BS EN 12168:2016

BSI Standards Publication

Copper and copper alloys — Hollow rod for free machining purposes

bsi.

National foreword

This British Standard is the UK implementation of EN 12168:2016. It supersedes BS EN 12168:2011 which is withdrawn.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.

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Published by BSI Standards Limited 2016

ISBN 978 0 580 91261 0

ICS 77.150.30

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 31 July 2016.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12168

July 2016

ICS 77.150.30

Supersedes EN 12168:2011

English Version

Copper and copper alloys - Hollow rod for free machining purposes

Cuivre et alliages de cuivre - Barres creuses pour décolletage

Kupfer und Kupferlegierungen - Hohlstangen für die spanende Bearbeitung

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

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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Ref. No. EN 12168:2016 E

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European foreword

This document (EN 12168:2016) 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of an identical text or by endorsement, at the latest by January 2017, and conflicting national standards shall be withdrawn at the latest by January 2017.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 12168:2011.

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 12168:2011, *Copper and copper alloys — Hollow rod for free machining purposes*.

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 12165, *Copper and copper alloys — Wrought and unwrought forging stock*;

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

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

— 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 wire for electrical purposes*.

In comparison with EN 12168:2011, the following significant technical changes were made:

a) addition of four new materials: CuZn37Pb1 (CW605N), 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 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 copper alloy hollow rod, finally produced by drawing or extruding, specifically intended for free machining purposes.

NOTE Hollow products having an outside diameter greater than 80 mm and/or a wall thickness less than 2 mm are specified in EN 12449.

The sampling procedures, 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 10204, *Metallic products - Types of inspection documents*

EN 14977, *Copper and copper alloys - Detection of tensile stress - 5 % ammonia test*

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 6509-1, *Corrosion of metals and alloys - Determination of dezincification resistance of copper alloys with zinc - Part 1: Test method (ISO 6509-1)*

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

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

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
hollow rod
straight product, of uniform cross-section along its whole length with an enclosed void for which the longitudinal axes of its external contour and its internal contour, which is the boundary with the enclosed void, are coincidental

Note 1 to entry: The external and internal contours of the rod, at any cross-section, can be that of a circle, square, rectangle, hexagon, or octagon, or with slight modification of those basic shapes by inclusion of detail(s) of relatively small size to the remainder of the cross-section. Examples of hollow rod cross-sections are shown in Figure 1.

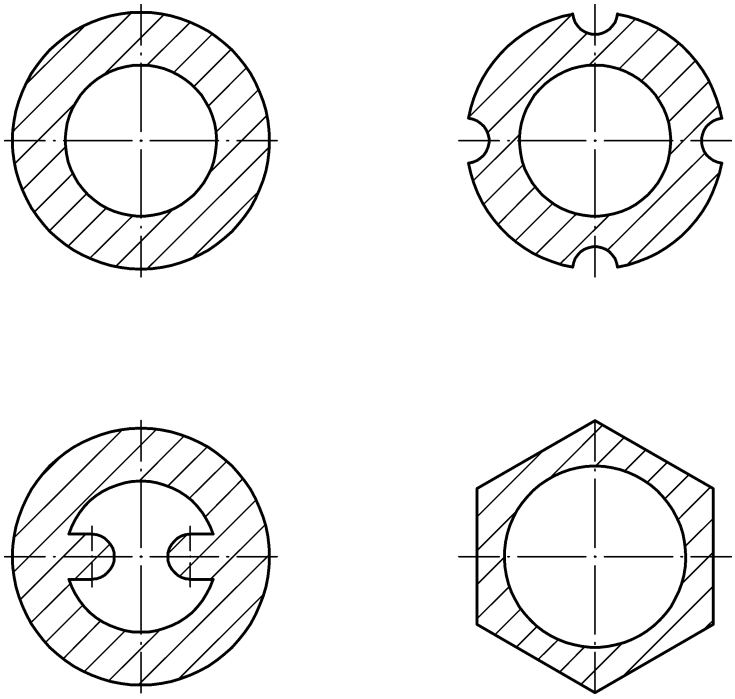


Figure 1 — Examples of hollow rod cross-sections

3.2
deviation from circular form
difference between the maximum and the minimum outside diameters measured at any one cross-section of the product

[SOURCE: EN 12163:2016, 3.2, modified — The definition was adapted.]

3.3
eccentricity
difference between the maximum and the minimum wall thickness, measured in the same cross-section perpendicular to the axis of the hollow rod, expressed as a percentage of the sum of the maximum and minimum wall thicknesses ($s_{\max.}$ and $s_{\min.}$):

$$e = \frac{s_{\max.} - s_{\min.}}{s_{\max.} + s_{\min.}} \times 100$$

Note 1 to entry: For polygons, wall thickness is measured perpendicular to the mid-points of the flat outside surfaces.

4 Designations

4.1 Material

4.1.1 General

The material is designated either by symbol or by number (see Tables 1 to 4).

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;

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

Products in the M or H... material condition may 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 and the dimensional stability on machining [see Clause 5 list entry k), list entry l) and 8.5].

