BRITISH STANDARD

BS EN
1982:2008

Copper and copper alloys — Ingots and castings

ICS 77.150.30

BSI
British Standards

National foreword

This British Standard is the UK implementation of EN 1982:2008. It supersedes BS EN 1982:1999 which is withdrawn.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.

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

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 May 2008

ISBN 978 0 580 59454 0

Amendments/corrigenda issued since publication

Date	Comments

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1982

April 2008

ICS 77.150.30

Supersedes EN 1982:1998

English Version

Copper and copper alloys - Ingots and castings

Cuivre et alliages de cuivre - Lingots et pièces moulées

Kupfer und Kupferlegierungen - Blockmetalle und Gussstücke

This European Standard was approved by CEN on 21 March 2008.

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

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

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

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

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 1982:2008: E

Contents

Page

Tables

a) Tables 1 and 2: Copper and copper-chromium alloy

b) Tables 3 to 16: Copper-zinc alloys

c) Tables 17 to 21: Copper-tin alloys

d) Tables 22 to 30: Copper-tin-lead alloys

e) Tables 31 to 35: Copper-aluminium alloys

Foreword

This document (EN 1982:2008) 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 October 2008, and conflicting national standards shall be withdrawn at the latest by October 2008.

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 1982:1998.

Within its programme of work, Technical Committee CEN/TC 133 requested CEN/TC 133/WG 7 "Ingots and castings" to prepare the revision of the following standard:

EN 1982, Copper and copper alloys – Ingots and castings

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of EU Directive 97/23/EC.

For relationship with EU Directive 97/23/EC, see Annex ZA (informative), which is an integral part of this document.

In comparison with the first edition of EN 1982:1998, the following significant technical changes were made:

— option s) in Clause 5 added;

— 8.1 amended;

— 8.6 Surface condition added;

— 9.2.2 amended with regard to pressure equipment applications;

— composition limits for alloy in Tables 2, 5, 8, 13, 14, 20, 25, 33, and 35 revised;

— correction of Table 30;

— Table 23a for the new alloy CuSn5Zn5Pb2-B (CB499K) and CuSn5Zn5Pb2-C (CC499K) added;

— Former Table 23 renumbered to Table 23b.

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, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This European Standard for copper alloy ingots, and copper and copper alloy castings is based on previous national standards and harmonizes the compositions and mechanical properties required.

This standard does not include copper refinery shapes which are intended for working into wrought products and are the subject of EN 1976. Neither does it include master alloys intended for the manufacture of copper alloys which are the subject of EN 1981.

The essential information relevant to correct ordering, given in Clause 5 of the standard, is supplemented by Annex A, which is based upon the recommended practice for the ordering and supply of castings given in EN 1559-1. Its purpose is to assist the purchaser in providing full information to the supplier to ensure that he supplies castings to the purchaser's intended requirements. It is recommended that full consultation takes place between the purchaser and the supplier at the stages of enquiry and ordering.

Sampling and testing rates, where applicable, are specified in Clause 7. For certain applications, more rigorous inspection procedures may be required. Annex B gives a range of supplementary inspection procedures which may be invoked, at the option of the purchaser [see 5 p)].

1 Scope

This European Standard specifies the composition, mechanical properties and other relevant characteristics of the materials. The sampling procedures and test methods for the verification of conformity to the requirements of this standard are also specified.

This standard is applicable to:

a) copper alloy ingots intended to be remelted for the production of castings; and

b) copper and copper alloy castings which are intended for use without subsequent working other than machining. The castings may be manufactured by the sand, permanent mould, centrifugal, continuous or pressure die casting process.

Recommended practice for the ordering and supply of castings is included in Annex A. Optional supplementary inspection procedures for ingots and castings are included in Annex B.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

EN 10002-1, *Metallic materials — Tensile testing — Part 1: Method of test at ambient temperature*

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

EN ISO 2624, *Copper and copper alloys — Estimation of average grain size (ISO 2624:1990)*

EN ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method (ISO 6506-1:2005)*

EN ISO 6509, *Corrosion of metals and alloys — Determination of dezincification resistance of brass (ISO 6509:1981)*

3 Terms and definitions

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

3.1
cast
any of the following:

a) product of one furnace melt; or

b) product of one crucible melt; or

c) product of a number of furnace or crucible melts where these are aggregated and mixed prior to sampling; or

d) production corresponding to the intervals between additions to a holding furnace of new furnace or crucible melts (for example in permanent mould casting or pressure die casting); or

e) product from a number of consecutive melts of the same alloy through a die, in the case of continuous casting.

3.2
batch
any of the following:

a) number of ingots taken from a single cast; or

b) number of castings of the same design produced from a single cast; or

c) portion of the output of a continuous caster during a cast.

4 Designations

4.1 Material

4.1.1 General

The material is designated either by symbol or number (see Tables 1 to 40).

4.1.2 Symbol

The material symbol designation is based on the designation system given in ISO 1190-1. A suffix -B is added to the designation to identify material in the form of ingots and a suffix -C is added to the designation to identify material in the form of castings (for example CuSn5Zn5Pb5-C). These suffixes also serve to avoid confusion with wrought products of a similar alloy.

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 (for example CuSn5Zn5Pb5-C is CC491K).

4.2 Casting process

The designations used to indicate the casting processes referred to in this standard are based on those given in ISO 1190-1, as follows:

GS sand casting;

GM permanent mould casting;

GZ centrifugal casting;

GC continuous casting;

GP pressure die casting.

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 (Ingot or Casting);

— number of this European Standard (EN 1982);

— material designation, either symbol or number (see Tables 1 to 40);

— for castings, the casting process designation (see 4.2);

— for castings, the pattern, die or drawing number, as appropriate.

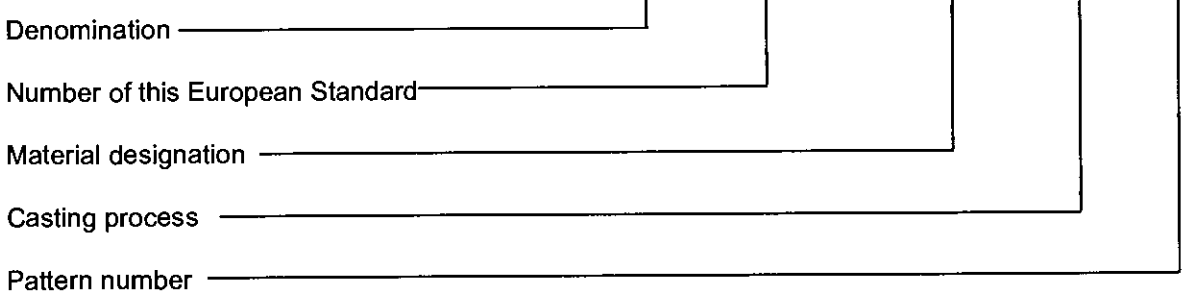
The derivation of a product designation is shown in the following examples.

EXAMPLE 1 Castings conforming to this standard, in material designated either CuAl10Fe5Ni5-C or CC333G, sand cast, pattern number XXXX, shall be designated as follows:

Casting EN 1982 — CuAl10Fe5Ni5-C — GS — XXXX

or

Casting EN 1982 — CC333G — GS — XXXX



EXAMPLE 2 Ingots conforming to this standard, in material designated either CuAl10Fe5Ni5-B or CB333G, shall be designated as follows:

Ingot EN 1982 – CuAl10Fe5Ni5-B

or

Ingot EN 1982 – CB333G

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 (mass or number of castings);

b) denomination (Ingot or Casting);

c) number of this European Standard (EN 1982);

d) material designation (see Tables 1 to 40);

e) for castings, the casting process to be used (see 4.2 and Tables 1 to 40);

f) for castings, full details of the casting(s), i.e. a fully dimensioned drawing, or identification of the casting by, for instance, reference to a pattern, die or drawing number (see Annex A);

g) for copper castings and for copper-chromium castings (see Tables 1 and 2), whether the electrical conductivity is to be determined, and if so the agreed test details and sampling rate (see note to 8.3) and for copper sand castings, whether Grade A, B or C electrical conductivity is required (see Table 1);

h) for ingots in the alloy in Table 3, and for ingots and castings in the alloys in Tables 7, 18, 32, 33, 34 and 35, details of any compositional deviations for special applications (see notes to Tables 3, 7, 18, 32, 33, 34 and 35);

i) for ingots in CuZn35Pb2Al-B (CB752S) and CuZn39Pb1Al-B (CB754S), whether they are to be supplied grain refined (see 6.4 and Tables 5 and 7);

j) for castings in alloys in Tables 4 and 5, whether Grade A or Grade B dezincification resistance acceptance criterion is required (see 6.5);

k) for castings in CuZn35Mn2Al1Fe1-C (CC765S), whether a minimum alpha-phase content of 15 % is required (see 6.4 and Table 14);

l) for ingots in the alloys in Tables 36, 39 and 40, the compositional requirements to which they are to conform (see notes to Tables 36, 39 and 40);

m) for centrifugal castings, whether the samples for mechanical testing are to be taken from the castings, or separately cast (see 8.2.2).

