BS EN 12165:2016

BSI Standards Publication

Copper and copper alloys — Wrought and unwrought forging stock

bsi.

National foreword

This British Standard is the UK implementation of EN 12165:2016. It supersedes BS EN 12165:2011 which is withdrawn.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 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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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12165

July 2016

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Supersedes EN 12165:2011

English Version

Copper and copper alloys - Wrought and unwrought forging stock

Cuivre et alliages de cuivre - Barres corroyées et brutes pour matriçage

Kupfer und Kupferlegierungen - Vormaterial für Schmiedestücke

This European Standard was approved by CEN on 9 April 2016.

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

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European foreword

This document (EN 12165:2016) 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of an identical text or by endorsement, at the latest by January 2017, and conflicting national standards shall be withdrawn at the latest by January 2017.

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

This document supersedes EN 12165:2011.

Within its programme of work, Technical Committee CEN/TC 133 requested CEN/TC 133/WG 4 “Extruded and drawn products, forgings and scrap” to revise the following standard:

— EN 12165:2011, *Copper and copper alloys — Wrought and unwrought forging stock*.

This document is one of a series of European Standards for the copper and copper alloy products rod, wire, profile and forgings. Other products are specified as follows:

— EN 12163, *Copper and copper alloys — Rod for general purposes*;

— EN 12164, *Copper and copper alloys — Rod for free machining purposes*;

— EN 12166, *Copper and copper alloys — Wire for general purposes*;

— EN 12167, *Copper and copper alloys — Profiles and bars for general purposes*;

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

— EN 12420, *Copper and copper alloys — Forgings*;

— EN 13601, *Copper and copper alloys — Copper rod, bar and wire for general electrical purposes*;

— EN 13602, *Copper and copper alloys — Drawn round copper wire for the manufacture of electrical conductors*;

— EN 13605, *Copper and copper alloys — Copper profiles and profiled wires for electrical purposes*.

In comparison with EN 12165:2011, the following significant technical changes were made:

a) addition of three new materials: CuZn35Pb1,5AlAs (CW625N), CuZn33Pb1,5AlAs (CW626N) and CuZn33Pb1AlSiAs (CW725R) due to the market requirements on restriction of lead and modification of the chemical composition for CuZn39Pb1 (CW611N);

b) introduction of an optional procedure how to refer to restrictions to the chemical composition imposed by the 4 MS Common Composition List for materials used for products accepted for contact with drinking water;

c) requirements and test methods for resistance of dezincification modified;

d) provisions for surface quality added;

e) mechanical properties for CuZn21Si3P (CW724R) modified.

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, 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 CuZn21Si3P (CW724R) and CuZn33Pb1AlSiAs (CW725R) 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 he is willing to negotiate licenses either free of charge or 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 CuZn21Si3P (CW724R) information may be obtained from:

Wieland-Werke AG
Graf Arco Straße 36
D-89079 Ulm
GERMANY

— For CuZn33Pb1AlSiAs (CW725R) information may be obtained from:

Diehl Metall Messing
Heinrich-Diehl-Straße 9
D-90552 Röthenbach/Pegnitz
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. Users are encouraged to consult the lists for the most up to date information concerning patents (ftp://ftp.cencenelec.eu/EN/IPR/Patents/IPRdeclaration.pdf).

Due to developing legislation, the composition of a material may be restricted to the composition specified in this European Standard with respect to individual uses (e.g. for the use in contact with drinking water in some Member States of the European Union). These individual restrictions are not part of this European Standard. Nevertheless, for materials for which traditional and major uses are affected, these restrictions are indicated. The absence of an indication, however, does not imply that the material can be used in any application without any legal restriction.

1 Scope

This European Standard specifies the composition, property requirements and dimensional tolerances for forging stock of copper and copper alloys.

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

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

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

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

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

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

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

EN ISO 6509-1, *Corrosion of metals and alloys — Determination of dezincification resistance of brass (ISO 6509-1)*

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

3 Terms and definitions

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

3.1
forging
three-dimensional shaped product produced by a plastic forming process such as hammering or pressing between open or closed dies, including hammering between flat surfaces, normally when hot

Note 1 to entry Forging processes include, drop forging, hot stamping and hot pressing.

