BS EN 12449:2016

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 12449:2016. It supersedes BS EN 12449:2012 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee NFE/34/1, Wrought and unwrought copper and copper alloys.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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

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Amendments issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12449

May 2016

ICS 23.040.15

Supersedes EN 12449:2012

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 28 February 2016.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (EN 12449:2016) 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of an identical text or by endorsement, at the latest by November 2016 and conflicting national standards shall be withdrawn at the latest by November 2016.

This document supersedes EN 12449:2012.

In comparison with EN 12449:2012, the following significant technical changes were made:

a) Addition of the new material CuFe0,1Sn0,1P (CW125C);

b) Modification of the elongation values for Cu-DHP (CW024A) in material condition R250 including new Table 16;

c) Modification of iron and tin content for CuZn37Pb1 (CW605N) from 0,2 % to 0,3 % in Table 7;

d) Replacement of the material number CW121C by CW124C for CuSi3Zn2P.

Within its programme of work, Technical Committee CEN/TC 133 requested CEN/TC 133/WG 3 "Copper tubes (installation and industrial)" to revise the following standard:

— EN 12449:2012, *Copper and copper alloys — Seamless, round copper tubes for general purposes*.

This is one of a series of European Standards for copper and copper alloy tubes. Other products are specified as follows:

— EN 1057, *Copper and copper alloys — Seamless, round copper tubes for water and gas in sanitary and heating applications*;

— EN 12450, *Copper and copper alloys — Seamless, round copper capillary tubes*;

— EN 12451, *Copper and copper alloys — Seamless, round tubes for heat exchangers*;

— EN 12452, *Copper and copper alloys — Rolled, finned, seamless tubes for heat exchangers*;

— EN 12735-1, *Copper and copper alloys — Seamless, round tubes for air conditioning and refrigeration — Part 1: Tubes for piping systems*;

— EN 12735-2, *Copper and copper alloys — Seamless, round tubes for air conditioning and refrigeration — Part 2: Tubes for equipment*;

— EN 13348, *Copper and copper alloys — Seamless, round copper tubes for medical gases or vacuum*;

— EN 13349, *Copper and copper alloys — Pre-insulated copper tubes with solid covering*;

— EN 13600, *Copper and copper alloys — Seamless copper tubes for electrical purposes*.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey 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) and CuZn21Si3P (CW724R) 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 assured the CEN that he is willing to negotiate licenses under reasonable and not-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 & Co. KG

Ennester Weg 9

57439 Attendorn

GERMANY

— For CuZn21Si3P (CW724R) information may be obtained from:

Wieland-Werke AG

Graf-Arco-Straße 36

89079 Ulm

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 (http://www.cencenelec.eu/ipr/Patents/PatentDeclaration/Pages/default.aspx) maintain on-line lists of patents relevant to their standards. Users are encouraged to consult the lists for the most up to date information concerning patents.

1 Scope

This European Standard 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 European Standard 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, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1655, *Copper and copper alloys - Declarations of conformity*

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 10204, *Metallic products - Types of inspection documents*

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*

3 Terms and definitions

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

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 Tables 1 to 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 standard 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 standard, 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 standard.

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

— denomination (Tube);

— number of this European Standard (EN 12449);

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

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

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

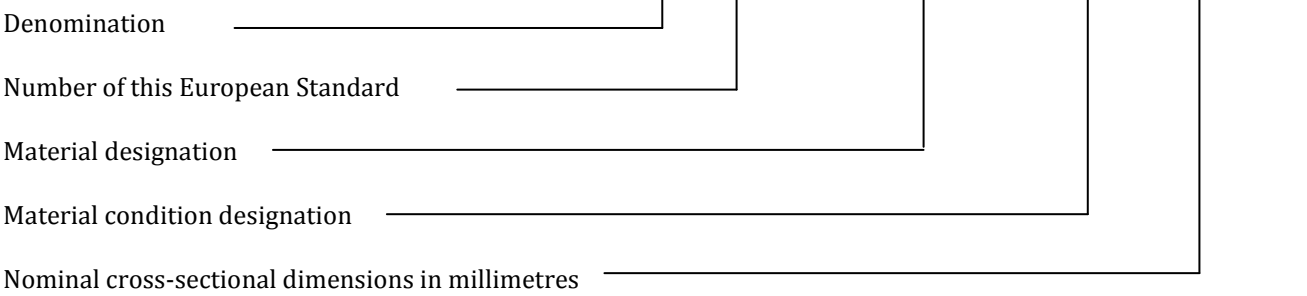
The derivation of a product designation is shown in Example 1.

