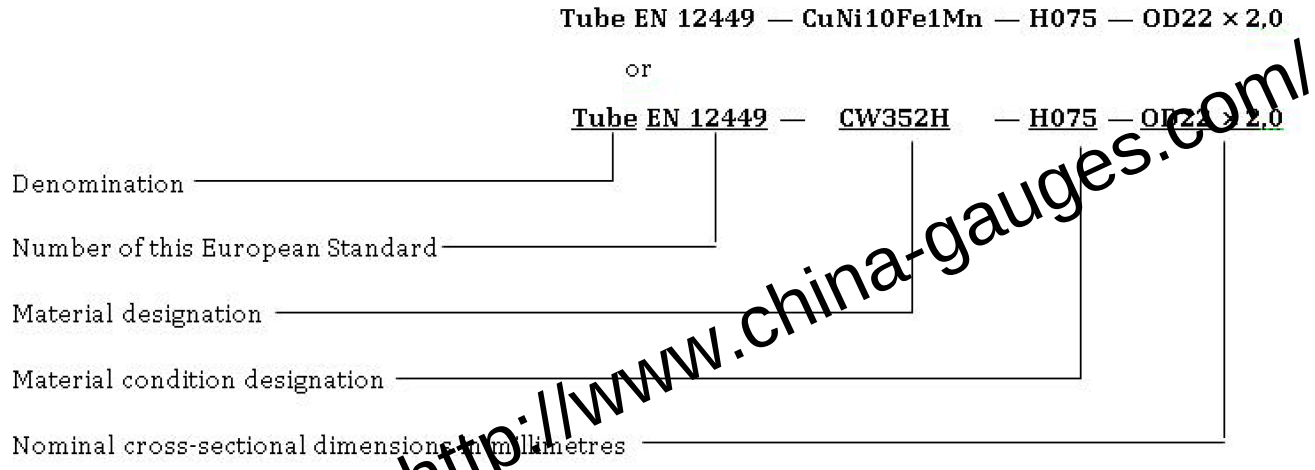
— material designation, either symbol or number (see Table 1 to Table 8);

— material condition designation (see Table 9 to Table 15);

— nominal cross-sectional dimensions, either outside diameter (OD) and wall thickness or inside diameter (ID) and wall thickness (see 6.3).

The derivation of a product designation is shown in EXAMPLE 1.

EXAMPLE 1 Tube conforming to this document, in material designated either CuNi10Fe1Mn or CW352H, in material condition H075, nominal outside diameter 22 mm, nominal wall thickness 2,0 mm, will be designated as follows:



EXAMPLE 2 Tube conforming to this document, in material designated either CuZn37 or CW508L, in material condition M, stress relieved, nominal inside diameter 30 mm, nominal wall thickness 2,5 mm, will be designated as follows:

Tube EN 12449 — CuZn37 — MS — ID30 × 2,5

or

Tube EN 12449 — CW508L — MS — ID30 × 2,5

5 Ordering information

In order to facilitate the enquiry, order and confirmation of order procedures between the purchaser and the supplier, the purchaser shall state on his enquiry and order the following information:

a) quantity of product required (number of pieces, length or mass);

b) denomination (Tube);

c) number of this document (i.e. EN 12449);

d) material designation (see Table 1 to Table 8);

e) material condition designation (see 4.2 and Table 9 to Table 15) if it is other than M;

f) nominal cross-sectional dimensions [either outside diameter (OD) and wall thickness or inside diameter (ID) and wall thickness] (see 6.3);

g) length, either nominal together with tolerance required, or fixed length (see 6.3.4).

It is advised that the product designation, as described in 4.3, is used for items b) to f).

In addition, the purchaser shall also state on the enquiry and order any of the following, if required:

h) whether the tubes are for sea water application (see Table 3). If so, the composition limits required;

i) test method to be used for the measurement of hardness, i.e. Vickers or Brinell (see 8.3);

j) where dimensional tolerances are to be applied, if not on the outside diameter and wall thickness (see 6.3.1);

k) whether the tubes are required to pass a drift expanding test (see 6.5.1);

l) whether the tubes are required to pass a stress corrosion resistance test (see 6.5.2);

m) whether the tubes are required to meet a grain size requirement (see 6.5.3); if so, the grain size limits required;

It is advised to agree the grain size limits between the purchaser and the supplier.

n) whether the tubes are required to pass freedom from defects tests (see 6.5.4); if so, which test method is to be used (see 8.5), if the choice is not to be left to the discretion of the supplier, and the acceptance criteria if they are not to be left to the discretion of the supplier;

o) whether deburring is required (see 6.4);

p) whether special surface quality is required (see 6.4);

q) whether a declaration of conformity is required (see 9.1);

r) whether an inspection document is required, and if so, which type (see 9.2);

s) whether there are any special requirements for marking, packaging or labelling (see Clause 10).

EXAMPLE Ordering details for 1 000 m tube conforming to EN 12449, in material designated either CuNi10Fe1Mn or CW352H, in material condition H075, nominal outside diameter 22 mm, nominal wall thickness 2,0 mm, in 3 000 mm fixed lengths:

1 000 m Tube EN 12449 — CuNi10Fe1Mn — H075 — OD22 × 2,0

— fixed length 3 000 mm

or

1 000 m Tube EN 12449 — CW352H — H075 — OD22 × 2,0

— fixed length 3 000 mm

6 Requirements

6.1 Composition

The composition shall conform to the requirements for the appropriate material given in Table 1 to Table 8.

6.2 Mechanical properties

The properties shall conform to the appropriate requirements given in Table 9 to Table 15. The tests shall be carried out in accordance with either 8.2 (tensile test) or 8.3 (hardness test).

Products in stress relieved condition shall conform to the same mechanical property requirements as for non stress relieved material.

6.3 Dimensions and tolerances

6.3.1 General

The geometrical properties of the tubes are defined by outside diameter or inside diameter, wall thickness and length.

Normally, tolerances for cross-sectional dimensions are applied on the outside diameter (see 6.3.2) and wall thickness (see 6.3.3) but other possibilities may be agreed between the purchaser and the supplier at the time of the enquiry and order [see Clause 5, list entry j)].

Normally, tubes are supplied in lengths with tolerances agreed between the purchaser and the supplier at the time of the enquiry and order [see Clause 5, list entry g)] but tubes may be ordered as "fixed lengths" (see 6.3.4).

6.3.2 Outside or inside diameter

The diameter of the tubes shall conform to the tolerances given in Table 17.

6.3.3 Wall thickness

The wall thickness, measured at any point, shall conform to the tolerances given in Table 18.

6.3.4 Fixed lengths

Tubes in straight lengths ordered as "fixed lengths" shall conform to the tolerances given in Table 19. Tubes in coiled form ordered as "fixed lengths" shall conform to the tolerances given in Table 20.

6.3.5 Tolerances on form

6.3.5.1 Deviation from circular form

For tubes in straight lengths the deviation from circular form is included in the tolerances on diameter given in Table 17.

For coiled tubes with wall thicknesses up to and including 2 mm, except for tubes with ratios of outside diameter to wall thickness greater than 20, the deviation from circular form is included in the tolerances on diameter given in Table 21.