3.2
forging stock
extruded, rolled or drawn product such as rod, hollow rod, bar or profile or cast product, intended for the production of forgings

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

[SOURCE: EN 12163:2016, 3.2]

4 Designations

4.1 Material

4.1.1 General

The material is designated either by symbol or by 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;

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

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 can be 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 (Forging stock);

— number of this European Standard (EN 12165);

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

— DW for compliance in the chemical composition according to the 4 MS Common Composition List. This information is mandatory in the case in which the product is used for drinking water applications according to the 4 MS Common Composition List and not to be given in other cases;

— material condition designation (see Tables 9 to 16);

— cross-sectional shape (the following designations shall be used as appropriate: RND for round, SQR for square, HEX for hexagonal, OCT for octagonal, RCT for rectangular (bar), PFL for profile);

— for rod with round or regular polygonal cross-section, hollow rod or bar, the nominal cross-sectional dimension(s) (diameter, width across-flats, external dimension × internal dimension, width × thickness, as appropriate);

— for profiles, the number of the profile, or a fully dimensioned and toleranced drawing;

— for round rod, the tolerance class (see Table 17).

The derivation of a product designation is shown in the following examples.

EXAMPLE 1 Forging stock conforming to this standard, in material designated either CuZn40Pb2 or CW617N, for standard applications, in material condition H080, round, nominal diameter 15 mm, tolerance class A, will be designated as follows:

Forging stock — EN 12165 — CuZn40Pb2 — H080 — RND15A

or

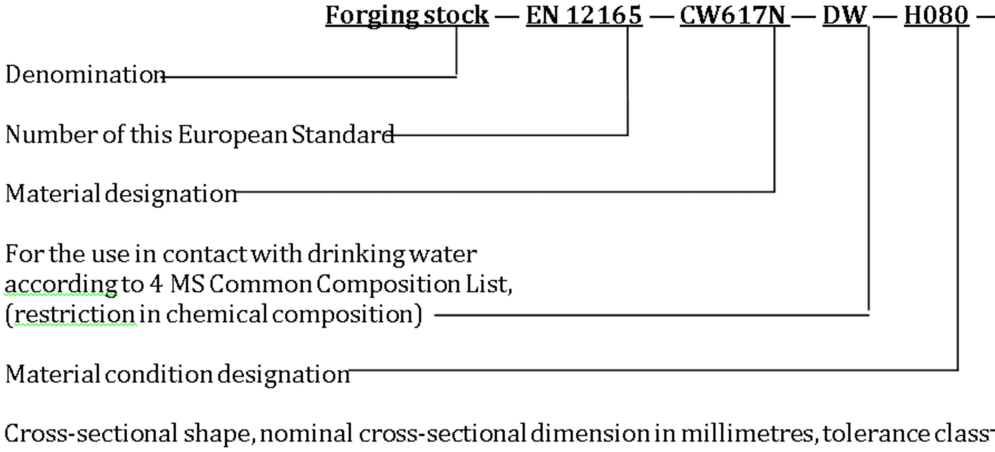
Forging stock — EN 12165 — CW617N — H080 — RND15A

EXAMPLE 2 Forging stock conforming to this standard, in material designated either CuZn40Pb2 or CW617N, for drinking water applications according to the 4 MS Common Composition List, in material condition H080, round, nominal diameter 15 mm, tolerance class A, will be designated as follows:

Forging stock — EN 12165 — CuZn40Pb2 — DW —- H080 — RND15A

or

Forging stock — EN 12165 — CW617N — DW — H080 — RND15A



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) mass of product required;

b) denomination (Forging stock);

c) number of this European Standard (EN 12165);

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

e) material condition designation (see 4.2 and Tables 9 to 16), if it is other than M;

f) DW for compliance in the chemical composition according to the 4 MS Common Composition List. This information is mandatory in the case in which the product is used for drinking water applications according to the 4 MS Common Composition List and not to be given in other cases;

g) cross-sectional shape;

h) size required:

   1) for round rod, diameter and whether class A or class B tolerance is required, unless the tolerance class shall be left to the discretion of the supplier (see Table 17);

   2) for rod with regular polygonal cross-section or hollow rod or bar, nominal dimension(s) and tolerance(s) required unless they shall be left to the discretion of the supplier;

   3) for profiles, a fully dimensioned and toleranced drawing;

i) the length of product required, if not left to the discretion of the supplier;

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

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

j) whether special surface quality is required (see 6.5);

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

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

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

EXAMPLE Ordering details for 500 kg of forging stock conforming to EN 12165, in material designated either CuZn40Pb2 or CW617N, for drinking water application according to the 4 MS Common Composition List in material condition H080, round, nominal diameter 15 mm, tolerance class A, length 2 500 mm:

500 kg Forging stock — CuZn40Pb2 — DW — H080 — RND15A
EN 12165

— length 2 500 mm

or

500 kg Forging stock — CW617N — DW — H080 — RND15A
EN 12165

— length 2 500 mm

6 Requirements

6.1 Composition

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

Due to developing legislation, specific applications (see 4.3) may require restrictions in the chemical composition. In this case the limitations shall be specified in the ordering information (see Clause 5 list entry f)).

6.2 Mechanical properties

Products whose shapes are other than round may be delivered in M material condition in accordance with an agreement between supplier and customer.

The hardness properties of H... material condition shall conform to the Brinell hardness requirements given for forging stock with round cross-section in Tables 9 to 16. The test shall be carried out in accordance with 8.2.

In case tensile properties are required for forging stock, rods in accordance with EN 12163 or EN 12164 should be used.

6.3 Resistance to dezincification

The maximum depth of dezincification, in any direction, of CuZn38As (CW511L), CuZn36Pb2As (CW602N), CuZn32Pb2AsFeSi (CW709R), CuZn21Si3P (CW724R) and CuZn33Pb1AlSiAs (CW725R) products shall be 100 µm. For the alloys CuZn35Pb1,5AlAs (CW625N), CuZn33Pb1,5AlAs (CW626N) the maximum depth of dezincification, in any direction, shall be 200 µm.

The test shall be carried out in accordance with 8.3.

NOTE 1 Shape and distribution of ß phase aggregates can influence the dezincification resistance of products. Special requirements relating to shape and distribution of beta phase aggregates are subject to agreement between purchaser and supplier.

NOTE 2 The as-supplied forging stock in alloys other than CuZn21Si3P (CW724R) may not necessarily meet this requirement unless suitably heat treated as described in 8.3. The test is intended to demonstrate that forgings produced from the stock are capable of being processed so as to pass the test requirement.

6.4 Dimensions and tolerances

6.4.1 Diameter

The diameter shall conform to the tolerances given in Table 17 for class A or class B, as appropriate to the order [see Clause 5 list entry h)]. The diameter is calculated as the mean of one or more pairs of measurements taken at right angles at the same cross-section of the rod.

6.4.2 Deviation from circular form

For round rod the deviation from circular form shall not exceed half the range of the tolerance on diameter given in Table 17.

6.4.3 Length

The forging stock shall have length and length tolerances agreed between customer and supplier.

6.4.4 Straightness

For round rod of diameter from 10 mm up to and including 50 mm of length 1 000 mm or over, the deviation from straightness, defined as the curvature (depth of arc) against a datum line when the product is lying flat in a horizontal plane, shall conform to the tolerances given in Table 18.

6.5 Surface quality

The surfaces shall be clean and smooth. The forging stock may have a superficial film of drawing lubricant or, if annealed or thermally stress relieved, a superficial, dull, iridescent oxide film, securely adherent on the surfaces.

Discontinuous irregularities on the surfaces of the forging stock 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 j)].

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 19. 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 system of the manufacturer is certified e.g. as conforming to EN ISO 9001.

7.3 Hardness and dezincification resistance tests

The sampling rate shall be in accordance with Table 19. Sampling units shall be selected from the finished products. The test samples shall be cut from the sampling units and may require heat treatment before testing. 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 at the discretion of the supplier. In cases of dispute concerning the results of analysis, methods of analysis to be used shall be agreed between the disputing parties. For expression of results, the rounding rules given in 8.5 shall be used.