EXAMPLE 1 Tube conforming to this standard, 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:

Tube EN 12449 — CuNi10Fe1Mn — H075 — OD22 × 2,0

or

Tube EN 12449 — CW352H — H075 — OD22 × 2,0



EXAMPLE 2 Tube conforming to this standard, 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 European Standard (EN 12449);

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

e) material condition designation (see 4.2 and Tables 9 to 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).

NOTE 1 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;

NOTE 2 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 Tables 1 to 8.

6.2 Mechanical properties

The properties shall conform to the appropriate requirements given in Tables 9 to 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 Tables 9 to 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 standard. If a test piece fails a test, the inspection lot represented shall be deemed not to conform to this standard.

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 standard 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 standard.

8.7 Rounding of results

For the purpose of determining conformity to the limits specified in this standard, 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 Annex B of ISO 80000-1:2009. It shall be rounded in one step to the same number of figures used to express the specified limit in this standard, 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 requested by the purchaser [see Clause 5, list entry q)] and agreed with the supplier, the supplier shall issue for the products the appropriate declaration of conformity in accordance with EN 1655.

9.2 Inspection documentation

When requested by the purchaser [see Clause 5, list entry r)] and agreed with the supplier, the supplier shall issue for the products the appropriate inspection document in accordance with EN 10204.

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)].

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

Table 1 — Composition of copper

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

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

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

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

[e] For information only.

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

Table 2 — Composition of low alloyed copper alloys

Material designation		Composition % (mass fraction)													Density[a] g/cm³
Symbol	Number	Element	Cu	Al	As	Fe	Mn	Ni	P	Pb	Si	Sn	Zn	others total	approx.
CuFe2P	**CW107C**	min.	Rem.	—	—	2,1	—	—	0,01	—	—	—	0,05	—	8,8
		max.	—	—	—	2,6	—	—	5 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	—	—	0,01 5	—	—	0,05	—	—	8,6
		max.	—	—	—	0,20	—	—	0,05 5	—	—	0,25	—	0,2	

[a] For information only.

Table 3 — Composition of copper-nickel alloys

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

[a] For information only.

Table 7 — Composition of copper-zinc-lead alloys

Material designation		Composition % (mass fraction)											Density[a] g/cm³
Symbol	Number	Element	Cu	Al	As	Fe	Mn	Ni	Pb	Sn	Zn	others total	approx.
CuZn35Pb1	**CW600N**	min. max.	62,5 64,0	— 0,05	— —	— 0,1	— —	— 0,3	0,8 1,6	— 0,1	Rem. —	— 0,1	8,5
CuZn35Pb2[b]	**CW601N**[b]	min. max.	62,0 63,5	— 0,05	— —	— 0,1	— —	— 0,3	1,6 2,5	— 0,1	Rem. —	— 0,1	8,5
CuZn36Pb2As[b]	**CW602N**[b]	min. max.	61,0 63,0	— 0,05	0,02 0,15	— 0,1	— 0,1	— 0,3	1,7 2,8	— 0,1	Rem. —	— 0,2	8,4
CuZn36Pb3[b]	**CW603N**[b]	min. max.	60,0 62,0	— 0,05	— —	— 0,3	— —	— 0,3	2,5 3,5	— 0,2	Rem. —	— 0,2	8,5
CuZn37Pb0,5	**CW604N**	min. max.	62,0 64,0	— 0,05	— —	— 0,1	— —	— 0,3	0,1 0,8	— 0,2	Rem. —	— 0,2	8,4
CuZn37Pb1[b]	**CW605N**[b]	min. max.	61,0 62,0	— 0,05	— —	— 0,3[c]	— —	— 0,3	0,8 1,6	— 0,3[c]	Rem. —	— 0,2	8,4
CuZn38Pb1[b]	**CW607N**[b]	min. max.	60,0 61,0	— 0,05	— —	— 0,2	— —	— 0,3	0,8 1,6	— 0,2	Rem. —	— 0,2	8,4
CuZn38Pb2[b]	**CW608N**[b]	min. max.	60,0 61,0	— 0,05	— —	— 0,2	— —	— 0,3	1,6 2,5	— 0,2	Rem. —	— 0,2	8,4
CuZn39Pb3[b]	**CW614N**[b]	min. max.	57,0 59,0	— 0,05	— —	— 0,3	— —	— 0,3	2,5 3,5	— 0,3	Rem. —	— 0,2	8,4
CuZn40Pb2[b]	**CW617N**[b]	min. max.	57,0 59,0	— 0,05	— —	— 0,3	— —	— 0,3	1,6 2,5	— 0,3	Rem. —	— 0,2	8,4