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 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:

a) denomination (hollow rod);

b) number of this European Standard (EN 12168);

c) material designation, either symbol or number (see Tables 1 to 4);

d) 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;

e) material condition designation (see Tables 5 to 8);

f) external and/or internal cross-sectional shape (the following designations shall be used as appropriate: RND for round, SQR for square, RCT for rectangular, HEX for hexagonal, OCT for octagonal, PFL for profile);

g) nominal cross-sectional dimensions (see Clause 5, list entry g)) or, for profiles, the number of the profile or a fully dimensioned and toleranced drawing, and:

   1) tolerance class A, B or C added to the external dimension (see Table 9); and/or

   2) tolerance class A or B added to the bore diameter (see Table 11);

h) wall thickness (the following designation shall be used for wall thickness: WT) (see Table 10);

i) for square, hexagonal or octagonal external shape, the corner shape (the following designations shall be used as appropriate: SH for sharp, RD for rounded) (see Table 15).

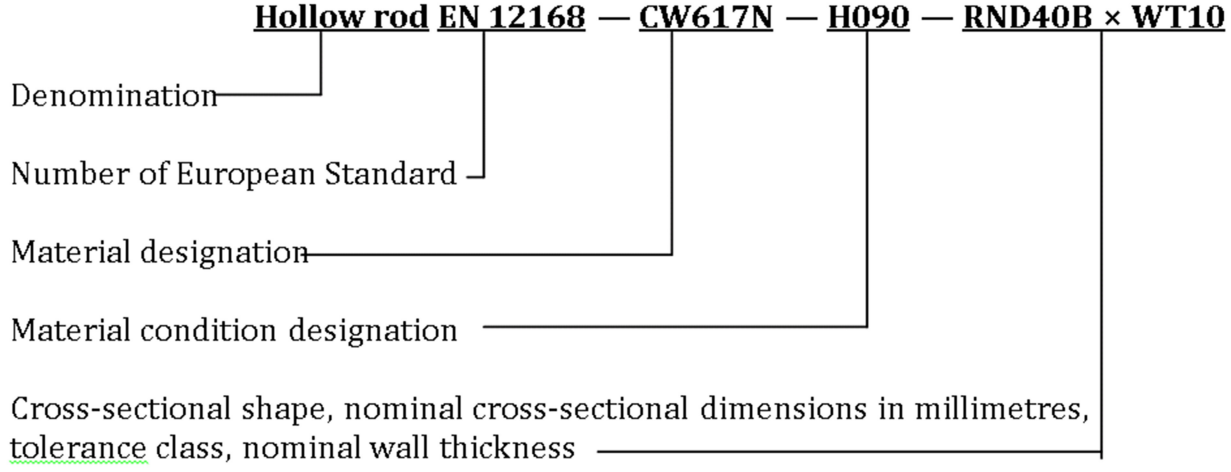
A typical product designation is shown in the following examples.

EXAMPLE 1 Hollow rod for free machining purposes conforming to this standard, in material designated either CuZn40Pb2 or CW617N, for standard applications, in material condition H090, round external shape and bore, nominal outside diameter 40 mm, tolerance Class B, and nominal wall thickness 10 mm will be designated as follows:

Hollow rod EN 12168 — CuZn40Pb2 — H090 — RND40B × WT10

or

Hollow rod EN 12168 — CW617N — H090 — RND40B × WT10

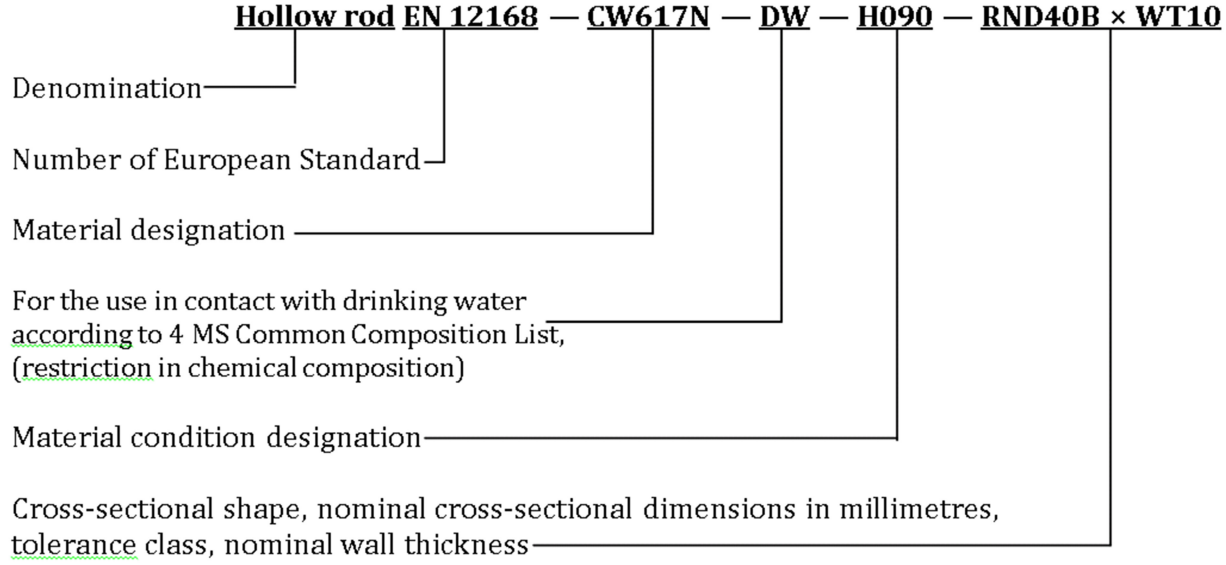


EXAMPLE 2 Hollow rod for free machining purposes conforming to this standard, in material designated either CuZn40Pb2 or CW617N, for drinking water applications according to the 4 MS Common Composition List, in material condition H090, round external shape and bore, nominal outside diameter 40 mm, tolerance Class B, and nominal wall thickness 10 mm will be designated as follows:

Hollow rod EN 12168 — CuZn40Pb2 — DW — H090 — RND40B × WT10

or

Hollow rod EN 12168 — CW617N — DW — H090 — RND40B × WT10

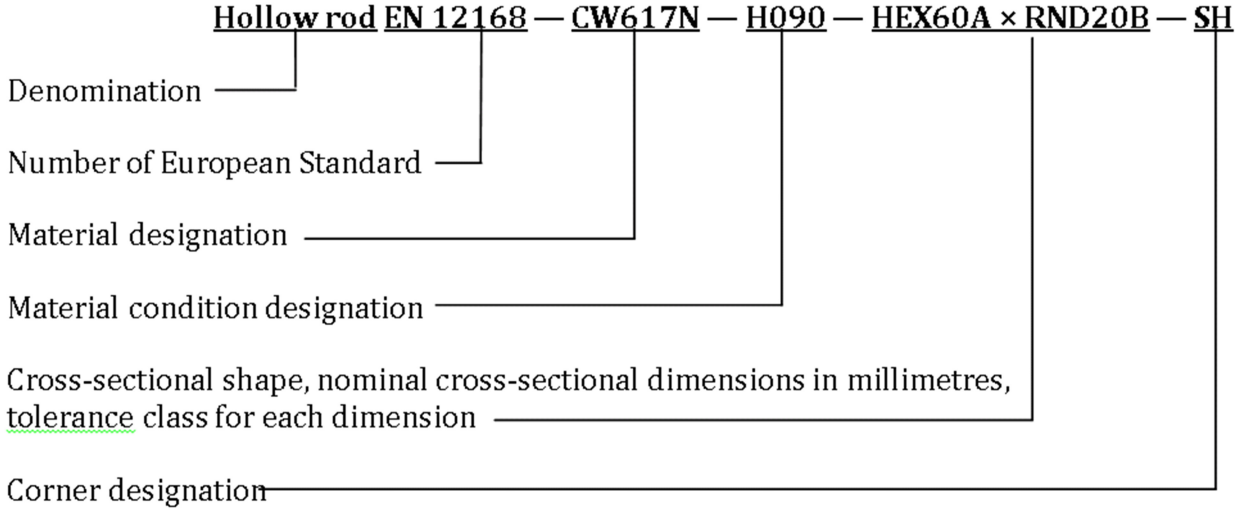


EXAMPLE 3 Hollow rod for free machining purposes conforming to this standard, in material designated either CuZn40Pb2 or CW617N, for standard applications, in material condition H090, hexagonal external shape, 60 mm nominal width across-flats dimension, tolerance Class A, round bore of nominal diameter 20 mm, tolerance Class B sharp corners, will be designated as follows:

Hollow rod EN 12168 — CuZn40Pb2 — H090 — HEX60A × RND20B — SH

or

Hollow rod EN 12168 — CW617N — H090 — HEX60A × RND20B — SH

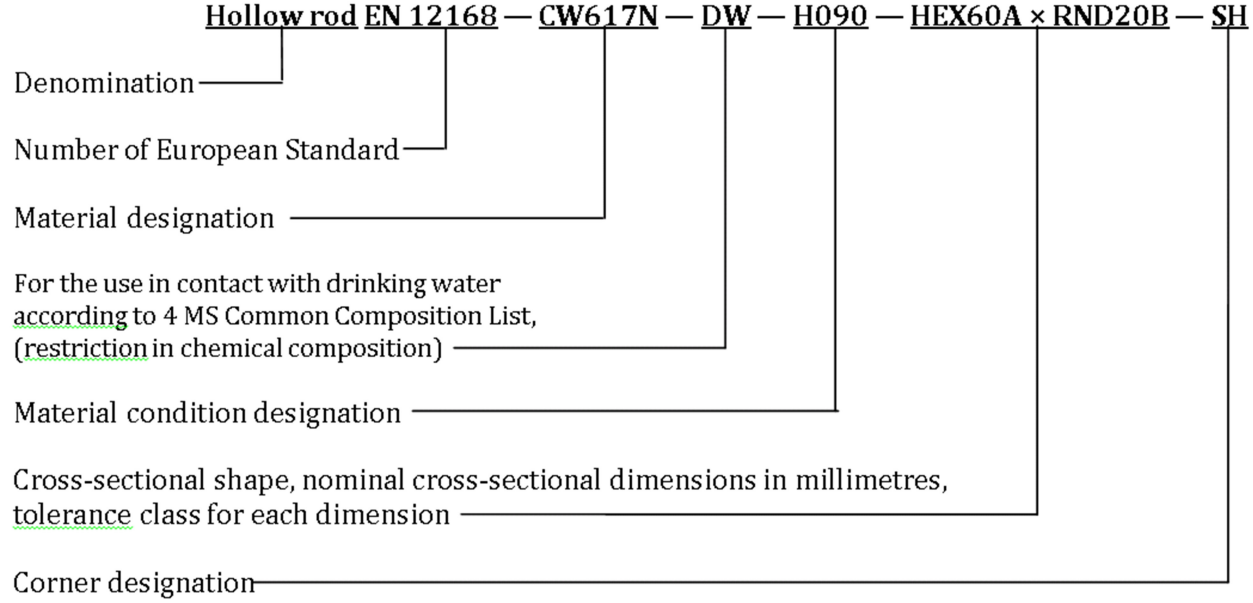


EXAMPLE 4 Hollow rod for free machining purposes conforming to this standard, in material designated either CuZn40Pb2 or CW617N, for drinking water applications according to the 4 MS Common Composition List, in material condition H090, hexagonal external shape, 60 mm nominal width across-flats dimension, tolerance Class A, round bore of nominal diameter 20 mm, tolerance Class B sharp corners, will be designated as follows:

Hollow rod EN 12168 — CuZn40Pb2 — DW — H090 — HEX60A × RND20B — SH

or

Hollow rod EN 12168 — CW617N — DW — H090 — HEX60A × RND20B — SH



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 (hollow rod);

c) number of this European Standard (EN 12168);

d) material designation (see Tables 1 to 4);

e) material condition designation (see 4.2 and Tables 5 to 8) 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) nominal cross-sectional dimensions or, in the case of hollow profiles, by a fully dimensioned and toleranced drawing:

   To define the nominal cross-sectional dimensions of a hollow rod, a purchaser should state one of the following:

   1) the external dimensions and the wall thickness (tolerances given in Tables 9 and 10); or

2) the internal dimensions and the wall thickness (tolerances given in Tables 11 and 10); or

3) the external and internal dimensions (tolerances given in Tables 9 and 11) and the maximum eccentricity (tolerances given in Table 12); or

4) the external and internal dimensions (tolerances given in Tables 9 and 11) and the wall thickness (tolerances given in Table 10);

h) whether:

1) class A, B or C tolerances shall apply to external dimensions (see Table 9); and/or

2) class A or B tolerances shall apply to internal dimensions (see Table 11); unless the choice of these tolerance classes is left to the discretion of the supplier;

i) for hollow rod having a square, hexagonal or octagonal external shape, whether "sharp" or "rounded" corners are required unless the corner radii of the rod are left to the discretion of the supplier (see 6.5.7 and Table 13);

j) length of product required. Normally hollow rod is supplied to "nominal length" tolerances (see 6.5.6 and Table 14);

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

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

k) whether the products are required to pass a stress corrosion resistance test. If so which test method shall be used (see 8.5), if the choice is not left to the discretion of the supplier. If the purchaser chooses ISO 6957, the pH value for the test solution shall be selected;

l) whether the products shall be supplied in a thermally stress relieved material condition;

m) whether special surface quality is required (see 6.6);

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

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

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

EXAMPLE Ordering details for 1 000 kg of hollow rod for free machining purposes conforming to EN 12168, in material designated either CuZn40Pb2 or CW617N, for drinking water application according to the 4 MS Common Composition List, in material condition H090, round external shape, nominal outside diameter 40 mm, tolerance class B, and nominal wall thickness 10 mm, tolerance class A, nominal length 3 000 mm:

1 000 kg Hollow rod — CuZn40Pb2 — DW — H090 — RND40B × WT10A
EN 12168

— nominal length 3 000 mm

or

1 000 kg Hollow rod — CW617N — DW — H090 — RND40B × WT10A
EN 12168

— nominal 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 4.

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 f)).

6.2 Mechanical properties

The properties shall conform to the appropriate requirements given in Tables 5 to 8. The tests shall be carried out in accordance with 8.2 or 8.3.

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 8.4.

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

Products in alloys other than CuZn21Si3P (CW724R) shall be subjected to heat treatment approximately in the range 500 °C to 550 °C. Should the user need to heat the material above 530 °C (i.e. soldering, brazing or welding operations) then advice should be sought from the supplier.

6.4 Residual stress level

Products ordered and supplied in the stress relieved condition (see 4.2, 2nd paragraph) shall show no evidence of cracking when tested. The tests shall be carried out in accordance with 8.5.

6.5 Dimensions and tolerances

6.5.1 Diameter or width across-flats

When specified by the purchaser (see Clause 5 list entry g)), the external diameter or width across-flats shall conform to the tolerances given in Table 9.

NOTE The external diameter of a hollow rod with circular cross-section is calculated as the mean of one or more pairs of measurements taken at right angles at the same cross-section of the hollow rod.