8.2 Hardness test

8.2.1 General

When a hardness test is to be carried out the test samples shall be prepared in accordance with 8.2.2 and the test shall be carried out in accordance with 8.2.3.

8.2.2 Preparation of samples

Test samples obtained in accordance with 7.3 shall be prepared directly from forging stock.

8.2.3 Procedure for testing

Hardness shall be determined on test pieces cut from the test sample prepared in accordance with 8.2.2. The test shall be carried out in accordance with EN ISO 6506-1 and the impression/indentation made on the cross-section of the test piece mid-way between the central axis and the outside surface.

When reporting hardness test results, reference should be made to the method of preparation of the sample (see 8.2.2).

8.3 Dezincification resistance test

The test method given in EN ISO 6509-1 shall be used on the test samples obtained in accordance with 7.3. If required, the test samples shall be heat treated in the temperature range 450 °C to 550 °C before testing. A test piece shall be taken from each test sample so as to expose a prepared cross-sectional surface to the test solution.

At the completion of the test the maximum depth of dezincification in a longitudinal direction shall be measured;

8.4 Retests for analysis, hardness and dezincification resistance

If there is a failure of one, or more than one, of the tests in 8.1, 8.2 or 8.3, 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 supplier.

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.

8.5 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 EN ISO 80000-1. It shall be rounded in one step to the same number of figures used to express the specified limit in this European Standard.

The following rules shall be used for rounding:

a) 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;

b) 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 k)] 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 l)] 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 m)].

Table 1 — Composition of copper

Material designation		Composition % (mass fraction)								Density[b] g/cm^3
		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[c]	—	0,005	0,03		
Cu-OF	CW008A	min.	99,95	—	—	—	—	—	Ag	8,9
		max.	—	0,000 5	—[d]	—	0,005	0,03		
Cu-HCP	CW021A	min.	99,95	—	—	0,002	—	—	Ag, P	8,9
		max.	—	0,000 5	— d	0,007	0,005	0,03		
Cu-DHP	CW024A	min.	99,90	—	—	0,015	—	—	—	8,9
		max.	—	—	—	0,040	—	—		

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

Table 2 — Composition of low alloyed copper alloys

Material designation		Composition % (mass fraction)												Density[a] g/cm^3
Symbol	Number	Element	Cu	Be	Co	Cr	Fe	Mn	Ni	Pb	Si	Zr	Others total	approx.
CuBe2	CW101C	min.	Rem.	1,8	—	—	—	—	—	—	—	—	—	8,3
		max.	—	2,1	0,3	—	0,2	—	0,3	—	—	—	0,5	
CuCo1Ni1Be	CW103C	min.	Rem.	0,4	0,8	—	—	—	0,8	—	—	—	—	8,8
		max.	—	0,7	1,3	—	0,2	—	1,3	—	—	—	0,5	
CuCo2Be	CW104C	min.	Rem.	0,4	2,0	—	—	—	—	—	—	—	—	8,8
		max.	—	0,7	2,8	—	0,2	—	0,3	—	—	—	0,5	
CuCr1Zr	CW106C	min.	Rem.	—	—	0,5	—	—	—	—	—	0,03	—	8,9
		max.	—	—	—	1,2	0,08	—	—	—	0,1	0,3	0,2	
CuNi1Si	CW109C	min.	Rem.	—	—	—	—	—	1,0	—	0,4	—	—	8,8
		max.	—	—	—	—	0,2	0,1	1,6	0,02	0,7	—	0,3	
CuNi2Si	CW111C	min.	Rem.	—	—	—	—	—	1,6	—	0,4	—	—	8,8
		max.	—	—	—	—	0,2	0,1	2,5	0,02	0,8	—	0,3	
CuZr	CW120C	min.	Rem.	—	—	—	—	—	—	—	—	0,1	—	8,9
		max.	—	—	—	—	—	—	—	—	—	0,2	0,1	

[a] For information only.