NOTE It is recommended 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:

n) whether analysis is required, or limits are to be agreed, for elements additional to those listed in the composition Tables 3 to 40 (see notes 1 and 2 of 6.1);

o) whether mechanical properties, other than those printed in bold typeface in the mechanical properties tables, are to be determined (see note 3 of 6.2 and Tables 1 to 40);

p) whether any of the optional supplementary inspection procedures given in Annex B are required, and if so, the full details of the agreed test parameters and acceptance criteria for each inspection option invoked;

q) in the case of castings, whether a declaration of conformity is required (see 9.1);

r) in the case of castings, whether an inspection document is required, and if so, which type (see 9.2.2);

s) whether a special inner or outer surface condition is required (see 8.6).

EXAMPLE 1 Ordering details for 1 500 kg of castings conforming to EN 1982, in material designated either CuAl10Fe5Ni5-C or CC333G, sand cast, pattern number XXXX, without any additional requirements:

1 500 kg Casting EN 1982 – CuAl10Fe5Ni5-C – GS – XXXX

or

1 500 kg Casting EN 1982 – CC333G – GS – XXXX

EXAMPLE 2 Ordering details for 500 castings conforming to EN 1982, in material designated either CuAl10Fe5Ni5-C or CC333G, sand cast, pattern number XXXX, without any additional requirements:

500 pieces Casting EN 1982 – CuAl10Fe5Ni5-C – GS – XXXX

or

500 pieces Casting EN 1982 – CC333G – GS – XXXX

6 Requirements

6.1 Composition

The composition of ingots and castings shall conform to the requirements for the appropriate material given in Tables 1 to 40. The analysis shall be carried out in accordance with 8.1. In the case of ingot casts of more than 2 t, both samples selected in accordance with 7.2.2 b) shall conform to the composition requirements.

NOTE 1 In Tables 3 to 40, elements with known harmful effects are shown separately, below the line, from alloying elements. Maximum limits for these harmful elements are specified.

NOTE 2 Small amounts of residual elements other than those listed in the composition Tables 3 to 40, for example As, Bi, Cd, Co, Cr, Mg, Ti, may be present in amounts which generally have no deleterious effects. If requested at the time of placing the order, the analytical determination of any of these elements, or of any other residual element not included in the composition tables, together with limiting values, should be agreed between the purchaser and the supplier. Usually such elements (excluding oxygen) will not exceed 0,05 % individually in ingots or 0,06 % in castings, and the total of such elements will not usually exceed 0,20 % in ingots or 0,25 % in castings.

NOTE 3 In all tables of composition the "Remainder" is the balance between the sum of the elements determined and 100 %. It is not determined by analysis.

6.2 Mechanical properties

The mechanical properties of castings shall conform to all the requirements relevant to the material and casting process given in Tables 1 to 40. The test(s) shall be carried out in accordance with 8.2.

NOTE 1 No mechanical properties are specified for ingots.

NOTE 2 The mechanical properties specified in this standard relate to separately cast test bars unless otherwise stated. Separately cast test bars have a valuable function as a check on the quality of the material and also on the foundry technology. It is emphasized that the mechanical properties obtained when testing a casting may differ from those obtained from a separately cast test bar(s) because of possible differences in structure between the test bars and the castings, arising mainly from variations in section thickness.

NOTE 3 All the mechanical properties given for castings in Tables 1 to 40 are mandatory requirements (but see note 4). However, only those mechanical properties printed in bold typeface are normally determined on a routine basis. Determination of the other properties should be specifically requested, if required [see 5 o)].

NOTE 4 Because of the dependence of the properties of pressure die castings on the injection parameters, the mechanical properties given in Tables 4, 5, 7, 8, 10 and 12 are given for information only.

6.3 Electrical properties

The electrical conductivity of Cu-C (CC040A) castings shall conform to the requirements given in Table 1. The electrical conductivity of CuCr1-C (CC140C) castings shall conform to the requirements given in Table 2. The test shall be carried out in accordance with 8.3.

NOTE 0,58 MS/m is equivalent to 1 % IACS.

6.4 Microstructure and grain size

For marine and other applications requiring high resistance to corrosion, the microstructure of CuZn35Mn2Al1Fe1-C (CC765S) castings shall reveal a minimum of 15 % alpha-phase when tested and examined as described in 8.4.1 [see 5 k)].

Ingots in certain alloys shall have maximum average grain diameters, as follows:

— 0,150 mm for material CuZn35Pb2Al-B (CB752S) (see Table 5) and CuZn39Pb1Al-B (CB754S) (see Table 7), when specifically ordered in the grain refined condition [see 5 i)];

— 0,100 mm for material CuZn39Pb1AlB-B (CB755S) (see Table 8);

— 0,300 mm for material CuZn37Pb2Ni1AlFe-B (CB753S) (see Table 6).

The tests shall be carried out in accordance with 8.4.2.

6.5 Dezincification resistance

The depth of dezincification after the test, in any section of a casting in CuZn33Pb2Si-C (CC751S) and CuZn35Pb2Al-C (CC752S) (see Tables 4 and 5), produced by permanent mould or pressure die casting, shall be:

— for Grade A: maximum 200 µm;

— for Grade B: mean not to exceed 200 µm and maximum 400 µm.

The test shall be carried out in accordance with 8.5.

6.6 Freedom from defects

6.6.1 Ingots

Ingots shall be free from dirt, dross, slag and residual moisture.

6.6.2 Castings

The castings shall be supplied fettled unless otherwise agreed between the purchaser and the supplier at the time of ordering [see 5 p)]. Gates and feeders shall be removed and residues of moulds shall be removed from accessible surfaces.

7 Sampling and testing rates

7.1 General

Except where a foundry operates a certified quality system conforming to EN ISO 9001, and as a consequence a different sampling regime has been agreed, the minimum sampling and testing rates for verifying conformity to the requirements of this standard for composition, mechanical properties, microstructure and dezincification resistance shall be as given in 7.2 to 7.5. The procedures for retesting in the event of a test piece failing the analysis, mechanical properties test or dezincification resistance test shall be as given in 8.7.

7.2 Analysis

7.2.1 General

Samples shall be taken from the melt they represent and poured into a clean chill mould, which is designed to give analysis samples of a shape and size appropriate to the analytical technique to be employed.

7.2.2 Ingots

Samples shall be taken from the melt to represent each cast, as follows:

a) for casts of 2 t or less, one sample shall be taken;

b) for casts of more than 2 t, two samples shall be taken, one at the beginning of the cast and one at the end of the cast.

7.2.3 Castings

7.2.3.1 Casting from a holding furnace

Samples shall be taken from the holding furnace at a rate of one per cast [see definition of cast in 3.1 d)].

7.2.3.2 Continuous casting

Samples shall be taken during the run of a cast [see 3.1 e)] at a rate corresponding to the pouring of each new melt.

7.2.3.3 Non-continuous casting

When the furnace charge consists wholly of:

a) ingots for which an analysis is already available; and/or

b) properly segregated and identified foundry returns,

then the rate of sampling shall be left to the discretion of the founder.

For other furnace charge constituents, samples shall be taken from the melt to represent each cast.

7.3 Mechanical tests

7.3.1 Mechanical testing of ingots

No minimum inspection requirements for the testing of ingots for mechanical properties are specified.

NOTE A purchaser may specify tensile testing of ingots as an optional requirement (see B.3.1).

7.3.2 Mechanical testing of continuous castings

When mechanical properties are specified, the minimum sampling and testing rate shall be one sample for each 5 t of product of identical dimensions and composition, except that for hardness testing of castings in CuCr1-C (CC140C), the minimum rate shall be one test per cast, or per heat treatment batch, whichever is the smaller mass.