When specified by the purchaser (see Clause 5 list entry g)), the internal diameter of the bore shall conform to the tolerances given in Table 11.

6.5.2 Tolerance on wall thickness

When specified by the purchaser (see Clause 5 list entry g)), the wall thickness shall conform to the tolerances given in Table 10. For hollow rod having a polygonal external shape, the wall thickness shall be measured at the centre of each flat.

6.5.3 Eccentricity

When specified by the purchaser (see Clause 5 list entry g)), the percentage eccentricity of hollow rod having a circular or polygonal external cross-section shall conform to Table 12.

6.5.4 Shape tolerances

6.5.4.1 Circular cross-sections

For hollow rod having a circular external cross-section and for circular bores, the deviation from circularity of their diameters shall not exceed half the appropriate range of the tolerance on diameter given in Tables 9 and 11 respectively.

6.5.4.2 Polygonal external cross-sections

For hollow rod having a polygonal external cross-section, the width across-flats at any one cross-section, measured at the centre of each pair of opposite faces, shall not differ by more than half the range of the tolerance given in Table 9.

6.5.5 Straightness

For hollow rod 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 13.

NOTE Outside this range, the deviation from straightness is subject to agreement between the purchaser and the supplier.

6.5.6 Length

Hollow rod shall be supplied as “nominal lengths”, generally in the preferred lengths given in Table 14, and shall conform to the tolerances in the table.

Subject to agreement between the purchaser and the supplier, an agreed proportion of underlength hollow rod may be included in a consignment of “nominal lengths” hollow rod.

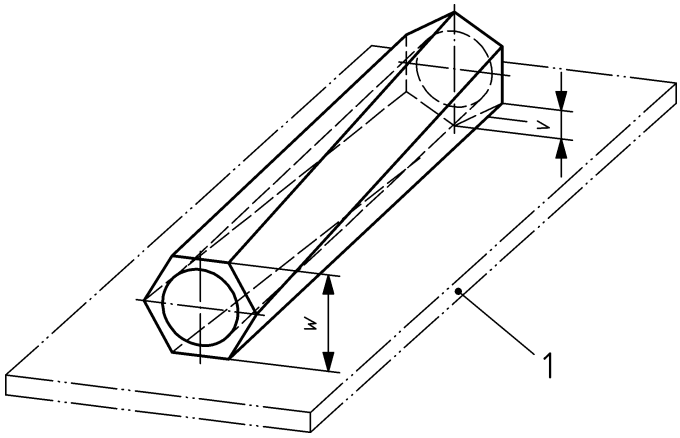
6.5.7 Corner radii

The corner radii of hollow rod having a square, hexagonal or octagonal external shape, shall conform to Table 15 [see Clause 5 list entry i)].

Except in cases of dispute, the corners should be measured directly, either by use of a gauge or an optical projector. In cases of dispute, the method by optical projector should be used.

6.5.8 Twist of polygonal hollow rod

The maximum permitted twist V (see Figure 2) of hollow rod having a square, hexagonal or octagonal external shape, as measured between two cross-sections along the rod, shall conform to Table 16.



Key

1 reference plane

V twist

W width across-flats

Figure 2 — Measurement of twist of polygonal hollow rod

6.6 Surface quality

The surfaces shall be clean and smooth. The hollow rods 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 hollow rods 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 m)].

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 to 7.4.

7.2 Analysis

The sampling rate shall be in accordance with Table 17. 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 Mechanical tests

The sampling rate shall be in accordance with Table 17. 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.

7.4 Dezincification resistance and stress corrosion resistance tests

The sampling rate which shall be applied to finished products shall be:

— for products that have been heat treated: one sampling unit per heat treatment batch;

— for products that have not been heat treated: in accordance with Table 17.

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 at the discretion of the supplier. In case of dispute the methods of analysis to be used shall be agreed between the disputing parties. For expression of results, the rounding rules given in 8.7 shall be used.

8.2 Tensile test

8.2.1 General

Tensile test pieces shall be prepared in accordance with 8.2.2 and 8.2.3 and the test shall be carried out in accordance with 8.2.4.

8.2.2 Location of test pieces

Test pieces shall be machined from one of the following locations in the test sample obtained in accordance with 7.3:

a) for test samples from products up to and including 25 mm diameter, or width across-flats or equivalent cross sectional area, the test piece shall be coaxial with the product;

b) for test samples from products over 25 mm diameter, or width across-flats or equivalent cross sectional area, the test piece shall be tested in full section or extracted from the wall of the hollow rod with the longitudinal axis parallel to that of the product. For thickness lower than 11 mm the test piece shall be a circumferential portion of the wall of the original hollow rod. For thickness greater than 11 mm a cylindrical test piece shall be obtained by machining the wall of the original

hollow rod; the longitudinal axis of the test piece shall be mid-way between the internal and external surface.

8.2.3 Shape and size of test pieces

Test pieces shall be in accordance with EN ISO 6892-1.

NOTE Elongation requirements for hollow rod of thickness are based on original gauge lengths of 5,65 $\sqrt{S_0}$ mm (A), where S_o is the original cross-sectional area of the test piece in square millimetres.