Table 3 — Composition of copper-aluminium alloys

Material designation		Composition % (mass fraction)											Density[a] g/cm^3
Symbol	Number	Element	Cu	Al	Fe	Mn	Ni	Pb	Si	Sn	Zn	Others total	approx.
CuAl8Fe3	CW303G	min.	Rem.	6,5	1,5	—	—	—	—	—	—	—	7,7
		max.	—	8,5	3,5	1,0	1,0	0,05	0,2	0,1	0,5	0,2	
CuAl10Fe1	CW305G	min.	Rem.	9,0	0,5	—	—	—	—	—	—	—	7,6
		max.	—	10,0	1,5	0,5	1,0	0,02	0,2	0,1	0,5	0,2	
CuAl10Fe3Mn2	CW306G	min.	Rem.	9,0	2,0	1,5	—	—	—	—	—	—	7,6
		max.	—	11,0	4,0	3,5	1,0	0,05	0,2	0,1	0,5	0,2	
CuAl10Ni5Fe4	CW307G	min.	Rem.	8,5	3,0	—	4,0	—	—	—	—	—	7,6
		max.	—	11,0	5,0	1,0	6,0	0,05	0,2	0,1	0,4	0,2	
CuAl11Fe6Ni6	CW308G	min.	Rem.	10,5	5,0	—	5,0	—	—	—	—	—	7,4
		max.	—	12,5	7,0	1,5	7,0	0,05	0,2	0,1	0,5	0,2	

[a] For information only.

Table 4 — Composition of copper-nickel alloys

Material designation		Composition % (mass fraction)													Density[a] g/cm^3
Symbol	Number	Element	Cu	C	Co	Fe	Mn	Ni	P	Pb	S	Sn	Zn	Others total	approx.
CuNi10Fe1Mn	CW352H	min.	Rem.	—	—	1,0	0,5	9,0	—	—	—	—	—	—	8,9
		max.	—	0,05	0,1[b]	2,0	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.

Table 5 — Composition of copper-nickel-zinc alloys

Material designation		Composition % (mass fraction)									Density[a] g/cm^3
Symbol	Number	Element	Cu	Fe	Mn	Ni	Pb	Sn	Zn	Others total	approx.
CuNi7Zn39Pb3Mn2	CW400J	min.	47,0	—	1,5	6,0	2,3	—	Rem.	—	8,5
		max.	50,0	0,3	3,0	8,0	3,3	0,2	—	0,2	

[a] For information only.

Table 6 — Composition of copper-zinc alloys

Material designation		Composition[b] % (mass fraction)											Density[a] g/cm^3
Symbol	Number	Element	Cu	As	Al	Fe	Mn	Ni	Pb	Sn	Zn	Others total	approx.
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	
CuZn42	CW510L	min.	57,0	—	—	—	—	—	—	—	Rem.	—	8,4
		max.	59,0	—	0,05	0,3	—	0,3	0,2	0,3	—	0,2	
CuZn38As	CW511L	min.	61,5	0,02	—	—	—	—	—	—	Rem.	—	8,4
		max.	63,5	0,15	0,05	0,1	—	0,3	0,2	0,1	—	0,2	

[a] For information only.

[b] For drinking water applications, restrictions to the chemical composition of some materials listed in this table may apply according to national regulations/laws, e.g. as specified in the 4 MS Common Composition List.