7.3.3 Mechanical testing of non-continuous castings

The minimum sampling and testing rate for non-continuous castings shall be:

a) for castings in alloys CuZn35Mn2Al1Fe1-C (CC765S), CuZn34Mn3Al2Fe1-C (CC764S), CuZn25Al5Mn4Fe3-C (CC762S), CuAl10Fe2-C (CC331G), CuAl10Ni3Fe2-C (CC332G), CuAl10Fe5Ni5-C (CC333G), CuAl11Fe6Ni6-C (CC334G), CuAl9-C (CC330G), CuMn11Al8Fe3Ni3-C (CC212E), CuNi30Cr2FeMnSi-C (CC382H) and CuNi30Fe1Mn1NbSi-C (CC383H) (see Tables 11, 13, 14, 31, 32, 33, 34, 35, 36, 39 and 40), at a rate corresponding to one test per cast [as defined in 3.1 a), 3.1 b) or 3.1 c)], or one test per 1 t of fettled castings, whichever is the less frequent rate of testing;

b) for castings in all other alloys for which routinely determined mechanical properties are required, at a rate corresponding to one test per 5 t of fettled castings;

c) for castings in alloy CuCr1-C (CC140C), the minimum sampling rate for hardness testing shall be one test per cast, or per heat treatment batch, whichever is the smaller mass.

7.4 Microstructure

7.4.1 Alpha-phase content

The sampling rate for the determination of the alpha-phase content of castings in alloy CuZn35Mn2Al1Fe1-C (CC765S), shall be one sampling unit per cast.

NOTE The determination may be conveniently carried out on the end of a tensile test piece.

7.4.2 Assessment of grain refinement

When grain refinement of ingots is specified [see 6.4 and 5 i)], the sampling rate shall be one ingot per cast, taken midway through the cast.

7.5 Dezincification resistance

For castings in alloys CuZn33Pb2Si-C (CC751S) and CuZn35Pb2Al-C (CC752S), one sample casting shall be taken from each batch [see 3.2 b)]. Where castings are required to be heat treated, the sample casting representative of each batch shall be taken after heat treatment. Of the sampling units representing batches of the same design of casting, a minimum of one in ten shall be selected for testing.

Two test pieces shall be taken from each casting so selected, one from the thickest section of the casting and one from the thinnest section. The test pieces shall be taken in such a way that the properties of the material are not affected.

Sampling units that have been taken but not tested shall be kept until the next in sequence has been tested and found to be satisfactory. If this next sampling unit proves to be unsatisfactory, then intermediate sampling units shall each be tested to verify the conformity of each design of casting in the batches represented.

8 Test methods

8.1 Analysis

When analysis is carried out to verify conformity of a batch of ingots or castings with this standard (see 6.1 and 7.2), except in cases of dispute, the analytical methods used shall be at the discretion of the supplier. The supplier shall ensure that the precision of the analytical methods used is compatible with the number of figures for the composition limits given in Tables 2 to 40. For expression of results, the rounding rules given in 8.8 shall be used.

NOTE In cases of dispute concerning the composition of ingots or of castings, the method of sampling and the analytical procedure to be used should be agreed between the disputing parties.

8.2 Mechanical tests

8.2.1 Tensile test

When the tensile properties are determined to verify conformity of a batch of ingots or castings with this standard (see 6.2), the test shall be carried out in accordance with EN 10002-1 on the proportional test pieces prepared from the test samples or bars (see 8.2.2).

For expression of the results of the tensile test, the rounding rules given in 8.8 shall be used.

8.2.2 Preparation of tensile test samples

Sand cast test bars shall have diameters between 12 mm and 25 mm. They shall be cast separately from the castings in sand moulds, from the same cast as the castings they represent.

NOTE 1 For alloys with a long freezing range, a test bar fed at one or both ends is recommended. For other alloys, a test bar fed all along its length is preferred.

In the case of permanent mould castings, test bars shall be separately cast in metal moulds.

NOTE 2 The test bars, whether sand cast or permanent mould cast, may be tested as cast (i.e. without machining). Alternatively, at the discretion of the supplier, test pieces may be machined from the bars for testing.

If test bars representing sand or permanent mould castings are machined, they shall have an effective diameter between 10 mm and 18 mm and shall be proportional test pieces, as described in EN 10002-1.

For centrifugal castings, the test bars shall be taken either from the casting, or cast separately, as specified by the purchaser [see 5 m)]. Separately cast test bars shall be cast in moulds comparable to the moulds for the castings. If the purchaser opts for test samples to be taken from castings over 50 mm thick, the location of the test sample and its properties should be agreed between the purchaser and the supplier.

NOTE 3 For castings which are to be heat treated, for example for homogenizing or stress relieving, the test bars corresponding to the castings should be heat treated with the castings, unless otherwise agreed between the purchaser and the supplier.

If test bars are required for pressure die castings, a separately cast flat test bar shall be used and tested without machining. It shall be from 2 mm to 4 mm thick and its freezing rate and injection parameters shall be as comparable as possible to the die castings represented. (See note 4 of 6.2 concerning the mechanical properties of pressure die castings.)

For continuous casting, test bars shall be taken from the casting itself, with a gauge length parallel to the direction of casting.

NOTE 4 If the shape or dimensions of the continuous casting precludes the use of a standard proportional test piece, then the form of the test piece and the results to be achieved should be agreed between the manufacturer and the purchaser.

NOTE 5 For continuous cast bars with diameter greater than 300 mm, the tensile test piece may be machined from a transverse slice of the casting.

NOTE 6 The mechanical property requirements given for continuous castings apply to sizes up to and including 300 mm external diameter. For larger continuous castings, the mechanical property requirements should be agreed between the supplier and the purchaser.

8.2.3 Hardness test

Where practicable, hardness tests shall be made either on a convenient portion of the casting, unless otherwise specified, or on the end of the tensile test bar representative of the castings. The test shall be carried out in accordance with EN ISO 6506-1 using a 0,102 F/D^2 ratio of 10, e.g. using a 1,00 mm diameter ball and a force of 98,07 N, or a 2,5 mm diameter ball and a force of 612,9 N.

8.3 Electrical conductivity

When the electrical conductivity of Cu-C (CC040A) and CuCr1-C (CC140C) castings is to be determined, the test shall be carried out by the use of an eddy current testing instrument.

NOTE The electrical conductivity of Cu-C (CC040A) and CuCr1-C (CC140C) castings is not routinely determined. If such tests are required, the details of the test and the sampling rate should be agreed between the purchaser and the supplier [see 5 g)].

8.4 Microstructure

8.4.1 Alpha-phase determination

When the proportion of alpha-phase in the microstructure of CuZn35Mn2Al1Fe1-C (CC765S) castings is to be determined, a suitable section of the test casting shall be polished, using normal metallographic techniques, etched to reveal the microstructure and examined microscopically. The proportion of alpha-phase in the microstructure shall be measured by any appropriate counting method. The test shall consist of at least five counts and the average of the counts shall be taken as the alpha-phase content of the material.

8.4.2 Grain size determination

The average grain diameter shall be determined in accordance with EN ISO 2624, using either the comparison method or the intercept method. A transverse slice shall be taken from the ingot, selected as a representative of the cast, at a point one third of the length of the ingot distant from one end. A surface area approximately 1 cm^2 on the vertical axis of this slice and one third of the depth of the ingot from the bottom, shall be prepared for metallographic examination, appropriate for the determination of the average grain size.

8.5 Dezincification resistance

When the dezincification resistance of permanent mould castings, or pressure die castings, in alloys CuZn33Pb2Si-C (CC751S) and CuZn35Pb2Al-C (CC752S) is to be determined, the test method given in EN ISO 6509 shall be used on test pieces prepared from samples obtained in accordance with 7.5.

8.6 Surface condition

When there is a special requirement for surface roughness, it is recommended that inspection is carried out in accordance with EN 1370.

8.7 Retests

8.7.1 General

Retests for analysis, mechanical properties and for dezincification resistance shall be permitted as specified in 8.7.2 to 8.7.4.

8.7.2 Analysis

If an analysis sample gives results which do not conform to the appropriate requirements, a further portion of the same sample shall be permitted to be taken for check analysis. If this check analysis is found to conform to the requirements, the ingots or castings represented shall be deemed to conform to the analytical requirements of this standard. If the check analysis does not conform to the requirements, the ingots or castings represented shall be deemed not to conform to this standard.

8.7.3 Mechanical test

If a test piece fails a mechanical test, two further samples taken at the same time and from the same cast shall be permitted to be retested. If the test pieces from both these samples pass the test, the castings represented shall be deemed to conform to the mechanical property requirements of this standard. If either of these test pieces fails the test, the castings represented shall be deemed not to conform to this standard.

If any test piece shows evidence of defective machining, or reveals casting defects, it may be discarded and replaced by another test piece from the same cast.