8.2.4 Procedure for testing

The tensile test shall be carried out in accordance with the method given in EN ISO 6892-1.

8.2.5 Determination of results

The tensile strength and the elongation shall be determined from the tensile test results obtained in accordance with 8.2.4. For expression of results the rounding rules given in 8.7 shall be used.

8.3 Hardness test

Hardness shall be determined on test pieces cut from the test sample obtained in accordance with 7.3. The test shall be carried out in accordance with EN ISO 6506-1 or EN ISO 6507-1 and the impression/ indentation made on the cross-section of the product mid-way between the external and internal surfaces.

8.4 Dezincification resistance test

The test method given in EN ISO 6509-1 shall be used on the test samples obtained in accordance with 7.4. 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;

8.5 Stress corrosion resistance test

The test method given in either ISO 6957 or EN 14977 shall be used on the test pieces prepared from the test samples obtained in accordance with 7.4. The choice of which of these tests is used shall be at the discretion of the supplier, unless a preference is expressed by the purchaser [see Clause 5 list entry k)].

8.6 Retests

8.6.1 Analysis, tensile, hardness and dezincification resistance tests

If there is a failure of one, or more than one, of the tests in 8.1, 8.2, 8.3 or 8.4, 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.

NOTE If an inspection lot of dezincification resistant alloys fails the dezincification resistance test when tested or retested, the supplier has the option to heat treat, or to further heat treat, the inspection lot and resubmit it for all the tests called for on the order, except for analysis.

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 7.4.

If a test piece from the further test sample passes the test, the stress relieved products 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 products 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 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 n)] 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 o)] 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 p)].

Table 1 — Composition of low alloyed copper alloys

Material designation		**Composition** **%** (mass fraction)							**Density**[a] g/cm^3
Symbol	Number	Element	Cu	P	Pb	S	Te	Others total	approx.
CuSP	CW114C	min.	Rem.	0,003	—	0,2	—	—	8,9
		max.	—	0,012	—	0,7	—	0,1	
CuTeP	CW118C	min.	Rem.	0,003	—	—	0,4	—	8,9
		max.	—	0,012	—	—	0,7	0,1	

[a] For information only.

Table 2 — 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.
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 3 — 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.
Group A alloys — These alloys have excellent machinability, but very limited cold workability													
CuZn36Pb3	CW603N	min.	60,0	—	—	—	—	—	2,5	—	Rem.	—	8,5
		max.	62,0	0,05	—	0,3	—	0,3	3,5	0,2	—	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	
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	
Group B alloys — These alloys have good machinability and some cold workability													
CuZn37Pb2	CW606N	min.	61,0	—	—	—	—	—	1,6	—	Rem.	—	8,4
		max.	62,0	0,05	—	0,2	—	0,3	2,5	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	
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	
Group C alloys — These alloys are machinable and have good to very good cold workability													
CuZn35Pb2	CW601N	min.	62,0	—	—	—	—	—	1,6	—	Rem.	—	8,5
		max.	63,5	0,05	—	0,1	—	0,3	2,5	0,1	—	0,1	
CuZn37Pb1	CW605N	min.	61,0	—	—	—	—	—	0,8	—	Rem.	—	8,5
		max.	62,5	0,05	—	0,3	—	0,3	1,6	0,3	—	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	

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.
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	

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.
Group D alloy — This alloy is dezincification resistant with good machinability and some cold workability													
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	
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 4 — 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.
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	
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	
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	
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 5 — Mechanical properties of low alloyed copper alloys

Designations			Thickness			Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	mm			R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		A %	HBW		HV	
Symbol	Number		from	over	up to and including	min.	min.	max.	min.	min.	max.	min.	max.
CuSP CuTeP	CW114C CW118C	M	All			As manufactured							
		H080	All			—	—	—	—	80	130	90	140

Table 6 — Mechanical properties of copper-zinc alloys

Designations			Thickness			Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	mm			R_m N/mm^2 (MPa)	$R_{p\ 0,2}$ N/mm^2 (MPa)		A %	HBW		HV	
Symbol	Number		from	over	up to and including	min.	min.	max.	min.	min.	max.	min.	max.
CuZn40	CW509L	M	All			As manufactured							
		R360	2		20	360	—	300	20	—	—	—	—
		H070	2		20	—	—	—		70	100	80	110
		R410	2		10	410	250	—	12	—	—	—	—
		H100	2		10	—	—	—	—	100	145	110	155
		R500	2		7	500	350	—	8	—	—	—	—
		H120	2		7	—	—	—	—	120	—	130	—
CuZn42	CW510L	M	All			As manufactured							
		R360	2		40	360	—	320	20	—	—	—	—
		H090	2		40	—	—	—	—	90	125	100	135
		R430	2		15	430	220		10	—	—	—	—
		H110	2		15	—	—	—	—	110	160	120	170

Designations			Thickness			Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	mm			R_m N/mm^2 (MPa)	$R_{p\ 0,2}$ N/mm^2 (MPa)		A %	HBW		HV	
Symbol	Number		from	over	up to and including	min.	min.	max.	min.	min.	max.	min.	max.
		R500	2		7	500	350	—	8	—	—	—	—
		H135	2		7	—	—	—	—	135	—	145	—