6.3.5.2 Straightness

Tubes in straight lengths, except for those in the annealed condition (see Table 9 to Table 15) or with outside diameter equal to or less than 10 mm, shall conform to the tolerances given in Table 22.

6.4 Surface quality

The external and internal surfaces shall be clean and smooth.

The tubes may have a superficial film of drawing lubricant or, if annealed or thermally stress relieved, a superficial, dull, iridescent oxide film, securely adherent on both the internal and external surfaces.

Discontinuous irregularities on the external and internal surfaces of the tubes are permitted if they are within the dimensional tolerances.

Special requirements (e.g. pickling, degreasing, etc.) relating to the surface quality shall be agreed between the purchaser and the supplier [see Clause 5, list entry p)].

If deburring of the cut ends of the tubes is required it shall be agreed between the purchaser and the supplier [see Clause 5, list entry o)].

6.5 Technological requirements

6.5.1 Drift expanding

No crack shall be visible to the unaided eye, corrected for normal vision if necessary, when tubes in the annealed condition and outside diameter up to and including 100 mm and when agreed between the purchaser and the supplier [see Clause 5, list entry k)] are tested in accordance with 8.4.1.

6.5.2 Residual stress level

No crack shall be visible to the unaided eye, corrected for normal vision if necessary, when tubes in the stress relieved condition and when requested by the purchaser [see Clause 5, list entry l)] are tested in accordance with 8.4.2.

6.5.3 Grain size

The average grain size of tubes in the annealed condition, when requested by the purchaser, [see Clause 5, list entry m)] shall conform to the limits agreed between the purchaser and the supplier. The test shall be carried out in accordance with 8.4.3.

6.5.4 Freedom from defects

When requested by the purchaser [see Clause 5, list entry n)] tubes shall be tested in accordance with 8.5 and the acceptance criteria, unless otherwise agreed between the purchaser and the supplier, shall be at the discretion of the supplier.

7 Sampling

7.1 General

When required (e.g. if necessary in accordance with specified procedures of a supplier's quality system, or when the purchaser requests inspection documents with test results, or for use in cases of dispute), an inspection lot shall be sampled in accordance with 7.2 and 7.3.

7.2 Analysis

The sampling rate shall be in accordance with Table 23. A test sample, depending on the analytical technique to be employed, shall be prepared from each sampling unit and used for the determination of the composition.

When preparing the test sample, care should be taken to avoid contaminating or overheating the test sample. Carbide tipped tools are recommended; steel tools, if used, should be made of magnetic material to assist in the subsequent removal of extraneous iron. If the test samples are in finely divided form (e.g. drillings, millings), they should be treated carefully with a strong magnet to remove any particles of iron introduced during preparation.

In cases of dispute concerning the results of analysis, the full procedure given in ISO 1811-2 should be followed.

Results may be used from analyses carried out at an earlier stage of manufacturing the product, e.g. at the casting stage, if the material identity is maintained and if the quality management system of the manufacturer is certified, e.g. as conforming to EN ISO 9001.

7.3 Mechanical tests and stress corrosion resistance test

The sampling rate shall be in accordance with Table 23. Sampling units shall be selected from the finished products. The test samples shall be cut from the sampling units. Test samples, and test pieces prepared from them, shall not be subjected to any further treatment, other than any machining operations necessary in the preparation of the test pieces.

8 Test methods

8.1 Analysis

Analysis shall be carried out on the test pieces, or test portions, prepared from the test samples obtained in accordance with 7.2. Except in cases of dispute, the analytical methods used shall be chemical or spectrographic according to EN or ISO standards in force. For expression of results, the rounding rules given in 8.7 shall be used.

In cases of dispute concerning the results of analysis, the method of analysis to be used should be chemical.

8.2 Tensile test

The tensile properties shall be determined in accordance with EN ISO 6892-1 on the test pieces obtained in accordance with 7.3.

8.3 Hardness test

Hardness shall be determined on test pieces prepared from the test samples obtained in accordance with 7.3. The test shall be carried out in accordance with either EN ISO 6506-1 or EN ISO 6507-1 and the impression/indentation made on the outside surface, unless otherwise agreed. For the Brinell test according to EN ISO 6506-1, a 0,102 F/D^2 ratio of 10 shall be used.

8.4 Technological tests

8.4.1 Drift expanding test

When required, the drift expanding test shall be carried out in accordance with EN ISO 8493. The outside diameter of the tube end shall be expanded by 30 % using a conical mandrel with an angle of 45°.

8.4.2 Stress corrosion resistance test

When required, the test method given in either EN ISO 196 or ISO 6957 shall be used on the test pieces prepared from the test samples obtained in accordance with 7.3. The choice of which of these tests is used shall be at the discretion of the supplier.

8.4.3 Average grain size determination

When required, the estimation of average grain size shall be carried out in accordance with EN ISO 2624 or EN 16090.

8.5 Freedom from defects tests

When required, each tube shall be subjected to one of the following tests:

— Eddy current test for detection of local defects, in accordance with EN 1971-1 or EN 1971-2;

— hydrostatic test;

— pneumatic test.

If not otherwise agreed between the purchaser and the supplier, which of the test methods to be used and the method of testing shall be at the discretion of the manufacturer.

8.6 Retests

8.6.1 Analysis, tensile, hardness, drift expanding and grain size tests

If there is a failure of one, or more than one, of the tests in 8.1, 8.2, 8.3, 8.4.1 or 8.4.3, two test samples from the same inspection lot shall be permitted to be selected for retesting the failed property (properties). One of these test samples shall be taken from the same sampling unit as that from which the original failed test piece was taken, unless that sampling unit is no longer available, or has been withdrawn by the manufacturer.

If the test pieces from both test samples pass the appropriate test(s), then the inspection lot represented shall be deemed to conform to the particular requirement(s) of this document. If a test piece fails a test, the inspection lot represented shall be deemed not to conform to this document.

8.6.2 Stress corrosion resistance test

If a test piece fails the test, the inspection lot represented by the failed test piece shall be permitted to be subjected to a stress relieving treatment. A further test sample shall then be selected in accordance with 7.3.

If a test piece from the further test sample passes the test, the stress relieved material shall be deemed to conform to the requirements of this document for residual stress level and shall then be subjected to all the other tests called for on the purchase order, except for analysis. If the test piece from the further test sample fails the test, the stress relieved material shall be deemed not to conform to this document.

8.7 Rounding of results

For the purpose of determining conformity to the limits specified in this document, an observed or a calculated value obtained from a test shall be rounded in accordance with the following procedure, which is based upon the guidance given in ISO 80000-1:2009, Annex B. It shall be rounded in one step to the same number of figures used to express the specified limit in this document, except that for tensile strength and 0,2 % proof strength the rounding interval shall be 10 N/mm^2 [1] and for elongation the value shall be rounded to the nearest 1 %.

The following rules shall be used for rounding:

— if the figure immediately after the last figure to be retained is less than 5, the last figure to be retained shall be kept unchanged;

— if the figure immediately after the last figure to be retained is equal to or greater than 5, the last figure to be retained shall be increased by one.