8.7.4 Dezincification resistance test

If a test piece fails the dezincification resistance test, two further castings of the same type, from the cast or heat treatment batch, shall be permitted to be selected for retesting.

If the test pieces from both these castings pass the test, the castings represented shall be deemed to conform to the dezincification resistance requirements of this standard. If either of these test pieces fails the test, the castings represented shall be deemed not to conform to this standard.

NOTE If a batch of castings fails the dezincification resistance test when tested or retested, the supplier has the option to heat treat, or to further heat treat, the whole batch and to resubmit it for all the tests called for on the order, except for analysis.

8.8 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 31-0:1992. 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 proof strength the rounding interval shall be 10 N/mm^2 and elongation shall be rounded to the nearest 0,5 %.

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

For castings, when requested by the purchaser [see 5 q)] and agreed with the supplier, the supplier shall issue for the castings the appropriate declaration of conformity in accordance with EN 1655.

9.2 Inspection documentation

9.2.1 For ingots, the supplier shall provide a certificate giving the analysis of each batch of ingots making up a consignment and, where appropriate, indicating conformity to the grain size requirements.

9.2.2 For castings, when requested by the purchaser [see 5 r)] and agreed with the supplier, the supplier shall issue for the castings the appropriate inspection document in accordance with EN 10204.

NOTE When ordering products for pressure equipment applications, the equipment manufacturer has the obligation to request appropriate inspection documentation according to EN 10204:2004, Annex ZA.

10 Marking, labelling, packaging

10.1 Ingots

Each batch of ingots shall be assembled into bundles and each bundle shall be labelled with the manufacturer's mark, material designation and cast numbers.

10.2 Castings

Castings inspected to optional supplementary inspection procedures specified by the purchaser (see Annex B), shall be individually marked, or batched and identified by a suitable means as soon as possible after casting. The identification shall be maintained to enable the castings to be correlated with their relevant inspection records at the time of their despatch from the foundry.

The form of packaging, if any, for the transport or storage of castings is at the discretion of the manufacturer, unless a specific agreement has been made at the time of placing the order.

Tables

a) Tables 1 and 2: Copper and copper-chromium alloy

Table 1 — Cu-C (CC040A)

Composition in % (mass fraction) element	castings	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.	Electrical conductivity MS/m min.
Cu	No composition specified	Permanent mould — GM	150	40	25	40	55
		Sand — GS					
		Grade A	150	40	25	40	50
		Grade B	150	40	25	40	45
		Grade C[a]	150	40	25	40	32
NOTE Ingots in this material are not specified.							
[a] Grade C is intended for certain heat transfer applications, such as water-cooled hot blast equipment.							

Table 2 — CuCr1-C (CC140C)

Composition in % (mass fraction) element	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.	Electrical conductivity [a] MS/m min.
Cu[b]	Remainder		Sand — GS	300	200	10	**95**	45
Cr[b]	0,4	1,2	Permanent mould — GM	300	200	10	**95**	45
NOTE Ingots in this material are not specified.								
[a] In fully heat treated condition								
[b] The sum of Cu + Cr shall be ≥ 99,5 %.								

b) Tables 3 to 16: Copper-zinc alloys

Table 3 — CuZn33Pb2-B (CB750S) and CuZn33Pb2-C (CC750S)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Cu[a]	63,0	66,0	63,0	67,0	Sand — GS	180	70	12	45
Ni	—	1,0	—	1,0					
Pb	1,0	2,8	1,0	3,0					
Sn	—	1,5	—	1,5					
Zn	Remainder		Remainder		Centrifugal — GZ	180	70	12	50
Al	—	0,1[b]	—	0,1					
Fe	—	0,7	—	0,8					
Mn	—	0,2	—	0,2					
P	—	0,02	—	0,05					
Si	—	0,04	—	0,05					

[a] Including nickel

[b] For ingots intended for the manufacture of pressure-tight sand castings and centrifugal castings, aluminium shall be restricted to 0,02 % max.

Table 4 — CuZn33Pb2Si-B (CB751S) and CuZn33Pb2Si-C (CC751S)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings[a] min.	castings[a] max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Cu[b]	63,5	65,5	63,5	66,0	Pressure die cast — GP (see note)	(400)	(280)	(5)	(110)
Fe	0,25	0,50	0,25	0,5					
Ni	—	0,80	—	0,8					
Pb	0,8	2,0	0,8	2,2					
Si	0,70	1,0	0,65	1,1					
Zn	Remainder		Remainder						
Al	—	0,10	—	0,10					
Mn	—	0,1	—	0,15					
Sb	—	0,05	—	0,05					
Sn	—	0,80	—	0,8					

NOTE The mechanical properties for pressure die castings (shown bracketed) are not mandatory requirements, but are given for information only (see note 4 of 6.2).

[a] Castings in this alloy shall conform to the dezincification resistance requirements given in 6.5.

[b] Including nickel

Table 5 — CuZn35Pb2Al-B (CB752S) and CuZn35Pb2Al-C (CC752S)

Composition in % (mass fraction)					Casting process and designation	Tensile strength R_m N/mm²	0,2 % proof strength $R_{p0,2}$ N/mm²	Elongation A %	Brinell hardness HBW
element	ingots		castings[a]						
	min.	max.	min.	max.		min.	min.	min.	min.
Al	0,3	0,7	0,3	0,70	Permanent mould — GM	280	120	10	70
As	0,04	0,12	0,04	0,14[b]					
Cu	61,5	65,0	61,5	64,5					
Pb	1,5	2,1	1,5	2,2					
Sb	0,04	0,12	—	0,14[b, c]					
Zn	Remainder		Remainder						
Fe	—	0,3	—	0,3	Pressure die cast — GP (see note 1)	(340)	(215)	(5)	(110)
Mn	—	0,1	—	0,1					
Ni	—	0,2	—	0,2					
Si	—	0,02	—	0,02					
Sn	—	0,3	—	0,3					

NOTE 1 The mechanical properties for pressure die castings (shown bracketed) are not mandatory requirements, but are given for information only (see note 4 of 6.2).

NOTE 2 For special applications requiring fine-grained castings, the ingots may be ordered and supplied grain refined to a maximum average grain diameter of 0,150 mm [see 5 i) and 6.4].

NOTE 3 For drinking water applications no other single element should be more than 0,02 %. The sum of these single elements should not exceed 0,25 %.

[a] Castings in this alloy shall conform to the dezincification resistance requirements given in 6.5.

[b] In castings for non drinking water applications, Sb can be used as alternative inhibitor of dezincification. If Sb is added as the inhibitor, then the As content shall be 0,04 % maximum. (Sb + As)shall be 0,14 % maximum.

[c] For drinking water applications, Sb shall be ≤ 0,02 %.

Table 6 — CuZn37Pb2Ni1AlFe-B (CB753S) and CuZn37Pb2Ni1AlFe-C (CC753S)

Composition in % (mass fraction)					Casting process and designation	Tensile strength R_m N/mm²	0,2 % proof strength $R_{p0,2}$ N/mm²	Elongation A %	Brinell hardness HBW
element	ingots[a]		castings						
	min.	max.	min.	max.		min.	min.	min.	min.
Al	0,4	0,8	0,4	0,8	Permanent mould — GM	300	150	15	90
Cu[b]	58,0	60,0	58,0	61,0					
Fe	0,5	0,8	0,5	0,8					
Ni	0,5	1,2	0,5	1,2					
Pb	1,8	2,50	1,8	2,50					
Sn	—	0,8	—	0,8					
Zn	Remainder		Remainder						
Mn	—	0,20	—	0,20					
P	—	0,02	—	0,02					
Sb	—	0,05	—	0,05					
Si	—	0,05	—	0,05					

[a] Unless it is agreed between the purchaser and the supplier that other grain refining agents may be used, ingots in this alloy shall be grain refined using zirconium, to have a maximum average grain diameter of 0,300 mm.

[b] Including nickel

Table 7 — CuZn39Pb1Al-B (CB754S) and CuZn39Pb1Al-C (CC754S)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Al[a]	0,10	0,8	—	0,8	Sand — GS	220	80	15	65
Cu[b]	58,0	62,0	58,0	63,0					
Ni	—	1,0	—	1,0					
Pb	0,5	2,4	0,5	2,5	Permanent mould — GM	280	120	10	70
Sn	—	1,0	—	1,0					
Zn	Remainder		Remainder						
Fe	—	0,7	—	0,7	Pressure die cast — GP (see note 2)	(350)	(250)	(4)	(110)
Mn	—	0,5	—	0,5					
P	—	0,02	—	0,02	Centrifugal — GZ	280	120	10	70
Si	—	0,05	—	0,05[c]					

NOTE 1 For special applications requiring fine-grained castings, the ingots may be ordered and supplied grain refined to a maximum average grain diameter of 0,150 mm [see 5 i) and 6.4].