Designations			Thickness			Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	mm			R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		A %	HBW		HV	
Symbol	Number		from	over	up to and including	min.	min.	max.	min.	min.	max.	min.	max.
CuZn38As	CW511L	M	All			As manufactured							
		R280	2		All	280	—	200	30	—	—	—	—
		H070	2		All	—	—	—	—	70	110	80	120
		R320	2		20	320	200	—	20	—	—	—	—
		H090	2		20	—	—	—	—	90	135	100	145
		R400	2		8	400	250		8	—	—	—	—
		H105	2		8	—	—	—	—	105	—	115	—

Table 7 — Mechanical properties of copper-zinc-lead alloys

Designations			Thickness			Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	mm			R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		A %	HBW		HV	
Symbol	Number		from	over	up to and including	min.	min.	max.	min.	min.	max.	min.	max.
CuZn36Pb2As CuZn35Pb1,5AlAs CuZn33Pb1,5AlAs	CW602N CW625N CW626N	M	All			As manufactured							
		R280	2		All	280	—	200	30	—	—	—	—
		H070	2		All	—	—	—	—	70	110	80	120
		R320	2		20	320	200	—	20	—	—	—	—
		H090	2		20	—	—	—	—	90	135	100	145
		R400	2		8	400	250	—	8	—	—	—	—
		H105	2		8	—	—	—	—	105	—	115	—
CuZn35Pb2 CuZn36Pb3 CuZn37Pb1 CuZn37Pb2	CW601N CW603N CW605N CW606N	M	All			As manufactured							
		R340	2		20	340	—	280	20	—	—	—	—
		H070	2		20	—	—	—	—	70	120	80	130
		R400	2		10	400	200	—	12	—	—	—	—
		H100	2		10	—	—	—	—	100	140	110	150
		R480	2		7	480	350	—	8	—	—	—	—

Designations			**Thickness**			**Tensile strength**	**0,2 % proof strength**		**Elongation**	**Hardness**			
Material		Material condition	mm			R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		A %	HBW		HV	
Symbol	Number		from	over	up to and including	min.	min.	max.	min.	min.	max.	min.	max.
		H125	2		7	—	—	—	—	125	—	135	—

Designations			Thickness			Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	mm			R_m N/mm^2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		A %	HBW		HV	
Symbol	Number		from	over	up to and including	min.	min.	max.	min.	min.	max.	min.	max.
CuZn38Pb1 CuZn38Pb2 CuZn39Pb1 CuZn39Pb2	CW607N CW608N CW611N CW612N	M	All			As manufactured							
		R360	2		20	360	—	300	20	—	—	—	—
		H070	2		20	—	—	—	—	70	100	80	110
		R410	2		10	410	250	—	12	—	—	—	—
		H100	2		10	—	—	—	—	100	145	110	155
		R500	2		7	500	350	—	8	—	—	—	—
		H120	2		7	—	—	—	—	120	—	130	—
CuZn39Pb3 CuZn40Pb2	CW614N CW617N	M	All			As manufactured							
		R360	2		40	360	—	320	20	—	—	—	—
		H090	2		40	—	—	—	—	90	125	100	135
		R430	2		15	430	220	—	10	—	—	—	—
		H110	2		15	—	—	—	—	110	160	120	170
		R500	2		7	500	350	—	8	—	—	—	—
		H135	2		7	—	—	—	—	135	—	145	—

Table 8 — Mechanical properties of complex copper-zinc alloys

Designations			Thickness			Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	mm			Rm N/mm2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		A %	HBW		HV	
Symbol	Number		from	over	up to and including	min.	min.	max.	min.	min.	max.	min.	max.
CuZn32Pb2AsFeSi	CW709R	M	All			As manufactured							
		R380	3		15	380	220	—	20	—	—	—	—
		H110	3		15	—	—	—	—	110	150	120	160
		R430	3		10	430	260	—	15	—	—	—	—
		H120	3		10	—	—	—	—	120	170	130	180
CuZn37Mn3Al2PbSi	CW713R	M	All			As manufactured							
		R540		10	30	540	280	—	15	—	—	—	—
		H130		10	30	—	—	—	—	130	170	140	180
		R590	5		10	590	320	—	10	—	—	—	—
		H150	5		10	—	—	—	—	150	190	160	200
CuZn40Mn1Pb1	CW720R	M	All			As manufactured							
		R390		10	30	390	180	—	20	—	—	—	—
		H090		10	30	—	—	—	—	90	125	100	135
		R440	5		10	440	250	—	18	—	—	—	—

Designations			Thickness			Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	mm			Rm N/mm2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		A %	HBW		HV	
Symbol	Number		from	over	up to and including	min.	min.	max.	min.	min.	max.	min.	max.
		H100	5		10	—	—	—	—	100	145	110	155