9 Declaration of conformity and inspection documentation

9.1 Declaration of conformity

When a supplier's declaration of conformity is required [see Clause 5 list entry q)], the relevant information is available in EN ISO/IEC 17050-1 and EN ISO/IEC 17050-2.

9.2 Inspection documentation

When an inspection document is required [see Clause 5 list entry r)], the relevant information is available in EN 10204.

1 1 N/mm^2 is equivalent to 1 MPa.

10 Marking, packaging, labelling

Unless otherwise specified by the purchaser and agreed by the supplier, the marking, packaging and labelling shall be left to the discretion of the supplier [see Clause 5, list entry s)].

Table 1 — Composition of copper

Material designation		Composition								Density [b]
		Element	Cu [a]	Bi	O	P	Pb	other elements (see NOTE)		
Symbol	Number							total	excluding	approx.
			% (mass fraction)							g/cm³
Cu-ETP	CW004A	min.	99,90	—	—	—	—	—	Ag, O	8,9
		max.	—	0,000 5	0,040 [c]	—	0,005	0,03		
Cu-FRHC	CW005A	min.	99,90	—	—	—	—	—	Ag, O	8,9
		max.	—	—	0,040 [c]	—	—	0,06 [d]		
Cu-OF	CW008A	min.	99,95	—	—	—	—	—	Ag	8,9
		max.	—	0,000 5	— [e]	—	0,005	0,03		
Cu-PHC	CW020A	min.	99,95	—	—	0,001	—	—	Ag, P	8,9
		max.	—	0,000 5	— [e]	0,006	0,005	0,03		
Cu-HCP	CW021A	min.	99,95	—	—	0,002	—	—	Ag, P	8,9
		max.	—	0,000 5	— [e]	0,007	0,005	0,03		
Cu-DHP	CW024A	min.	99,90	—	—	0,015	—	—	—	8,9
		max.	—	—	— [e]	0,040	—	— [f]		

NOTE The total of other elements (than copper) is defined as the sum of Ag, As, Bi, Cd, Co, Cr, Fe, Mn, Ni, O, P, Pb, S, Sb, Se, Si, Sn, Te and Zn, subject to the exclusion of any individual elements indicated.

[a] Including silver, up to a maximum of 0,015 %.

[b] For information only.

[c] Oxygen content up to 0,060 % is permitted, subject to agreement between the purchaser and the supplier.

[d] Higher total impurities content is permitted, subject to agreement between the purchaser and the supplier.

[e] The oxygen content shall be such that the material conforms to the hydrogen embrittlement requirements of EN 1976.

[f] If required, the permitted total of elements, other than silver and phosphorus, should be agreed between the purchaser and the supplier.

Table 2 — Composition of low alloyed copper alloys

Material designation		Composition														Density [a]
Symbol	Number	Element	Cu	Al	As	Cr	Fe	Mn	Ni	P	Pb	Si	Sn	Zn	Zr	others total	approx.
			% (mass fraction)														g/cm³
CuCr1Zr	CW106C	min.	Rem.	—	—	**0,5**	—	—	—	—	—	—	—	—	0,03	—	8,9
		max.	—	—	—	**1,2**	0,08	—	—	—	—	0,1	—	—	0,3	0,2	
CuFe2P	CW107C	min.	Rem.	—	—	—	2,1	—	—	0,015	—	—	—	0,05	—	—	8,8
		max.	—	—	—	—	2,6	—	—	0,15	0,03	—	—	0,20	—	0,2	
CuNi2Si	CW111C	min.	Rem.	—	—	—	—	—	1,6	—	—	0,4	—	—	—	—	8,8
		max.	—	—	—	—	0,2	0,1	2,5	—	0,02	0,8	—	—	—	0,3	
CuSi3Zn2P	CW124C	min.	Rem.	—	—	—	—	—	—	0,01	—	2,5	—	1,0	—	—	8,6
		max.	—	—	—	—	—	0,20	0,20	0,20	0,10	3,5	—	3,0	—	0,2	
CuFe0,1Sn0,1P	CW125C	min.	Rem.	—	—	—	0,05	—	—	0,015	—	—	0,05	—	—	—	8,6
		max.	—	—	—	—	0,20	—	—	0,055	—	—	0,25	—	—	0,2	

[a] For information only.

Table 3 — Composition of copper-nickel alloys

Material designation		Composition													Density [a]
Symbol	Number	Element	Cu	C	Co	Fe	Mn	Ni	P	Pb	S	Sn	Zn	others total	approx.
			% (mass fraction)												g/cm³
CuNi10Fe1Mn	CW352H	min.	Rem.	—	—	1,0 [c]	0,5	9,0	—	—	—	—	—	—	8,9
		max.	—	0,05	0,1 [b]	2,0 [c]	1,0	11,0	0,02	0,02	0,05	0,03	0,5	0,2	
CuNi30Mn1Fe	CW354H	min.	Rem.	—	—	0,4	0,5	30,0	—	—	—	—	—	—	8,9
		max.	—	0,05	0,1 [b]	1,0	1,5	32,0	0,02	0,02	0,05	0,05	0,5	0,2	

[a] For information only.

[b] Co max. 0,1 % is counted as Ni.

[c] For sea water applications, the composition limits shall be agreed between the purchaser and the supplier [see Clause 5, list entry h)].

Table 4 — Composition of copper-nickel-zinc alloys

Material designation		Composition									Density [a]
Symbol	Number	Element	Cu	Fe	Mn	Ni	Pb	Sn	Zn	others total	approx.
			% (mass fraction)								g/cm³
CuNi12Zn24	CW403J	min.	63,0	—	—	11,0	—	—	Rem.	—	8,7
		max.	66,0	0,3	0,5	13,0	0,03	0,03	—	0,2	
CuNi18Zn20	CW409J	min.	60,0	—	—	17,0	—	—	Rem.	—	8,7
		max.	63,0	0,3	0,5	19,0	0,03	0,03	—	0,2	

[a] For information only.

Table 5 — Composition of copper-tin alloys

Material designation		Composition									Density [a]
Symbol	Number	Element	Cu	Fe	Ni	P	Pb	Sn	Zn	others total	approx.
			% (mass fraction)								g/cm³
CuSn6	CW452K	min.	Rem.	—	—	0,01	—	5,5	—	—	8,8
		max.		0,1	0,2	0,4	0,02	7,0	0,2	0,2	
CuSn8	CW453K	min.	Rem.	—	—	0,01	—	7,5	—	—	8,8
		max.	—	0,1	0,2	0,4	0,02	8,5	0,2	0,2	
CuSn4Pb2P	CW455K	min.	Rem.	—	—	0,2	1,5	3,5	—	—	8,9
		max.	—	0,1	0,2	0,4	2,5	4,5	0,3	0,2	
CuSn8P	CW459K	min.	Rem.	—	—	0,2	—	7,5	—	—	8,8
		max.	—	0,1	0,3	0,4	0,05	8,5	0,3	0,2	
CuSn8PbP	CW460K	min.	Rem.	—	—	0,2	0,1	7,5	—	—	8,8
		max.	—	0,1	0,3	0,4	0,5	9,0	0,3	0,2	

[a] For information only.