NOTE 2 The mechanical properties for pressure die castings (shown bracketed) are not mandatory requirements, but are given for information only (see note 4 of 6.2).

[a] For ingots for the manufacture of sand castings or centrifugal castings, the aluminium content shall be restricted to 0,02 % max.

[b] Including nickel

[c] For pressure die castings the silicon shall be increased to 0,30 % max.

Table 8 — CuZn39Pb1AlB-B (CB755S) and CuZn39Pb1AlB-C (CC755S)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Al	0,4	0,65	0,4	0,7	Permanent mould — GM	350	180	13	90
B	—[a]	—[a]	—[a]	—[a]					
Cu	59,0	60,5	59,5	61,0					
Fe	0,05	0,2	0,05	0,2					
Pb	1,2	1,7	1,2	1,7					
Zn	Remainder		Remainder						
Mn	—	0,05	—	0,05	Pressure die cast — GP (see note 1)	(350)	(250)	(4)	(110)
Ni	—	0,2	—	0,2					
Si	—	0,03	—	0,05					
Sn	—	0,3	—	0,3					

NOTE 1 The mechanical properties for pressure die castings (shown bracketed) are not mandatory requirements, but are given for information only (see note 4 of 6.2).

NOTE 2 For drinking water applications no other single element should be more than 0,02 %. The sum of these single elements should not exceed 0,25 %.

[a] Unless it is agreed between the purchaser and the supplier that other grain refining agents may be used, ingots in this alloy shall be grain refined using boron, to have a maximum average grain diameter of 0,100 mm.

Table 9 — CuZn15As-B (CB760S) and CuZn15As-C (CC760S)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm^2 min.	0,2 % proof strength $R_{p0,2}$ N/mm^2 min.	Elongation A % min.	Brinell hardness HBW min.
As	0,06	0,15	0,05	0,15	Sand — GS	160	70	20	45
Cu	83,0	87,5	83,0	88,0					
Zn	Remainder		Remainder						
Al	—	0,01	—	0,01					
Fe	—	0,15	—	0,15					
Mn	—	0,1	—	0,1					
Ni	—	0,1	—	0,1					
Pb	—	0,5	—	0,5					
Si	—	0,02	—	0,02					
Sn	—	0,3	—	0,3					

Table 10 — CuZn16Si4-B (CB761S) and CuZn16Si4-C (CC761S)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm2 min.	0,2 % proof strength $R_{p0,2}$ N/mm2 min.	Elongation A % min.	Brinell hardness HBW min.
Al	—	0,10	—	0,1	Sand — GS	**400**	**230**	**10**	**100**
Cu	78,5	82,0	78,0	83,0					
Ni	—	1,0	—	1,0					
Pb	—	0,6	—	0,8	Permanent mould — GM	**500**	**300**	**8**	**130**
Si	3,0	5,0	3,0	5,0					
Zn	Remainder		Remainder		Pressure die cast — GP (see note)	(530)	(370)	(5)	(150)
Fe	—	0,5	—	0,6					
Mn	—	0,2	—	0,2					
P	—	0,02	—	0,03	Centrifugal — GZ	**500**	**300**	**8**	**130**
Sb	—	0,05	—	0,05					
Sn	—	0,25	—	0,3					

NOTE The mechanical properties for pressure die castings (shown bracketed) are not mandatory requirements, but are given for information only (see note 4 of 6.2).

Table 11 — CuZn25Al5Mn4Fe3-B (CB762S) and CuZn25Al5Mn4Fe3-C (CC762S)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Al	4,0	7,0	3,0	7,0	Sand — GS	**750**	**450**	**8**	**180**
Cu[a]	60,0	66,0	60,0	67,0					
Fe	1,5	3,5	1,5	4,0					
Mn	3,0	5,0	2,5	5,0	Permanent mould — GM	**750**	**480**	**8**	**180**
Ni	—	2,7	—	3,0					
Zn	Remainder		Remainder		Centrifugal — GZ	**750**	**480**	**5**	**190**
P	—	0,02	—	0,03					
Pb	—	0,20	—	0,2					
Sb	—	0,03	—	0,03	Continuous — GC	**750**	**480**	**5**	**190**
Si	—	0,08	—	0,1					
Sn	—	0,20	—	0,2					

[a] Including nickel

Table 12 — CuZn32Al2Mn2Fe1-B (CB763S) and CuZn32Al2Mn2Fe1-C (CC763S)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm²% min.	Elongation A % min.	Brinell hardness HBW min.
Al	1,0	2,5	1,0	2,5	Sand — GS	**430**	150	**10**	**100**
Cu[a]	59,0	67,0	59,0	67,0					
Fe	0,5	2,0	0,5	2,0					
Mn	1,0	3,5	1,0	3,5					
Ni	—	2,5	—	2,5					
Pb	—	1,5	—	1,5	Pressure die cast — GP (see note)	(440)	(330)	(3)	(130)
Si	—	1,0	—	1,0					
Sn	—	1,0	—	1,0					
Zn	Remainder		Remainder						
Sb	—	0,08	—	0,08					

NOTE The mechanical properties for pressure die castings (shown bracketed) are not mandatory requirements, but are given for information only (see note 4 of 6.2).

[a] Including nickel

Table 13 — CuZn34Mn3Al2Fe1-B (CB764S) and CuZn34Mn3Al2Fe1-C (CC764S)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Al	1,5	3,0	1,0	3,0	Sand — GS	**600**	**250**	**15**	**140**
Cu[a]	55,0	65,0	55,0	66,0					
Fe	0,8	2,0	0,5	2,5					
Mn	1,0[b]	3,5	1,0[b]	4,0					
Ni	—	2,7	—	3,0	Permanent mould — GM	**600**	**260**	**10**	**140**
Zn	Remainder		Remainder						
P	—	0,02	—	0,03					
Pb	—	0,2	—	0,3	Centrifugal — GZ	**620**	**260**	**14**	**150**
Sb	—	0,05	—	0,05					
Si	—	0,08	—	0,1					
Sn	—	0,3	—	0,3					

a Including nickel

b For permanent mould castings, the minimum manganese content shall be 0,3 % for ingots and castings.

Table 14 — CuZn35Mn2Al1Fe1-B (CB765S) and CuZn35Mn2Al1Fe1-C (CC765S)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Al	0,7	2,2	0,5	2,5	Sand — GS	**450**	**170**	**20**	110
Cu[a]	56,0	64,0	57,0	65,0					
Fe	0,5	1,8	0,5	2,0					
Mn	0,5[b]	2,5	0,5[b]	3,0	Permanent mould — GM	**475**	**200**	**18**	110
Ni	—	6,0	—	6,0					
Sn	—	0,8	—	1,0					
Zn	Remainder		Remainder		Centrifugal — GZ	**500**	**200**	**18**	120
P	—	0,02	—	0,03					
Pb	—	0,5	—	0,5	Continuous — GC	**500**	**200**	**18**	120
Sb	—	0,08	—	0,08					
Si	—	0,10	—	0,1					

NOTE For certain applications a minimum proportion of alpha-phase in the microstructure of castings is required (see 6.4).

a Including nickel

b For permanent mould castings, the minimum manganese content shall be 0,3 % for ingots and castings.