Table 7 — Composition of copper-zinc-lead alloys

Material designation		Composition[b] % (mass fraction)											Density[a] g/cm^3
Symbol	Number	Element	Cu	Al	As	Fe	Mn	Ni	Pb	Sn	Zn	Others total	approx.
CuZn36Pb2As	CW602N	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	
CuZn38Pb1	CW607N	min.	60,0	—	—	—	—	—	0,8	—	Rem.	—	8,4
		max.	61,0	0,05	—	0,2	—	0,3	1,6	0,2	—	0,2	
CuZn38Pb2	CW608N	min.	60,0	—	—	—	—	—	1,6	—	Rem.	—	8,4
		max.	61,0	0,05	—	0,2	—	0,3	2,5	0,2	—	0,2	
CuZn39Pb0,5	CW610N	min.	59,0	—	—	—	—	—	0,2	—	Rem.	—	8,4
		max.	60,5	0,05	—	0,2	—	0,3	0,8	0,2	—	0,2	
CuZn39Pb1	CW611N	min.	59,0	—	—	—	—	—	0,8	—	Rem.	—	8,4
		max.	60,0	0,05	—	0,3	—	0,3	1,6	0,3	—	0,2	
CuZn39Pb2	CW612N	min.	59,0	—	—	—	—	—	1,6	—	Rem.	—	8,4
		max.	60,0	0,05	—	0,3	—	0,3	2,5	0,3	—	0,2	
CuZn39Pb2Sn	CW613N	min.	59,0	—	—	—	—	—	1,6	0,2	Rem.	—	8,4
		max.	60,0	0,1	—	0,4	—	0,3	2,5	0,5	—	0,2	
CuZn39Pb3	CW614N	min.	57,0	—	—	—	—	—	2,5	—	Rem.	—	8,4
		max.	59,0	0,05	—	0,3	—	0,3	3,5	0,3	—	0,2	
CuZn40Pb1Al	CW616N	min.	57,0	0,05	—	—	—	—	1,0	—	Rem.	—	8,3
		max.	59,0	0,30	—	0,2	—	0,2	2,0	0,2	—	0,2	
CuZn40Pb2	CW617N	min.	57,0	—	—	—	—	—	1,6	—	Rem.	—	8,4
		max.	59,0	0,05	—	0,3	—	0,3	2,5	0,3	—	0,2	

Material designation		**Composition**[b] % (mass fraction)											**Density**[a] g/cm^3
Symbol	Number	Element	Cu	Al	As	Fe	Mn	Ni	Pb	Sn	Zn	Others total	approx.
CuZn35Pb1,5AlAs	CW625N	min.	62,0	0,5	0,02	—	—	—	1,2	—	Rem.	—	8,4
		max.	64,0	0,7	0,15	0,3	0,1	0,2	1,6	0,3	—	0,2	
CuZn33Pb1,5AlAs	CW626N	min.	64,0	0,8	0,02	—	—	—	1,2	—	Rem.	—	8,4
		max.	66,0	1,0	0,15	0,3	0,1	0,2	1,7	0,3	—	0,2	

[a] For information only.

[b] For drinking water applications, restrictions to the chemical composition of some materials listed in this table may apply according to national regulations/laws, e.g. as specified in the 4 MS Common Composition List.

Table 8 — Composition of complex copper-zinc alloys

Material designation		Composition[b] % (mass fraction)													Density[a] g/cm^3
Symbol	Number	Element	Cu	Al	As	Fe	Mn	Ni	P	Pb	Si	Sn	Zn	Others total	approx.
CuZn23Al6Mn4Fe3Pb	CW704R	min.	63,0	5,0	—	2,0	3,5	—	—	0,2	—	—	Rem.	—	8,2
		max.	65,0	6,0	—	3,5	5,0	0,5	—	0,8	0,2	0,2	—	0,2	
CuZn32Pb2AsFeSi	CW709R	min.	64,0	—	0,03	0,1	—	—	—	1,5	0,45	—	Rem.	—	8,4
		max.	66,5	0,05	0,08	0,2	—	0,3	—	2,2	0,8	0,3	—	0,2	
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	
CuZn36Sn1Pb	CW712R	min.	61,0	—	—	—	—	—	—	0,2	—	1,0	Rem.	—	8,3
		max.	63,0	—	—	0,1	—	0,2	—	0,6	—	1,5	—	0,2	
CuZn37Mn3Al2PbSi	CW713R	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	
CuZn39Sn1	CW719R	min.	59,0	—	—	—	—	—	—	—	—	0,5	Rem.	—	8,4
		max.	61,0	—	—	0,1	—	0,2	—	0,2	—	1,0	—	0,2	
CuZn40Mn1Pb1	CW720R	min.	57,0	—	—	—	0,5	—	—	1,0	—	—	Rem.	—	8,3
		max.	59,0	0,2	—	0,3	1,5	0,6	—	2,0	0,1	0,3	—	0,3	
CuZn40Mn1Pb1AlFeSn	CW721R	min.	57,0	0,3	—	0,2	0,8	—	—	0,8	—	0,2	Rem.	—	8,3
		max.	59,0	1,3	—	1,2	1,8	0,3	—	1,6	—	1,0	—	0,3	
CuZn40Mn1Pb1FeSn	CW722R	min.	56,5	—	—	0,2	0,8	—	—	0,8	—	0,2	Rem.	—	8,3
		max.	58,5	0,1	—	1,2	1,8	0,3	—	1,6	—	1,0	—	0,3	
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	