Designations			Thickness			Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	mm			Rm N/mm2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		A %	HBW		HV	
Symbol	Number		from	over	up to and including	min.	min.	max.	min.	min.	max.	min.	max.
CuZn40Mn1Pb1AlFeSn CuZn40Mn1Pb1FeSn	CW721R CW722R	M	All			As manufactured							
		R440		10	30	440	180	—	20	—	—	—	—
		H100		10	30	—	—	—	—	100	140	110	150
		R500	5		10	500	270	—	12	—	—	—	—
		H130	5		10	—	—	—	—	130		140	
CuZn21Si3P	CW724R	M	All			As manufactured							
		R500	2		20	500	—	450	15	—	—	—	—
		H130	2		20	—	—	—		130	180	140	190
		R600	2		20	600	350	—	12	—	—	—	—
		H150	2		20	—	—	—	—	150	220	160	230
		R650	2		7	650	400	—	10	—	—	—	—
		H170	2		7	—	—	—	—	170	—	180	—

Designations			Thickness			Tensile strength	0,2 % proof strength		Elongation	Hardness			
Material		Material condition	mm			Rm N/mm2 (MPa)	$R_{p\,0,2}$ N/mm^2 (MPa)		A %	HBW		HV	
Symbol	Number		from	over	up to and including	min.	min.	max.	min.	min.	max.	min.	max.
CuZn33Pb1AlSiAs	CW725R	M	All			As manufactured							
		R290	2		All	290	—	200	30	—	—	—	—
		H070	2		All	—	—	—		70	110	80	120
		R320	2		20	320	200	—	20	—	—	—	—
		H090	2		20	—	—	—	—	90	135	100	145
		R400	2		8	400	250	—	8	—	—	—	—
		H105	2		8	—	—	—	—	105	—	115	—

Table 9 — Tolerances on external diameter or width across-flats

Dimensions in millimetres

Nominal external diameter or width across-flats		Tolerances on diameter or width across-flats		
over	up to and including	class A	class B	class C
12[a]	18	—	$^{0}_{-0,18}$	$^{0}_{-0,11}$
18	30	—	$^{0}_{-0,21}$	$^{0}_{-0,13}$
30	50	±0,31	$^{0}_{-0,25}$	$^{0}_{-0,16}$
50	80	±0,60	$^{0}_{-0,46}$	$^{0}_{-0,30}$
NOTE 1 For hollow rod of circular external shape, the above tolerances include any deviations from circular form.				
NOTE 2 Products supplied to class B and class C tolerances will normally be drawn finish.				
[a] Including 12.				

Table 10 — Tolerances on wall thickness

Nominal wall thickness mm		Tolerance on wall thickness expressed as a percentage of nominal wall thickness
over	up to and including	%
2 [a]	3	±12
3	6	±10
6	10	±9
10	—	±8
[a] Including 2.		

Table 11 — Tolerances on diameter of the bore

Dimensions in millimetres

Nominal bore diameter		Tolerances on bore diameter	
over	up to and including	class A	class B
8[a]	10	±0,29	±0,11
10	18	±0,35	±0,14
18	30	±0,42	±0,17
30	50	±0,80	±0,20
50	70	±0,95	±0,37
NOTE Products supplied to class B tolerances will normally be drawn finish.			
[a] Including 8.			

Table 12 — Tolerances on eccentricity

Nominal wall thickness *WT* mm	Maximum eccentricity %
$2 < WT \leq 3$	10
$WT > 3$	8

Table 13 — Tolerances on straightness of hollow rod

Nominal external diameter or width across-flats	Maximum deviation from straightness (see 6.5.5) mm			
	localized over any 400 mm length		over whole length of hollow rod of length L in metres ($L \geq 1$ m)	
	for alloys in Tables 2 and 3	for alloys in Tables 1 and 4	for alloys in Tables 2 and 3	for alloys in Tables 1 and 4
Round external shape				
from 12 mm up to and including 50 mm	0,7	1,4	1,5 × L	3,0 × L
Polygonal external shape				
from 12 mm up to and including 50 mm	1,0	2,0	2,0 × L	4,0 × L
NOTE The tolerances of straightness shown in the table only apply to material condition foreseen in this standard.				

Table 14 — Tolerances on length of hollow rod

Dimensions in millimetres

Nominal external diameter or width across-flats		Preferred (available) lengths	Tolerance on length
over	up to and including		
—	30	3 000 and 4 000	±50
30	50	2 500 and 3 000	±100
50	80	2 000 and 3 000	±100

Table 15 — Corner radii for hollow rod with square, hexagonal or octagonal external shape

Dimensions in millimetres

Nominal width across-flats		Radii for sharp and rounded corners	
over	up to and including	sharp max.	rounded range
12[a]	18	0,5	0,5 to 1,2
18	30	0,6	0,6 to 1,8
30	50	0,7	0,7 to 2,8
50	60	0,8	0,8 to 4,0

[a] Including 12.

Table 16 — Maximum twist for hollow rod with square, hexagonal or octagonal external shape

Dimensions in millimetres

Nominal width across-flats *W*		**Maximum permitted twist *V* in any 1 m length of rod**
over	up to and including	
12[a]	18	1,0
18	30	2,0
30	60	3,0

[a] Including 12.

Table 17 — Sampling rate

Ordered nominal dimensions (external diameter or width across-flats) mm		**Size 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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