Table 15 — CuZn37Al1-B (CB766S) and CuZn37Al1-C (CC766S)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Al	0,6	1,8	0,3	1,8	Permanent mould — GM	**450**	**170**	**25**	105
Cu[a]	60,0	63,0	60,0	64,0					
Ni	—	1,8	—	2,0					
Zn	Remainder		Remainder						
Fe	—	0,4	—	0,5					
Mn	—	0,4	—	0,5					
P	—	0,02	—	—					
Pb	—	0,4	—	0,50					
Sb	—	0,05	—	0,1					
Si	—	0,5	—	0,6					
Sn	—	0,4	—	0,50					

[a] Including nickel

Table 16 — CuZn38Al-B (CB767S) and CuZn38Al-C (CC767S)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Al	0,1	0,8	0,1	0,8	Permanent mould — GM	**380**	**130**	**30**	75
Cu[a]	59,0	64,0	59,0	64,0					
Ni	—	0,8	—	1,0					
Zn	Remainder		Remainder						
Fe	—	0,4	—	0,5					
Mn	—	0,4	—	0,5					
P	—	0,05	—	–					
Pb	—	0,1	—	0,1					
Si	—	0,05	—	0,2					
Sn	—	0,1	—	0,1					

[a] Including nickel

c) Tables 17 to 21: Copper-tin alloys

Table 17 — CuSn10-B (CB480K) and CuSn10-C (CC480K)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Cu[a]	88,5	90,5	88,0	90,0	Sand — GS	**250**	130	**18**	70
Ni	–	1,8	–	2,0					
P	–	0,05	–	0,2					
Pb	–	0,8	–	1,0	Permanent mould — GM	**270**	160	**10**	80
Sn	9,3	11,0	9,0	11,0					
Al	–	0,01	–	0,01					
Fe	–	0,15	–	0,2	Continuous — GC	**280**	170	**10**	80
Mn	–	0,10	–	0,10					
S	–	0,04	–	0,05					
Sb	–	0,15	–	0,2	Centrifugal — GZ	**280**	160	**10**	80
Si	–	0,01	–	0,02					
Zn	–	0,5	–	0,5					

[a] Including nickel

Table 18 — CuSn11P-B (CB481K) and CuSn11P-C (CC481K)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Cu	87,0	89,3	87,0	89,5	Sand — GS	**250**	130	**5**	60
Pa	0,6	1,0	0,5	1,0					
Sn	10,2	11,5	10,0	11,5	Permanent mould — GM	**310**	170	**2**	**85**
Al	—	0,01	—	0,01					
Fe	—	0,10	—	0,10					
Mn	—	0,05	—	0,05					
Ni	—	0,10	—	0,10	Continuous — GC	**350**	170	**5**	**85**
Pb	—	0,25	—	0,25					
S	—	0,05	—	0,05					
Sb	—	0,05	—	0,05	Centrifugal — GZ	**330**	170	**4**	**85**
Si	—	0,01	—	0,01					
Zn	—	0,05	—	0,05					

[a] For sand castings for non-bearing applications the phosphorus may be restricted to 0,15 max. [see 5 h)].

Table 19 — CuSn11Pb2-B (CB482K) and CuSn11Pb2-C (CC482K)

Composition in % (mass fraction)					Casting process and designation	Tensile strength R_m N/mm²	0,2 % proof strength $R_{p0,2}$ N/mm²	Elongation A %	Brinell hardness HBW
element	ingots		castings						
	min.	max.	min.	max.		min.	min.	min.	min.
Cu	83,5	86,5	83,5	87,0	Sand — GS	240	130	5	**80**
Ni	—	2,0	–	2,0					
P	—	0,05	–	0,40					
Pb	0,7	2,5	0,7	2,5					
Sn	10,7	12,5	10,5	12,5	Centrifugal — GZ	280	150	5	**90**
Zn	—	2,0	—	2,0					
Al	—	0,01	—	0,01					
Fe	—	0,15	—	0,20					
Mn	—	0,2	—	0,2	Continuous — GC	280	150	5	**90**
S	—	0,08	—	0,08					
Sb	—	0,20	—	0,2					
Si	—	0,01	—	0,01					

Table 20 — CuSn12-B (CB483K) and CuSn12-C (CC483K)

Composition in % (mass fraction)					Casting process and designation	Tensile strength R_m N/mm²	0,2 % proof strength $R_{p0,2}$ N/mm²	Elongation A %	Brinell hardness HBW
element	ingots		castings						
	min.	max.	min.	max.		min.	min.	min.	min.
Cu	85,5	88,5[a]	85,0	88,5[a]	Sand — GS	**260**	140	**7**	**80**
Ni	—	2,0	—	2,0					
P	—	0,20	—	0,60					
Pb	—	0,6	—	0,7	Permanent mould — GM	**270**	150	**5**	**80**
Sn	11,2[a]	13,0	11,0[a]	13,0					
Al	—	0,01	—	0,01					
Fe	—	0,15	—	0,2	Continuous — GC	**300**	150	**6**	**90**
Mn	—	0,2	—	0,2					
S	—	0,05	—	0,05					
Sb	—	0,15	—	0,15	Centrifugal — GZ	**280**	150	**5**	**90**
Si	—	0,01	—	0,01					
Zn	—	0,4	—	0,5					

[a] For continuous castings and centrifugal castings, the minimum tin content for ingots shall be 10,7 % and for castings 10,5 % and the maximum copper content for ingots and castings shall be 89,0 %.

Table 21 — CuSn12Ni2-B (CB484K) and CuSn12Ni2-C (CC484K)

Composition in % (mass fraction)					Casting process and designation	Tensile strength R_m N/mm^2	0,2 % proof strength $R_{p0,2}$ N/mm^2	Elongation A %	Brinell hardness HBW
element	ingots		castings						
	min.	max.	min.	max.		min.	min.	min.	min.
Cu	84,0	87,0	84,5	87,5	Sand — GS	**280**	160	**12**	**85**
Ni	1,5	2,4	1,5	2,5					
P	—	0,05	0,05	0,40					
Sn	11,3	13,0	11,0	13,0	Centrifugal — GZ	**300**	180	**8**	**95**
Al	—	0,01	—	0,01					
Fe	—	0,15	—	0,20					
Mn	—	0,10	—	0,2					
Pb	—	0,2	—	0,3					
S	—	0,04	—	0,05	Continuous — GC	**300**	180	**10**	**95**
Sb	—	0,05	—	0,1					
Si	—	0,01	—	0,01					
Zn	—	0,3	—	0,4					

d) Tables 22 to 30: Copper-tin-lead alloys

Table 22 — CuSn3Zn8Pb5-B (CB490K) and CuSn3Zn8Pb5-C (CC490K)

Composition in % (mass fraction)					Casting process and designation	Tensile strength R_m N/mm2	0,2 % proof strength $R_{p0,2}$ N/mm2	Elongation A %	Brinell hardness HBW
element	ingots		castings						
	min.	max.	min.	max.		min.	min.	min.	min.
Cu[a]	81,0	85,5	81,0	86,0	Sand — GS	180	85	15	60
Ni	—	2,0	—	2,0					
P	—	0,03	—	0,05					
Pb	3,5	5,8	3,0	6,0					
Sn	2,2	3,5	2,0	3,5	Centrifugal — GZ	220	100	12	70
Zn	7,5	10,0	7,0	9,5					
Al	—	0,01	—	0,01					
Fe	—	0,50	—	0,5	Continuous — GC	220	100	12	70
S	—	0,08	—	0,10					
Sb	—	0,25	—	0,30					
Si	—	0,01	—	0,01					

[a] Including nickel

Table 23a — CuSn5Zn5Pb2-B (CB499K) and CuSn5Zn5Pb2-C (CC499K)

Composition in % (mass fraction)					Casting process and designation	Tensile strength R_m N/mm^2	0,2 % proof strength $R_{p0,2}$ N/mm^2	Elongation A %	Brinell hardness HBW
element	ingots		castings						
	min.	max.	min.	max.		min.	min.	min.	min.
Cu	84,0	87,5	84,0	88,0	Sand — GS	**200**	90	**13**	60
Ni	—	0,60	—	0,60					
P	—	0,03	—	0,04					
Pb	—	3,0	—	3,0	Permanent mould — GM	**220**	110	**6**	65
Sn	4,2	6,0	4,0	6,0					
Zn	4,5	6,5	4,0	6,0	Centrifugal — GZ	**250**	110	**13**	65
Al	—	0,01	—	0,01					
As	—	0,03	—	0,03					
Bi	—	0,02	—	0,02					
Cd	—	0,02	—	0,02					
Cr	—	0,02	—	0,02					
Fe	—	0,30	—	0,30					
S	—	0,04	—	0,04	Continuous — GC	**250**	110	**13**	65
Sb	—	0,10	—	0,10					
Si	—	0,01	—	0,01					

NOTE For drinking water applications no other single element should be more than 0,02 %. The sum of these single elements should not exceed 0,25 %.