Table 6 — Composition of binary copper-zinc alloys

Material designation		Composition									Density [a]
Symbol	Number	Element	Cu	Al	Fe	Ni	Pb	Sn	Zn	others total	approx.
			% (mass fraction)								g/cm³
CuZn5	CW500L	min.	94,0	—	—	—	—	—	Rem.	—	8,9
		max.	96,0	0,02	0,05	0,3	0,05	0,1	—	0,1	
CuZn10	CW501L	min.	89,0	—	—	—	—	—	Rem.	—	8,8
		max.	91,0	0,02	0,05	0,3	0,05	0,1	—	0,1	
CuZn15	CW502L	min.	84,0	—	—	—	—	—	Rem.	—	8,8
		max.	86,0	0,02	0,05	0,3	0,05	0,1	—	0,1	
CuZn20	CW503L	min.	79,0	—	—	—	—	—	Rem.	—	8,7
		max.	81,0	0,02	0,05	0,3	0,05	0,1	—	0,1	
CuZn30	CW505L	min.	69,0	—	—	—	—	—	Rem.	—	8,5
		max.	71,0	0,02	0,05	0,3	0,05	0,1	—	0,1	
CuZn36	CW507L	min.	63,5	—	—	—	—	—	Rem.	—	8,4
		max.	65,5	0,02	0,05	0,3	0,05	0,1	—	0,1	
CuZn37	CW508L	min.	62,0	—	—	—	—	—	Rem.	—	8,4
		max.	64,0	0,05	0,1	0,3	0,1	0,1	—	0,1	
CuZn40	CW509L	min.	59,0	—	—	—	—	—	Rem.	—	8,4
		max.	61,5	0,05	0,2	0,3	0,2	0,2	—	0,2	

[a] For information only.

Table 7 — Composition of copper-zinc-lead alloys

Material designation		Composition											Density [a]
Symbol	Number	Element	Cu	Al	As	Fe	Mn	Ni	Pb	Sn	Zn	others total	approx.
		% (mass fraction)											g/cm³
CuZn35Pb1	CW600N	min.	62,5	—	—	—	—	—	0,8	—	Rem.	—	8,5
		max.	64,0	0,05	—	0,1	—	0,3	1,6	0,1	—	0,1	
CuZn35Pb2 [b]	CW601N [b]	min.	62,0	—	—	—	—	—	1,6	—	Rem.	—	8,5
		max.	63,5	0,05	—	0,1	—	0,3	2,5	0,1	—	0,1	
CuZn36Pb2As [b]	CW602N [b]	min.	61,0	—	0,02	—	—	—	1,7	—	Rem.	—	8,4
		max.	63,0	0,05	0,15	0,1	0,1	0,3	2,8	0,1	—	0,2	
CuZn36Pb3 [b]	CW603N [b]	min.	60,0	—	—	—	—	—	2,5	—	Rem.	—	8,5
		max.	62,0	0,05	—	0,3	—	0,3	3,5	0,2	—	0,2	
CuZn37Pb0,5	CW604N	min.	62,0	—	—	—	—	—	0,1	—	Rem.	—	8,4
		max.	64,0	0,05	—	0,1	—	0,3	0,8	0,2	—	0,2	
CuZn37Pb1 [b]	CW605N [b]	min.	61,0	—	—	—	—	—	0,8	—	Rem.	—	8,4
		max.	62,0	0,05	—	0,3 [c]	—	0,3	1,6	0,3 [c]	—	0,2	
CuZn38Pb1 [b]	CW607N [b]	min.	60,0	—	—	—	—	—	0,8	—	Rem.	—	8,4
		max.	61,0	0,05	—	0,2	—	0,3	1,6	0,2	—	0,2	
CuZn38Pb2 [b]	CW608N [b]	min.	60,0	—	—	—	—	—	1,6	—	Rem.	—	8,4
		max.	61,0	0,05	—	0,2	—	0,3	2,5	0,2	—	0,2	
CuZn39Pb3 [b]	CW614N [b]	min.	57,0	—	—	—	—	—	2,2	—	Rem.	—	8,4
		max.	59,0	0,05	—	0,3	—	0,3	3,5	0,3	—	0,2	

Material designation		Composition											Density [a]
Symbol	Number	Element	Cu	Al	As	Fe [c]	Mn	Ni	Pb	Sn	Zn	others total	approx.
		% (mass fraction)											g/cm³
CuZn40Pb2 [b]	**CW617N** [b]	min.	57,0	—	—	—	—	—	1,6	—	Rem.	—	8,4
		max.	59,0	0,05	—	0,3	—	0,3	2,2	0,3	—	0,2	

[a] For information only.

[b] See NOTE to Clause 1.

[c] The maximum value of iron and tin was modified from 0,2 % to 0,3 % based on a CEN/TC 133 decision.

Table 8 — Composition of complex copper-zinc alloys

Material designation		Composition												Density [a]
Symbol	Number	Element	Cu	Al	As	Fe	Mn	Ni	P	Pb	Si	Sn	Zn	others total	approx.
			% (mass fraction)												g/cm³
CuZn13Al1Ni1Si1	CW700R	min.	81,0	0,7	—	—	—	0,8	—	—	0,8	—	Rem.	—	8,5
		max.	84,0	1,2	—	0,25	0,1	1,4	—	0,05	1,3	0,1	—	0,5	
CuZn20Al2As	CW702R	min.	76,0	1,8	0,02	—	—	—	—	—	—	—	Rem.	—	8,4
		max.	79,0	2,3	0,06	0,07	0,1	0,1	0,01	0,05	—	—	—	0,3	
CuZn31Si1	CW708R	min.	66,0	—	—	—	—	—	—	—	0,7	—	Rem.	—	8,4
		max.	70,0	—	—	0,4	—	0,5	—	0,8	1,3	—	—	0,5	
CuZn35Ni3Mn2AlPb	CW710R	min.	58,0	0,3	—	—	1,5	2,0	—	0,2	—	—	Rem.	—	8,3
		max.	60,0	1,3	—	0,5	2,5	3,0	—	0,8	0,1	0,5	—	0,3	
CuZn37Mn3Al2PbSi [b]	CW713R [b]	min.	57,0	1,3	—	—	1,5	—	—	0,2	0,3	—	Rem.	—	8,1
		max.	59,0	2,3	—	1,0	3,0	1,0	—	0,8	1,3	0,4	—	0,3	
CuZn38Mn1Al	CW716R	min.	59,0	0,3	—	—	0,6	—	—	—	—	—	Rem.	—	8,3
		max.	61,5	1,3	—	1,0	1,8	0,6	—	1,0	0,5	0,3	—	0,3	
CuZn39Mn1AlPbSi	CW718R	min.	57,0	0,3	—	—	0,8	—	—	0,2	0,2	—	Rem.	—	8,2
		max.	59,0	1,3	—	0,5	1,8	0,5	—	0,8	0,8	0,5	—	0,3	

Material designation		Composition													Density [a]
Symbol	Number	Element	Cu	Al	As	Fe	Mn	Ni	P	Pb	Si	Sn	Zn	others total	approx.
			% (mass fraction)												g/cm³
CuZn40Mn2Fe1	CW723R	min.	56,5	—	0,5	1,0	—	—	—	—	—	—	Rem.	—	8,3
		max.	58,5	0,1	—	1,5	2,0	0,6	—	0,5	0,1	0,3	—	0,4	
CuZn21Si3P	CW724R	min.	75,0	—	—	—	—	—	0,02	—	2,7	—	Rem.	—	8,3
		max.	77,0	0,05	—	0,3	0,05	0,2	0,10	0,10	3,5	0,3	—	0,2	

[a] For information only.