[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 % (mass fraction)													Density[a] g/cm³
Symbol	Number	Element	Cu	Al	As	Fe	Mn	Ni	P	Pb	Si	Sn	Zn	others total	approx.
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	
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	
			mm	N/mm²	N/mm²		%				
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
		H035	20	—	—	—	—	35	65	35	60
		R200	20	200	—	120	35	—	—	—	—
		H065	10	—	—	—	—	65	95	60	90
Cu-ETP	**CW004A**	R250	10	250	150	—	15	—	—	—	—
Cu-FRHC	**CW005A**										
Cu-OF	**CW008A**	H090	5	—	—	—	—	90	110	85	105
Cu-PHC	**CW020A**	R290	5	290	250	—	5	—	—	—	—
Cu-HCP	**CW021A**										
		H100	3	—	—	—	—	100	—	95	—
		R360	3	360	320	—	(3)	—	—	—	—
		M	20	—	—	—	—	—	—	—	—
		R200[a]	20	200	—	110	40	—	—	—	—
		H040[a]	20	—	—	—	—	40	65	35	60
		R250	3	250	150	—	30[f]	—	—	—	—
			3				20[f]				
			10				15[f]				
Cu-DHP	**CW024A**	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	—

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

Designations		Material condition	Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material			t	R_m	$R_{p0,2}$		A	HV		HBW	
			mm	N/mm²	N/mm²		%				
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
CuSi3Zn2P	**CW124C**	M	all	—	—	—	—	—	—	—	—
		R370	7	370	80	—	50	—	—	—	—
		H065	7	—	—	—	—	70	—	65	—
		R650	3	650	550	—	5	180	—	170	—
		H170	3	—	—	—	—	—	—	—	—
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 standard, but are given for information only.

[a] Annealed condition.

[b] Solution heat treated.

[c] Solution heat treated and precipitation hardened.

[d] Solution heat treated and cold formed.

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

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

Table 10 — Mechanical properties of copper-nickel alloys

Designations			Wall thickness	Tensile strength	0,2 % proof strength	Elongation	Hardness			
Material		Material condition	t mm	R_m N/mm²	$R_{p0,2}$ N/mm²	A %	HV		HBW	
Symbol	Number		max.	min.	min.	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		Material condition	Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material			t mm	R_m N/mm²	$R_{p0,2}$ N/mm²		A %	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
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
		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	t mm	R_m N/mm²	$R_{p0,2}$ N/mm²		A %	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
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	—

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t mm	R_m N/mm²	$R_{p0,2}$ N/mm²		A %	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
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
		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	—

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t mm	R_m N/mm²	$R_{p0,2}$ N/mm²		A %	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
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	—	—	—	—
		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		Material condition	Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material			t	R_m	$R_{p0,2}$		A	HV		HBW	
			mm	N/mm²	N/mm²		%				
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
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
		R360	5	360	280	—	8	—	—	—	—
		H100	5	—	—	—	—	100	—	95	—