Table 23b — CuSn5Zn5Pb5-B (CB491K) and CuSn5Zn5Pb5-C (CC491K)

Composition in % (mass fraction)					Casting process and designation	Tensile strength R_m N/mm^2	0,2 % proof strength $R_{p0,2}$ N/mm^2	Elongation A %	Brinell hardness HBW
element	ingots		castings						
	min.	max.	min.	max.		min.	min.	min.	min.
Cu[a]	83,0	86,5	83,0	87,0	Sand — GS	**200**	90	**13**	60
Ni	—	2,0	—	2,0					
P	—	0,03	—	0,10					
Pb	4,2	5,8	4,0	6,0	Permanent mould — GM	**220**	110	**6**	65
Sn	4,2	6,0	4,0	6,0					
Zn	4,5	6,5	4,0	6,0	Centrifugal — GZ	**250**	110	**13**	65
Al	—	0,01	—	0,01					
Fe	—	0,25	—	0,3					
S	—	0,08	—	0,10	Continuous — GC	**250**	110	**13**	65
Sb	—	0,25	—	0,25					
Si	—	0,01	—	0,01					

[a] Including nickel

Table 24 — CuSn7Zn2Pb3-B (CB492K) and CuSn7Zn2Pb3-C (CC492K)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Cu[a]	85,0	88,5	85,0	89,0	Sand — GS	**230**	**130**	**14**	65
Ni[b]	—	2,0	—	2,0					
P	—	0,03	—	0,10					
Pb	2,7	3,5	2,5	3,5	Permanent mould — GM	**230**	130	**12**	**70**
Sn[b]	6,2	8,0	6,0	8,0					
Zn	1,7	3,2	1,5	3,0	Centrifugal — GZ	**260**	130	**12**	**70**
Al	—	0,01	—	0,01					
Fe	—	0,20	—	0,2					
S	—	0,08	—	0,10	Continuous — GC	**270**	130	**12**	**70**
Sb	—	0,25	—	0,25					
Si	—	0,01	—	0,01					

[a] Including nickel

[b] (Tin+½ nickel) content shall be in the range 7,0 % to 8,0 %.

Table 25 — CuSn7Zn4Pb7-B (CB493K) and CuSn7Zn4Pb7-C (CC493K)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Cu[a]	81,0	84,5[b]	81,0	85,0[b]	Sand — GS	**230**	120	**15**	**60**
Ni	—	2,0	—	2,0					
P	—	0,03	—	0,10					
Pb	5,2	8,0	5,0	8,0	Permanent mould — GM	**230**	120	**12**	**60**
Sn	6,2[b]	8,0	6,0[b]	8,0					
Zn	2,3	5,0	2,0	5,0	Continuous — GC	**260**	120	**12**	**70**
Al	—	0,01	—	0,01					
Fe	—	0,20	—	0,2					
S	—	0,08	—	0,10	Centrifugal — GZ	**260**	120	**12**	**70**
Sb	—	0,30	—	0,3					
Si	—	0,01	—	0,01					

[a] Including nickel

[b] For continuous castings and centrifugal castings, the minimum tin content for ingots shall be 5,4 % and for castings 5,2 % and the maximum copper content for ingots shall be 85,0 % and for castings 86,0 %.

Table 26 — CuSn6Zn4Pb2-B (CB498K) and CuSn6Zn4Pb2-C (CC498K)

Composition in % (mass fraction)					Casting process and designation	Tensile strength R_m N/mm²	0,2 % proof strength $R_{p0,2}$ N/mm²	Elongation A %	Brinell hardness HBW
element	ingots		castings						
	min.	max.	min.	max.		min.	min.	min.	min.
Cu[a]	86,0	89,5	86,0	90,0	Sand — GS	**220**	**110**	**15**	65
Ni	—	1,0	—	1,0					
P	—	0,03	—	0,05					
Pb	1,2	2,0	1,0	2,0	Permanent mould — GM	**220**	**110**	**12**	70
Sn	5,7	6,5	5,5	6,5					
Zn	3,2	5,0	3,0	5,0	Centrifugal — GZ	**240**	**110**	**12**	70
Al	—	0,01	—	0,01					
Fe	—	0,25	—	0,25					
S	—	0,08	—	0,10	Continuous — GC	**240**	**110**	**12**	70
Sb	—	0,25	—	0,25					
Si	—	0,01	—	0,01					

[a] Including nickel

Table 27 — CuSn5Pb9-B (CB494K) and CuSn5Pb9-C (CC494K)

Composition in % (mass fraction)					Casting process and designation	Tensile strength R_m N/mm²	0,2 % proof strength $R_{p0,2}$ N/mm²	Elongation A %	Brinell hardness HBW
element	ingots		castings						
	min.	max.	min.	max.		min.	min.	min.	min.
Cu[a]	80,0	86,5	80,0	87,0	Sand — GS	**160**	60	**7**	55
Ni	—	2,0	—	2,0					
P	—	0,10	—	0,10					
Pb	8,2	10,0	8,0	10,0	Permanent mould — GM	**200**	80	**5**	60
Sn	4,2	6,0	4,0	6,0					
Zn	—	2,0	—	2,0	Centrifugal — GZ	**200**	90	**6**	60
Al	—	0,01	—	0,01					
Fe	—	0,20	—	0,25					
Mn	—	0,2	—	0,2					
S	—	0,08	—	0,10	Continuous — GC	**200**	100	**9**	60
Sb	—	0,5	—	0,5					
Si	—	0,01	—	0,01					

[a] Including nickel

Table 28 — CuSn10Pb10-B (CB495K) and CuSn10Pb10-C (CC495K)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Cu[a]	78,0	81,5	78,0	82,0	Sand — GS	**180**	80	**8**	60
Ni	—	2,0	—	2,0					
P	—	0,10	—	0,10					
Pb	8,2	10,5	8,0	11,0	Permanent mould — GM	**220**	110	**3**	65
Sn	9,2	11,0	9,0	11,0					
Zn	—	2,0	—	2,0	Centrifugal — GZ	**220**	110	**6**	70
Al	—	0,01	—	0,01					
Fe	—	0,20	—	0,25					
Mn	—	0,2	—	0,2					
S	—	0,08	—	0,10	Continuous — GC	**220**	110	**8**	70
Sb	—	0,5	—	0,5					
Si	—	0,01	—	0,01					

[a] Including nickel

Table 29 — CuSn7Pb15-B (CB496K) and CuSn7Pb15-C (CC496K)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Cu[a]	74,0	79,5	74,0	80,0	Sand — GS	**170**	80	**8**	60
Ni	0,5	2,0	0,5	2,0					
P	–	0,10	–	0,10					
Pb	13,2	17,0	13,0	17,0					
Sn	6,2	8,0	6,0	8,0	Continuous — GC	**200**	90	**8**	65
Zn	—	2,0	—	2,0					
Al	—	0,01	—	0,01					
Fe	—	0,20	—	0,25					
Mn	—	0,20	—	0,20	Centrifugal — GZ	**200**	90	**7**	65
S	—	0,08	—	0,10					
Sb	—	0,5	—	0,5					
Si	—	0,01	—	0,01					

[a] Including nickel

Table 30 — CuSn5Pb20-B (CB497K) and CuSn5Pb20-C (CC497K)

Composition in % (mass fraction)					Casting process and designation	Tensile strength R_m N/mm²	0,2 % proof strength $R_{p0,2}$ N/mm²	Elongation A %	Brinell hardness HBW
element	ingots		castings						
	min.	max.	min.	max.		min.	min.	min.	min.
Cu[a]	70,0	77,5	70,0	78,0	Sand — GS	**150**	70	**5**	45
Ni	0,5	2,5	0,5	2,5					
P	—	0,10	—	0,10					
Pb	19,0	23,0	18,0	23,0					
Sn	4,2	6,0	4,0	6,0	Continuous — GC	**180**	90	**7**	50
Zn	—	2,0	—	2,0					
Al	—	0,01	—	0,01					
Fe	—	0,20	—	0,25					
Mn	—	0,20	—	0,20	Centrifugal — GZ	**170**	80	**6**	50
S	—	0,08	—	0,10					
Sb	—	0,75	—	0,75					
Si	—	0,01	—	0,01					

[a] Including nickel

e) Tables 31 to 35: Copper-aluminium alloys

Table 31 — CuAl9-B (CB330G) and CuAl9-C (CC330G)

Composition in % (mass fraction)					Casting process and designation	Tensile strength R_m N/mm²	0,2 % proof strength $R_{p0,2}$ N/mm²	Elongation A %	Brinell hardness HBW
element	ingots		castings						
	min.	max.	min.	max.		min.	min.	min.	min.
Al	8,2	10,5	8,0	10,5	Permanent mould — GM	**500**	**180**	**20**	100
Cu[a]	88,0	91,5	88,0	92,0					
Fe	—	1,0	—	1,2					
Mn	—	0,50	—	0,50					
Ni	—	1,0	—	1,0	Centrifugal — GZ	**450**	160	**15**	100
Pb	—	0,25	—	0,30					
Si	—	0,15	—	0,20					
Sn	—	0,25	—	0,30					
Zn	—	0,40	—	0,50					

[a] Including nickel

Table 32 — CuAl10Fe2-B (CB331G) and CuAl10Fe2-C (CC331G)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Al	8,7	10,5	8,5	10,5	Sand — GS	**500**	**180**	**18**	100
Cu	83,0	89,0	83,0	89,5					
Fe	1,5	3,3	1,5	3,5	Permanent mould — GM	**600**	**250**	**20**	130
Mn	—	1,0	—	1,0					
Ni	—	1,5	—	1,5	Centrifugal — GZ	**550**	**200**	**18**	130
Mg	—	0,05	—	0,05					
Pb	—	0,03	—	0,10[a]					
Si	—	0,15	—	0,2	Continuous — GC	**550**	**200**	**15**	130
Sn	—	0,20	—	0,20					
Zn	—	0,50	—	0,50					

[a] For castings intended to be welded, the maximum lead content shall be 0,03 %.