[b] See NOTE to Clause 1.

Table 9 — Mechanical properties of copper and low alloyed copper alloys

Designations		Material condition	Wall thickness	Tensile strength	0,2% proof strength		Elongation	Hardness			
Material			t	R_m	$R_{p0,2}$		A	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
Cu-ETP Cu-FRHC Cu-OF Cu-PHC Cu-HCP	CW004A CW005A CW008A CW020A CW021A	H035	20	—	—	—	—	35	65	35	60
		R200	20	200	—	120	35	—	—	—	—
		H065	10	—	—	—	—	65	95	60	90
		R250	10	250	150	—	15	—	—	—	—
		H090	5	—	—	—	—	90	110	85	105
		R290	5	290	250	—	5	—	—	—	—
		H100	3	—	—	—	—	100	—	95	—
		R360	3	360	320	—	(3)	—	—	—	—
Cu-DHP	CW024A	M	20	—	—	—	—	—	—	—	—
		R200 [a]	20	200	—	110	40	—	—	—	—
		H040 [a]	20	—	—	—	—	40	65	35	60
		R250	3	250	150	—	30 [b]	—	—	—	—
			3				20 [b]				

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t	R_m	$R_{p0,2}$		A	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
			10				15 [b]				
		H070	10	—	—	—	—	70	100	65	95
		R290	5	290	250	—	3	—	—	—	—
		H095	5	—	—	—	—	95	120	90	115
		R360	3	360	320	—	—	—	—	—	—
		H110	3	—	—	—	—	110	—	105	—
CuCr1Zr	**CW106C**	R260 [c]	25	260	60		30	—	—	—	—
		H060 [c]	25	—	—	—	—	65	95	60	90
		R300 [d]	20	300	250	—	25	—	—	—	—
		H080 [d]	20	—	—	—	—	85	115	80	110
		R350 [e]	25	350	240	—	15	—	—	—	—
		H105 [e]	25	—	—	—	—	110	135	105	130
		R370 [f]	20	370	250	—	16	—	—	—	—
		H120 [f]	20	—	—	—	—	125	185	120	180
		R430 [f]	15	430	350	—	10			—	—
		H140 [f]	15	—	—	—	—	145	195	140	190
		R470 [f]	10	470	420	—	8		—	—	—

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t	R_m	$R_{p0,2}$		A	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
		H160 [f]	10	—	—	—	—	165	215	160	210
CuFe2P	CW107C	M	20	—	—	—	—	—	—	—	—
		R300 [a]	10	300	—	250	25	—	—	—	—
		H085 [a]	10	—	—	—	—	85	115	80	110
		R370	5	370	250	—	15	—	—	—	—
		H110	5	—	—	—	—	110	140	105	135
		R420	5	420	320	—	5	—	—	—	—
		H135	5	—	—	—	—	135	—	130	—

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t	R_m	$R_{p0,2}$		A	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
CuNi2Si	CW111C	M	20	—	—	—	—	—	—	—	—
		R260 [c]	10	260	60	—	30	—	—	—	—
		H065 [c]	10	—	—	—	—	65	100	60	90
		R460 [e]	10	460	300	—	12	—	—	—	—
		H150 [e]	10	—	—	—	—	150	190	140	180
		R380 [d]	10	380	260	—	6	—	—	—	—
		H130 [d]	10	—	—	—	—	130	170	120	160
		R600 [f]	10	600	480	—	8	—	—	—	—
		H190 [f]	10	—	—	—	—	190	—	180	—
CuSi3Zn2P	CW124C	M	all	—	—	—	—	—	—	—	—
		R370	7	370	80	—	50	—	—	—	—
		H065	7	—	—	—	—	70	—	65	—
		R650	3	650	550	—	5	—	—	—	—

Designations		Material condition	Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material								HV		HBW	
Symbol	Number		t	R_m	$R_{p0,2}$		A				
			max.	min.	min.	max.	min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
		H170	3	—	—	—	—	180	—	170	—
CuFe0,01Sn0,1P	CW125C	R250	3	250	60	100	30	—	—	—	—
		R270	3	270	100	170	40	—	—	—	—
		R290	3	290	120	300	20	—	—	—	—
		R400	3	400	300	520	3	—	—	—	—

NOTE 1 1 N/mm² is equivalent to 1 MPa.

NOTE 2 Figures in parentheses are not requirements of this document, but are given for information only.

[a] Annealed condition.

[b] See Table 16 for relationship between tube dimensions and elongation for R250 (half hard) tube.

[c] Solution heat treated.

[d] Solution heat treated and cold formed.

[e] Solution heat treated and precipitation hardened.

[f] Solution heat treated, cold formed and precipitation hardened.

Table 10 — Mechanical properties of copper-nickel alloys

Designations			Wall thickness	Tensile strength	0,2 % proof strength	Elongation	Hardness			
Material		Material condition	t	R_m	$R_{p0,2}$	A	HV		HBW	
Symbol	Number		max. mm	min. N/mm²	min. N/mm²	min. %	min.	max.	min.	max.
CuNi10Fe1Mn	CW352H	M	20	—	—	—	—	—	—	—
		R290 [a]	20	290	90	30	—	—	—	—
		H075 [a]	20	—	—	—	75	110	70	105
		R310	6	310	220	12	—	—	—	—
		H105	6	—	—	—	105	—	100	—
		R480	4	480	400	8	—	—	—	—
		H150	4	—	—	—	150	—	145	—
CuNi30Mn1Fe	CW354H	M	20	—	—	—	—	—	—	—
		R370 [a]	10	370	120	35	—	—	—	—
		H085 [a]	10	—	—	—	85	120	80	115
		R480	5	480	300	12	—	—	—	—
		H135	5	—	—	—	135	—	130	—

NOTE 1 N/mm² is equivalent to 1 MPa.

[a] Annealed condition.