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t mm	R_m N/mm²	$R_{p0,2}$ N/mm²		A %	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
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	—
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	—

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t mm	R_m N/mm²	$R_{p0,2}$ N/mm²		A %	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
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	—
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	—

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t mm	R_m N/mm²	$R_{p0,2}$ N/mm²		A %	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
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	—
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			t	R_m	$R_{p0,2}$		A	HV		HBW	
			mm	N/mm²	N/mm²		%				
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
CuZn35Pb1 **CuZn35Pb2**[b]	**CW600N** **CW601N**[b]	M	20	—	—	—	—	—	—	—	—
		R290[a]	10	290	—	180	45	—	—	—	—
		H060[a]	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[b]	**CW602N**[b]	M	20	—	—	—	—	—	—	—	—
		R290[a]	10	290	—	250	40	—	—	—	—
		H080[a]	10	—	—	—	—	80	110	75	105
		R370	10	370	250	—	20	—	—	—	—
		H105	10	—	—	—	—	105	140	100	135
		R440	5	440	340	—	10	—	—	—	—
		H135	5	—	—	—	—	135	—	130	—

Designations		Material condition	Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material			t mm	R_m N/mm²	$R_{p0,2}$ N/mm²		A %	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
CuZn36Pb3[b]	**CW603N[b]**	M	20	—	—	—	—	—	—	—	—
		R300[a]	10	300	—	250	35	—	—	—	—
		H080[a]	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	—
CuZn37Pb0,5 CuZn37Pb1[b]	**CW604N CW605N[b]**	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		Material condition	Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material			t	R_m	$R_{p0,2}$		A	HV		HBW	
			mm	N/mm²	N/mm²		%				
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
CuZn38Pb1[b] **CuZn38Pb2**[b]	**CW607N**[b] **CW608N**[b]	M	20	—	—	—	—	—	—	—	—
		R340[a]	10	340	—	250	35	—	—	—	—
		H080[a]	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	—
CuZn39Pb3[b] **CuZn40Pb2**[b]	**CW614N**[b] **CW617N**[b]	M	20	—	—	—	—	—	—	—	—
		R360[a]	10	360	—	250	25	—	—	—	—
		H085[a]	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] Annealed condition.

[b] See NOTE to Clause 1.

Table 15 — Mechanical properties of complex copper-zinc alloys

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t mm	R_m N/mm²	$R_{p0,2}$ N/mm²		A %	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
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	—

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t mm	R_m N/mm²	$R_{p0,2}$ N/mm²		A %	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
CuZn31Si1	**CW708R**	M	20	—	—	—	—	—	—	—	—
		R440	8	440	200	—	20	—	—	—	—
		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	—

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t mm	R_m N/mm²	$R_{p0,2}$ N/mm²		A %	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
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
		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	—

Designations			Wall thickness	Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	t mm	R_m N/mm²	$R_{p0,2}$ N/mm²		A %	HV		HBW	
Symbol	Number		max.	min.	min.	max.	min.	min.	max.	min.	max.
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	—	—	—	—
		H115	8	—	—	—	—	115	155	110	150
		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 Tables 9 to 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 mm		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
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/wall 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

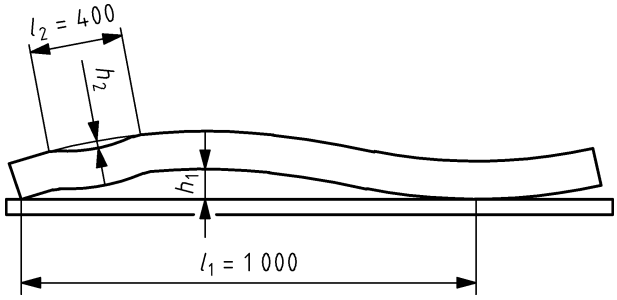


Figure 1 — Measurement of straightness

Table 23 — Sampling rate

Mass per unit length kg/m	Size of inspection lot for one test sample kg up to and including
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.

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