Material designation		**Composition**[b] % (mass fraction)												**Density**[a] g/cm^3
Symbol	Number	Element	Cu	Al	As	Fe	Mn	Ni	P	Pb	Si	Sn	Zn	Others total	approx.
CuZn33Pb1AlSiAs	CW725R	min.	64,0	0,1	0,05	—	—	—	—	0,4	0,1	—	Rem.	—	8,5
		max.	67,0	0,4	0,08	0,3	0,1	0,2	0,02	0,9	0,3	0,3	—	0,2	

[a] For information only.

[b] For drinking water applications, restrictions to the chemical composition of some materials listed in this table may apply according to national regulations/laws, e.g. as specified in the 4 MS Common Composition List.

Table 9 — Mechanical properties of round forging stock of copper

Designations			Diameter		Hardness	
Material		Material condition	mm		HBW	
Symbol	Number		from	up to and including	min.	max.
Cu-ETP Cu-OF Cu-HCP Cu-DHP	CW004A CW008A CW021A CW024A	M	All		As manufactured	
		H040	6	160	40	

Table 10 — Mechanical properties of round forging stock of low alloyed copper alloys

Designations			Diameter		Hardness	
Material		Material condition	mm		HBW	
Symbol	Number		from	up to and including	min.	max.
CuBe2	CW101C	M	All		As manufactured	
		H080	8	80	80	420
CuCo1Ni1Be CuCo2Be	CW103C CW104C	M	All		As manufactured	
		H090	8	80	90	320
CuCr1Zr	CW106C	M	All		As manufactured	
		H070	8	80	70	150
CuNi1Si	CW109C	M	All		As manufactured	
		H050	8	80	50	180
CuNi2Si	CW111C	M	All		As manufactured	
		H060	8	80	60	220
CuZr	CW120C	M	All		As manufactured	
		H050	8	80	50	120
NOTE These alloys are precipitation hardenable copper alloys. The hardness depends on the production process.						

Table 11 — Mechanical properties of round forging stock of copper-aluminium alloys

Designations			Diameter		Hardness	
Material		Material condition	mm		HBW	
Symbol	Number		from	up to and including	min.	max.
CuAl8Fe3	CW303G	M	All		As manufactured	
		H090	8	80	90	150
CuAl10Fe1	CW305G	M	All		As manufactured	
		H100	8	80	100	200
CuAl10Fe3Mn2	CW306G	M	All		As manufactured	
		H120	8	80	120	220
CuAl10Ni5Fe4	CW307G	M	All		As manufactured	
		H170	8	80	170	250
CuAl11Fe6Ni6	CW308G	M	All		As manufactured	
		H180	8	80	180	280

Table 12 — Mechanical properties of round forging stock of copper-nickel alloys

Designations			Diameter		Hardness	
Material		Material condition	mm		HBW	
Symbol	Number		from	up to and including	min.	max.
CuNi10Fe1Mn	CW352H	M	All		As manufactured	
		H070	8	80	70	100
CuNi30Mn1Fe	CW354H	M	All		As manufactured	
		H080	8	80	80	110

Table 13 — Mechanical properties of round forging stock of copper-nickel-zinc alloys

Designations			Diameter		Hardness	
Material		Material condition	mm		HBW	
Symbol	Number		from	up to and including	min.	max.
CuNi7Zn39Pb3Mn2	CW400J	M	All		As manufactured	
		H110	8	80	110	—