Table 11 — Mechanical properties of copper-nickel-zinc alloys

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t	R_m	$R_{p0,2}$		A	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
CuNi12Zn24	CW403J	M	20	—	—	—	—	—	—	—	—
		R340 [a]	10	340	—	290	45	—	—	—	—
		H075 [a]	10	—	—	—	—	75	110	70	105
		R420	5	420	240	—	25	—	—	—	—
		H110	5	—	—	—	—	110	140	105	135
		R490	3	490	390	—	10	—	—	—	—
		H135	3	—	—	—	—	135	—	130	—
CuNi18Zn20	CW409J	M	20	—	—	—	—	—	—	—	—
		R370 [a]	10	370	—	290	40	—	—	—	—
		H080 [a]	10	—	—	—	—	80	115	75	110
		R440	5	440	290	—	20	—	—	—	—
		H115	5	—	—	—	—	115	150	110	145

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t	R_m	$R_{p0,2}$		A	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
		R540	3	540	450	—	5	—	—	—	—
		H145	3	—	—	—	—	145	—	140	—
NOTE 1 N/mm² is equivalent to 1 MPa.											
[a] Annealed condition.											

Table 12 — Mechanical properties of copper-tin alloys

Designations			Wall thickness	Tensile strength	0,2 % proof Strength		Elongation	Hardness			
Material		Material condition						HV		HBW	
Symbol	Number		t	R_m	$R_{p0,2}$		A				
			max.	min.	min.	max.	min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
CuSn6	CW452K	M	20	—	—	—	—	—	—	—	—
		R340 [a]	10	340	—	260	50	—	—	—	—
		H070 [a]	10	—	—	—	—	70	105	65	100
		R400	5	400	220	—	30	—	—	—	—
		H105	5	—	—	—	—	105	150	100	145
		R490	3	490	390	—	10	—	—	—	—
		H140	3	—	—	—	—	140	175	135	170
		R580	2	580	500	—	5	—	—	—	—
		H170	2	—	—	—	—	170	—	165	—
CuSn8	CW453K	M	20	—	—	—	—	—	—	—	—
		R380 [a]	10	380	—	290	55	—	—	—	—
		H080 [a]	10	—	—	—	—	80	110	75	105
		R450	5	450	250	—	25	—	—	—	—
		H115	5	—	—	—	—	115	160	110	155

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t	R_m	$R_{p0,2}$		A	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
		R520	3	520	440	—	10	—	—	—	—
		H155	3	—	—	—	—	155	190	150	185
		R590	2	590	520	—	5	—	—	—	—
		H180	2	—	—	—	—	180	—	175	—
CuSn4Pb2P	**CW455K**	M	20	—	—	—	—	—	—	—	—
		R430	10	430	220	—	25	—	—	—	—
		H125	10	—	—	—	—	125	155	120	150
		R520	5	520	430	—	8	—	—	—	—
		H155	5	—	—	—	—	155	—	150	—
CuSn8P CuSn8PbP	**CW459K CW460K**	M	20	—	—	—	—	—	—	—	—
		R460	10	460	280	—	30	—	—	—	—
		H130	10	—	—	—	—	130	165	125	160
		R550	5	550	480	—	12	—	—		
		H165	5	—	—	—	—	165	195	160	190
		R620	3	620	540	—	5	—	—	—	—

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t	R_m	$R_{p0,2}$		A	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
		H180	3	—	—	—	—	180	—	175	—
NOTE 1 N/mm² is equivalent to 1 MPa.											
[a] Annealed condition.											

Table 13 — Mechanical properties of binary copper-zinc alloys

Designations			Wall thickness	Tensile strength	0,2 % proof Strength		Elongation	Hardness			
Material		Material condition	t	R_m	$R_{p0,2}$		A	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
CuZn5	CW500L	M	20	—	—	—	—	—	—	—	—
		R220 [a]	20	220	—	130	40	—	—	—	—
		H050 [a]	20	—	—	—	—	50	75	45	70
		R260	10	260	190	—	18	—	—	—	—
		H075	10	—	—	—	—	75	105	70	100
		R320	5	320	260	—	8	—	—	—	—
		H095	5	—	—	—	—	95	125	90	120
		R440	3	440	410	—	—	—	—	—	—
		H120	3	—	—	—	—	120	—	115	—
CuZn10	CW501L	M	20	—	—	—	—	—	—	—	—
		R240 [a]	20	240	—	140	40	—	—	—	—
		H050 [a]	20	—	—	—	—	50	80	45	75
		R300	10	300	180	—	20	—	—	—	—
		H075	10	—	—	—	—	75	105	70	100

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t	R_m	$R_{p0,2}$		A	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
		R360	5	360	280	—	8	—	—	—	—
		H100	5	—	—	—	—	100	—	95	—
CuZn15	CW502L	M	20	—	—	—	—	—	—	—	—
		R260 [a]	20	260	—	150	42	—	—	—	—
		H050 [a]	20	—	—	—	—	50	80	45	75
		R310	10	310	200	—	20	—	—	—	—
		H080	10	—	—	—	—	80	110	75	105
		R370	5	370	290	—	10	—	—	—	—
		H105	5	—	—	—	—	105	—	100	—

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t	R_m	$R_{p0,2}$		A	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
CuZn20	CW503L	M	20	—	—	—	—	—	—	—	—
		R260 [a]	20	260	—	160	45	—	—	—	—
		H055 [a]	20	—	—	—	—	55	85	50	80
		R320	10	320	200	—	25	—	—	—	—
		H085	10	—	—	—	—	85	120	80	115
		R390	5	390	300	—	10	—	—	—	—
		H115	5	—	—	—	—	115	—	110	—
CuZn30	CW505L	M	20	—	—	—	—	—	—	—	—
		R280 [a]	20	280	—	180	50	—	—	—	—
		H055 [a]	20	—	—	—	—	55	85	50	80
		R350	10	350	200	—	25	—	—	—	—
		H085	10	—	—	—	—	85	120	80	115
		R420	5	420	320	—	10	—	—	—	—
		H115	5	—	—	—	—	115	—	110	—

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t	R_m	$R_{p0,2}$		A	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
CuZn36	CW507L	M	20	—	—	—	—	—	—	—	—
		R290 [a]	20	290	—	180	50	—	—	—	—
		H055 [a]	20	—	—	—	—	55	85	50	80
		R360	10	360	180	—	25	—	—	—	—
		H080	10	—	—	—	—	80	115	75	110
		R430	5	430	300	—	12	—	—	—	—
		H110	5	—	—	—	—	110	—	105	—
CuZn37	CW508L	M	20	—	—	—	—	—	—	—	—
		R300 [a]	20	300	—	220	45	—	—	—	—
		H060 [a]	20	—	—	—	—	60	90	55	85
		R370	10	370	200	—	25	—	—	—	—
		H085	10	—	—	—	—	85	120	80	115
		R440	5	440	320	—	10	—	—	—	—
		H115	5	—	—	—	—	115	—	110	—

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t	R_m	$R_{p0,2}$		A	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
CuZn40	CW509L	M	20	—	—	—	—	—	—	—	—
		R340 [a]	20	340	—	250	35	—	—	—	—
		H075 [a]	20	—	—	—	—	75	105	70	100
		R410	10	410	250	—	18	—	—	—	—
		H100	10	—	—	—	—	100	130	95	125
		R470	5	470	400	—	5	—	—	—	—
		H125	5	—	—	—	—	125	—	120	—

NOTE 1 N/mm² is equivalent to 1 MPa.

[a] Annealed condition.

Table 14 — Mechanical properties of copper-zinc-lead alloys

Designations		Material condition	Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material								HV		HBW	
Symbol	Number		t max.	R_m min.	$R_{p0,2}$ min.	$R_{p0,2}$ max.	A min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
CuZn35Pb1 CuZn35Pb2 [a]	**CW600N CW601N** [a]	M	20	—	—	—	—	—	—	—	—
		R290 [b]	10	290	—	180	45	—	—	—	—
		H060 [b]	10	—	—	—	—	60	90	55	85
		R370	10	370	200	—	20	—	—	—	—
		H085	10	—	—	—	—	85	120	80	115
		R440	5	440	340	—	10	—	—	—	—
		H115	5	—	—	—	—	115	—	110	—
CuZn36Pb2As [a]	**CW602N** [a]	M	20	—	—	—	—	—	—	—	—
		R290 [b]	10	290	—	250	40	—	—	—	—
		H080 [b]	10	—	—	—	—	80	110	75	105
		R370	10	370	250	—	20	—	—	—	—
		H105	10	—	—	—	—	105	140	100	135

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition						HV		HBW	
Symbol	Number		t	R_m	$R_{p0,2}$		A				
			max. mm	min. N/mm²	min. N/mm²	max. N/mm²	min. %	min.	max.	min.	max.
		R440	5	440	340	—	10	—	—	—	—
		H135	5	—	—	—	—	135	—	130	—
CuZn36Pb3 [a]	**CW603N** [a]	M	20	—	—	—	—	—	—	—	—
		R300 [b]	10	300	—	250	35	—	—	—	—
		H080 [b]	10	—	—	—	—	80	110	75	105
		R400	10	400	250	—	15	—	—	—	—
		H105	10	—	—	—	—	105	140	100	135
		R460	5	460	350	—	10	—	—	—	—
		H135	5	—	—	—	—	135	—	130	—

Designations		Material condition	Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material								HV		HBW	
Symbol	Number		t	R_m	$R_{p0,2}$		A				
			max.	min.	min.	max.	min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
CuZn37Pb0,5 **CuZn37Pb1** [a]	**CW604N** **CW605N** [a]	M	20	—	—	—	—	—	—	—	—
		R300 [b]	20	300	—	220	45	—	—	—	—
		H060 [b]	20	—	—	—	—	60	90	55	85
		R370	10	370	200	—	25	—	—	—	—
		H085	10	—	—	—	—	85	120	80	115
		R440	5	440	320	—	10	—	—	—	—
		H115	5	—	—	—	—	115	—	110	—
CuZn38Pb1 [a] **CuZn38Pb2** [a]	**CW607N** [a] **CW608N** [a]	M	20	—	—	—	—	—	—	—	—
		R340 [b]	10	340	—	250	35	—	—	—	—
		H080 [b]	10	—	—	—	—	80	110	75	105
		R410	10	410	250	—	15	—	—	—	—
		H105	10	—	—	—	—	105	140	100	135
		R470	5	470	350	—	10	—	—	—	—
		H135	5	—	—	—	—	135	—	130	—

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t	R_m	$R_{p0,2}$		A	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
CuZn39Pb3 [a] **CuZn40Pb2** [a]	**CW614N** [a] **CW617N** [a]	M	20	—	—	—	—	—	—	—	—
		R360 [b]	10	360	—	250	25	—	—	—	—
		H085 [b]	10	—	—	—	—	85	120	80	115
		R430	10	430	250	—	12	—	—	—	—
		H115	10	—	—	—	—	115	150	110	145
		R500	5	500	370	—	8	—	—	—	—
		H140	5	—	—	—	—	140	—	135	—

NOTE 1 N/mm² is equivalent to 1 MPa.

[a] See NOTE to Clause 1.

[b] Annealed condition.

Table 15 — Mechanical properties of complex copper-zinc alloys

Designations		Material condition	Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material								HV		HBW	
Symbol	Number		t max.	R_m min.	$R_{p0,2}$ min.	$R_{p0,2}$ max.	A min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
CuZn13Al1Ni1Si1	CW700R	M	20	—	—	—	—	—	—	—	—
		R380 [a]	10	380	115	—	50	—	—	—	—
		H065 [a]	10	—	—	—	—	65	85	60	80
		R430	10	430	220	—	40	—	—	—	—
		H120	10	—	—	—	—	120	140	115	135
		R550	5	550	330	—	10	—	—	—	—
		H170	5	—	—	—	—	170	—	165	—
CuZn20Al2As	CW702R	M	20	—	—	—	—	—	—	—	—
		R340 [a]	10	340	120	—	45	—	—	—	—
		H070 [a]	10	—	—	—	—	70	100	65	95
		R390 [a]	5	390	150	—	40	—	—	—	—
		H085 [a]	5	—	—	—	—	85	—	80	—
CuZn31Si1	CW708R	M	20	—	—	—	—	—	—	—	—
		R440	8	440	200	—	20	—	—	—	—

Designations		Material condition	Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material			t	R_m	$R_{p0,2}$		A	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
		H115	8	—	—	—	—	115	155	110	150
		R490	8	490	250	—	15	—	—	—	—
		H145	8	—	—	—	—	145	—	140	—
CuZn35Ni3Mn2AlPb	**CW710R**	M	20	—	—	—	—	—	—	—	—
		R490	8	490	290	—	15	—	—	—	—
		H125	8	—	—	—	—	125	165	120	160
		R540	8	540	390	—	10	—	—	—	—
		H145	8	—	—	—	—	145	—	140	—
CuZn37Mn3Al2PbSi [b]	**CW713R** [b]	M	20	—	—	—	—	—	—	—	—
		R540	8	540	250	—	10	—	—	—	—
		H145	8	—	—	—	—	145	185	140	180
		R590	5	590	320	—	8	—	—	—	—
		H155	5	—	—	—	—	155	195	150	190

Designations		Material condition	Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material			t	R_m	$R_{p0,2}$		A	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
		R640	3	640	350	—	5	—	—	—	—
		H165	3	—	—	—	—	165	—	160	—
CuZn38Mn1Al	CW716R	M	20	—	—	—	—	—	—	—	—
		R440	8	440	200	—	15	—	—	—	—
		H115	8	—	—	—	—	115	155	110	150
		R510	8	510	270	—	10	—	—	—	—
		H140	8	—	—	—	—	140	—	135	—
CuZn39Mn1AlPbSi	CW718R	M	20	—	—	—	—	—	—	—	—
		R440	8	440	200	—	15	—	—	—	—
		H120	8	—	—	—	—	120	160	115	155
		R510	8	510	270	—	10	—	—	—	—
		H145	8	—	—	—	—	145	—	140	—
CuZn40Mn2Fe1	CW723R	M	20	—	—	—	—	—	—	—	—
		R440	8	440	170	—	15	—	—	—	—

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t	R_m	$R_{p0,2}$		A	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
			mm	N/mm²	N/mm²		%				
		H115	8	—	—	—	—	115	155	110	150
		[illegible]									
		R490	8	490	270	—	10	—	—	—	—
		H135	8	—	—	—	—	135	—	130	—
CuZn21Si3P	**CW724R**	M	all	as manufactured							
		R500	20	500	—	450	15	—	—	—	—
		H110	20	—	—	—	—	115	180	110	170
		R600	20	600	350	—	12	—	—	—	—
		H130	20	—	—	—	—	135	200	130	190
		R650	7	650	400	—	10	—	—	—	—
		H150	7	—	—	—	—	160	220	150	210

NOTE 1 N/mm² is equivalent to 1 MPa.