Table 14 — Mechanical properties of round forging stock of copper-zinc alloys

Designations			Diameter		Hardness	
Material		Material condition	mm		HBW	
Symbol	Number		from	up to and including	min.	max.
CuZn37 CuZn40	CW508L CW509L	M	All		As manufactured	
		H070	8	120	70	100
CuZn42	CW510L	M	All		As manufactured	
		H090	8	120	90	125
CuZn38As	CW511L	M	All		As manufactured	
		H070	8	120	70	110

Table 15 — Mechanical properties of round forging stock of copper-zinc-lead alloys

Designations			Diameter		Hardness	
Material		Material condition	mm		HBW	
Symbol	Number		from	up to and including	min.	max.
CuZn36Pb2As	CW602N	M	All		As manufactured	
CuZn35Pb1,5AlAs	CW625N	H070	8	120	70	110
CuZn33Pb1,5AlAs	CW626N					
CuZn38Pb1	CW607N	M	All		As manufactured	
CuZn38Pb2 CuZn39Pb0,5 CuZn39Pb1 CuZn39Pb2 CuZn39Pb2Sn	CW608N CW610N CW611N CW612N CW613N	H070	8	120	70	100
CuZn39Pb3	CW614N	M	All		As manufactured	
CuZn40Pb1Al CuZn40Pb2	CW616N CW617N	H080	8	120	80	125

Table 16 — Mechanical properties of round forging stock of complex copper-zinc alloys

Designations			Diameter		Hardness	
Material		Material condition	mm		HBW	
Symbol	Number		from	up to and including	min.	max.
CuZn23Al6Mn4Fe3Pb	CW704R	M	All		As manufactured	
		H190	8	80	190	
CuZn32Pb2AsFeSi	CW709R	M	All		As manufactured	
		H090	8	80	90	170
CuZn35Ni3Mn2AlPb	CW710R	M	All		As manufactured	
		H120	8	80	120	160
CuZn36Sn1Pb	CW712R	M	All		As manufactured	
		H080	8	80	80	120
CuZn37Mn3Al2PbSi	CW713R	M	All		As manufactured	
		H130	8	80	130	170
CuZn39Sn1	CW719R	M	All		As manufactured	
		H080	8	80	80	120
CuZn40Mn1Pb1	CW720R	M	All		As manufactured	
		H100	8	80	100	140
CuZn40Mn1Pb1AlFeSn	CW721R	M	All		As manufactured	
		H100	8	80	100	140
CuZn40Mn1Pb1FeSn	CW722R	M	All		As manufactured	
		H100	8	80	100	160
CuZn21Si3P	CW724R	M	All		As manufactured	
		H130	8	80	130	220
CuZn33Pb1AlSiAs	CW725R	M	All		As manufactured	
		H070	8	80	70	110

Table 17 — Tolerances on diameter of round forging stock

Dimensions in millimetres

Nominal diameter		**Tolerances**	
over	up to and including	class A	class B
10[a]	18	±0,25	±0,14
18	30	±0,30	±0,17
30	50	±0,60	±0,20
50	80	±0,70	±0,37
80	120	±2	—
120	160	±2,5	—

[a] Including 10.

Table 18 — Tolerances on straightness of round forging stock

Nominal diameter	**Maximum deviation from straightness** (see 6.4.4) mm			
	localized over any 400 mm length		over whole length L of forging stock in metres ($L \geq 1$ m)	
	for alloys in Tables 5, 6 and 7	for alloys in Tables 1, 2, 3, 4 and 8	for alloys in Tables 5, 6 and 7	for alloys in Tables 1, 2, 3, 4 and 8
from 10 mm up to and including 60 mm	1,5	3,0	3,0 × L	6,0 × L
Straightness tolerances for rods over 60 mm diameter shall be agreed between customer and supplier.				

Table 19 — Sampling rate

Nominal diameter mm		**Mass of inspection lot for one test sample** kg
over	up to and including	up to and including
—	25	1 000
25	—	2 000
NOTE Larger quantities require sampling in proportion, up to a maximum of three test samples.		

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