[a] Annealed condition.

[b] See NOTE to Clause 1.

Table 16 — Minimal elongation values for R250 (half hard) material condition tubes

Dimensions in millimetres

Nominal diameter		Wall thickness		Elongation
over	up to and including	over	up to and including	min.
3 [a]	66,7	0,3	3,0	30
		3,0	10,0	20
66,7	450	0,3	3,0	20
		3,0	10,0	15

[a] Including 3.

Table 17 — Tolerances on diameter

Dimensions in millimetres

Nominal diameter		Tolerances on nominal diameter	
over	up to and including	applicable to mean diameter	applicable to any diameter including deviation from circular form for straight lengths [a, b]
3[c]	10	±0,06	±0,12
10	20	±0,08	±0,16
20	30	±0,12	±0,24
30	50	±0,15	±0,30
50	100	±0,20	±0,50
100	200	±0,50	±1,0
200	300	±0,75	±1,5
300	450	±1,0	±2,0

[a] The tolerances in this column are not applicable to tubes in coiled form (for tolerances on coils see Table 21), for tubes with OD/t > 50 or to tubes in annealed condition (see Table 9 to Table 15).

[b] When the diameter is measured at a distance from the ends of the tube of up to 100 mm or the equivalent of one nominal outside diameter (whichever is the smaller), unless otherwise agreed, the tolerance may be increased by a factor of 3.

[c] Including 3.

Table 18 — Tolerances on wall thickness

Nominal outside diameter		Tolerances on nominal wall thickness				
over	up to and including	*t* from 0,3 mm up to and including 1 mm	*t* over 1 mm up to and including 3 mm	*t* over 3 mm up to and including 6 mm	*t* over 6 mm up to and including 10 mm	*t* over 10 mm
mm		%				
3 [a]	40	±15	±13	±11	±10	—
40	120	±15	±13	±12	±11	±10
120	250	—	±13	±13	±12	±11
250	450	—	—	±15	±15	±15

[a] Including 3.

Table 19 — Tolerances on fixed lengths, tubes in straight lengths

Dimensions in millimetres

Nominal outside diameter		Tolerance on fixed length			
over	up to and including	up to and including 250	over 250 up to and including 1 000	over 1 000 up to and including 4 000	over 4 000
3 [a]	25	+1 0	+3 0	+5 0	by agreement
25	100	+2 0	+5 0	+7 0	
100	450	+3 0	+5 0	+10 0	

[a] Including 3.

Table 20 — Tolerances on fixed lengths, tube in coils (not level wound)

Specified length m	Tolerance %
up to and including 50	+2 0
over 50 up to and including 100	+3 0
over 100	+5 0

Table 21 — Tolerances on diameter including deviation from circular form, tube in coils

Dimensions in millimetres

Nominal outside diameter		Tolerance on nominal diameter including deviation from circular form	Applicable for coil inside diameter
over	up to and including		min.
3 [a]	6	±0,30	400
6	10	±0,50	600
10	20	±0,70	800
20	30	±0,90	1 000

[a] Including 3.

Table 22 — Tolerances on straightness

Dimensions in millimetres

Ratio of outside diameter/thickness		Depth of arc [a]	
		h_1 in any length l_1 of 1 000	h_2 in any length l_2 of 400
over	up to and including	max.	max.
—	5	2	0,8
5	10	3	1,2
10	20	4	1,6
20	40	5	2,0
40	—	6	2,5

[a] See Figure 1.

Dimensions in millimetres

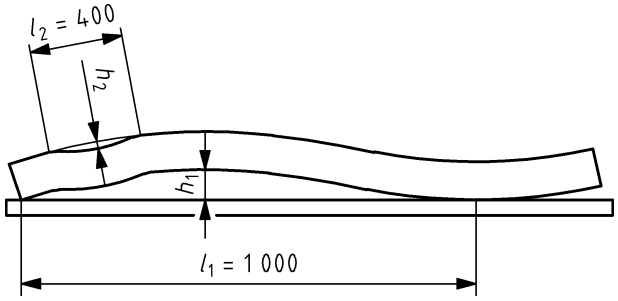


Figure 1 — Measurement of straightness

Table 23 — Sampling rate

Mass per unit length kg/m	**Size of inspection lot for one test sample up to and including** kg
up to and including 0,25	500
over 0,25 up to and including 5	1 000
over 5	2 500
NOTE Larger inspection lots require sampling in proportion, up to a maximum of five test samples.	

Bibliography

EN 1057:2006+A1:2010, *Copper and copper alloys - Seamless, round copper tubes for water and gas in sanitary and heating applications*

EN 10204, *Metallic products - Types of inspection documents*

EN 12168, *Copper and copper alloys - Hollow rod for free machining purposes*

EN ISO 9001, *Quality management systems - Requirements (ISO 9001)*

EN ISO/IEC 17050-1, *Conformity assessment - Supplier's declaration of conformity - Part 1: General requirements (ISO/IEC 17050-1)*

EN ISO/IEC 17050-2, *Conformity assessment - Supplier's declaration of conformity - Part 2: Supporting documentation (ISO/IEC 17050-2)*

ISO 1190-1, *Copper and copper alloys — Code of designation — Part 1: Designation of materials*

ISO 1811-2, *Copper and copper alloys — Selection and preparation of samples for chemical analysis — Part 2: Sampling of wrought products and castings*

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Copyright in BSI publications

All the content in BSI publications, including British Standards, is the property of and copyrighted by BSI or some person or entity that owns copyright in the information used (such as the international standardization bodies) and has formally licensed such information to BSI for commercial publication and use.

Save for the provisions below, you may not transfer, share or disseminate any portion of the standard to any other person. You may not adapt, distribute, commercially exploit or publicly display the standard or any portion thereof in any manner whatsoever without BSI's prior written consent.

Storing and using standards

Standards purchased in soft copy format:

- A British Standard purchased in soft copy format is licensed to a sole named user for personal or internal company use only.
- The standard may be stored on more than one device provided that it is accessible by the sole named user only and that only one copy is accessed at any one time.
- A single paper copy may be printed for personal or internal company use only.

Standards purchased in hard copy format:

- A British Standard purchased in hard copy format is for personal or internal company use only.
- It may not be further reproduced – in any format – to create an additional copy. This includes scanning of the document.

If you need more than one copy of the document, or if you wish to share the document on an internal network, you can save money by choosing a subscription product (see 'Subscriptions').

Reproducing extracts

For permission to reproduce content from BSI publications contact the BSI Copyright and Licensing team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member.**

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email cservices@bsigroup.com.

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Useful Contacts

Customer Services
Tel: +44 345 086 9001
Email: cservices@bsigroup.com

Subscriptions
Tel: +44 345 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

bsi.