Table 33 — CuAl10Ni3Fe2-B (CB332G) and CuAl10Ni3Fe2-C (CC332G)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Al[a]	8,7	10,5	8,5	10,5	Sand — GS	**500**	**180**	**18**	100
Cu	80,0	85,5[b]	80,0	86,0[b]					
Fe	1,0	2,8	1,0	3,0	Permanent mould — GM	**600**	**250**	**20**	130
Mn	—	2,0	—	2,0					
Ni[a]	1,5	4,0	1,5	4,0	Centrifugal — GZ	**550**	**220**	**20**	120
Mg	—	0,05	—	0,05					
Pb	—	0,03	—	0,10[c]					
Si	—	0,15	—	0,2	Continuous — GC	**550**	**220**	**20**	120
Sn	—	0,20	—	0,20					
Zn	—	0,50	—	0,50					

[a] For castings for sea-water applications, the aluminium content shall be such that Al % < (8,2+0,5 Ni %).

[b] For permanent mould castings, the maximum copper content for ingots and castings shall be 88,5 %.

[c] For castings intended to be welded, the maximum lead content shall be 0,03 %.

Table 34 — CuAl10Fe5Ni5-B (CB333G) and CuAl10Fe5Ni5-C (CC333G)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Al	8,8	10,0	8,5	10,5	Sand — GS	**600**	**250**	**13**	140
Cu	76,0	82,5	76,0	83,0					
Fe[a]	4,0	5,3	4,0	5,5					
Mn	—	2,5	—	3,0	Permanent mould — GM	**650**	**280**	**7**	150
Ni[a]	4,0	5,5	4,0	6,0					
Bi	—	0,01	—	0,01					
Cr	—	0,05	—	0,05	Centrifugal — GZ	**650**	**280**	**13**	150
Mg	—	0,05	—	0,05					
Pb	—	0,03	—	0,03					
Si	—	0,10	—	0,1	Continuous — GC	**650**	**280**	**13**	150
Sn	—	0,1	—	0,1					
Zn	—	0,40	—	0,50					

[a] For permanent mould castings, the minimum iron content of ingots and castings shall be 3,0 % and the minimum nickel content shall be 3,7 %.

Table 35 — CuAl11Fe6Ni6-B (CB334G) and CuAl11Fe6Ni6-C (CC334G)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Al[a]	10,3	12,0	10,0	12,0	Sand — GS	680	320	5	**170**
Cu[a]	72,0	81,5	72,0	82,5					
Fe[a]	4,2	7,0	4,0	7,0					
Mn	—	2,5	—	2,5	Permanent mould[a] — GM	750	380	5	**185**
Ni	4,3	7,5	4,0	7,5					
Mg	—	0,05	—	0,05					
Pb	—	0,04	—	0,05	Centrifugal — GZ	750	380	5	**185**
Si	—	0,10	—	0,1					
Sn	—	0,20	—	0,2					
Zn	—	0,40	—	0,50					

[a] For permanent mould castings, the minimum iron content of ingots and castings shall be 3,0 % and the minimum aluminium content shall be 9,0 %. In this case, the maximum copper content shall be 84,5 %.

f) Table 36: Copper-manganese-aluminium alloy

Table 36 — CuMn11Al8Fe3Ni3-C (CC212E)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Al			7,0	9,0	Sand — GS	**630**	**275**	**18**	150
Cu			68,0	77,0					
Fe	a		2,0	4,0					
Mn			8,0	15,0					
Ni			1,5	4,5					
Mg			—	0,05					
Pb			—	0,05					
Si	a		—	0,1					
Sn			—	0,5					
Zn			—	1,0					

[a] Ingot properties for producing castings conforming to CuMn11Al8Fe3Ni3-C (CC212E) are not specified in this standard. The composition limits for ingots are at the discretion of the purchaser and shall be stated on the enquiry and order [see 5 l)].

g) Tables 37 to 40: Copper-nickel alloys

Table 37 — CuNi10Fe1Mn1-B (CB380H) and CuNi10Fe1Mn1-C (CC380H)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Cu	84,5	—	84,5	—	Sand — GS	**280**	120	**20**	70
Fe	1,2	1,8	1,0	1,8					
Mn	1,2	1,5	1,0	1,5					
Ni	9,2	11,0	9,0	11,0	Centrifugal — GZ	**280**	100	**25**	70
Si	—	0,10	—	0,10					
Al	—	0,01	—	0,01					
C	—	0,10	—	0,10	Continuous — GC	**280**	100	**25**	70
Nb	—	1,0	—	1,0					
Pb	—	0,03	—	0,03					
Zn	—	0,50	—	0,5					

Table 38 — CuNi30Fe1Mn1-B (CB381H) and CuNi30Fe1Mn1-C (CC381H)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Cu	64,5	—	64,5	—	Sand — GS	**340**	120	**18**	80
Fe	0,5	1,5	0,5	1,5					
Mn	0,7	1,2	0,6	1,2					
Ni	29,2	31,0	29,0	31,0					
Si	—	0,10	—	0,1					
Al	—	0,01	—	0,01					
C	—	0,02	—	0,03	Centrifugal — GZ	**340**	120	**18**	80
P	—	0,01	—	0,01					
Pb	—	0,03	—	0,03					
S	—	0,01	—	0,01					
Zn	—	0,50	—	0,5					

Table 39 — CuNi30Cr2FeMnSi-C (CC382H)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Brinell hardness HBW min.
Cr			1,5	2,0	Sand — GS	**440**	**250**	**18**	115
Cu			Remainder						
Fe			0,5	1,0					
Mn	a		0,5	1,0					
Ni			29,0	32,0					
Si			0,15	0,50					
Ti			—	0,25					
Zr			—	0,15					
Al			—	0,01					
B			—	0,01					
Bi			—	0,002					
C			—	0,03					
Mg	a		—	0,01					
P			—	0,01					
Pb			—	0,005					
S			—	0,01					
Se			—	0,005					
Te			—	0,005					
Zn			—	0,2					

[a] Ingot properties for producing castings conforming to CuNi30Cr2FeMnSi-C (CC382H) are not specified in this standard. The composition limits for ingots are at the discretion of the purchaser and shall be stated on the enquiry and order [see 5 l)].

Table 40 — CuNi30Fe1Mn1NbSi-C (CC383H)

Composition in % (mass fraction) element	ingots min.	ingots max.	castings min.	castings max.	Casting process and designation	Tensile strength R_m N/mm^2 min.	0,2 % proof strength $R_{p0,2}$ N/mm^2 min.	Elongation A % min.	Brinell hardness HBW min.
Cu			Remainder		Sand — GS	**440**	**230**	**18**	115
Fe			0,5	1,5					
Mn	a		0,6	1,2					
Nb			0,5	1,0					
Ni			29,0	31,0					
Si			0,3	0,7					
Al			—	0,01					
B			—	0,01					
Bi			—	0,01					
C			—	0,03					
Cd			—	0,02					
Mg	a		—	0,01					
P			—	0,01					
Pb			—	0,01					
S			—	0,01					
Se			—	0,01					
Te			—	0,01					
Zn			—	0,50					

[a] Ingot properties for producing castings conforming to CuNi30Fe1Mn1NbSi-C (CC383H) are not specified in this standard. The composition limits for ingots are at the discretion of the purchaser and shall be stated on the enquiry and order [see 5 l)].

Annex A
(informative)

Recommended code of practice for the ordering and supply of copper and copper alloy castings

A.1 General

This annex recommends good, accepted practice to be followed in the ordering and supply of copper and copper alloy castings. The recommendations given in this annex supplement the ordering information in Clause 5. The aim is to ensure that the purchaser provides all that is essential for the manufacturer to fulfil the order satisfactorily and that the manufacturer produces castings to the purchaser's intended requirements.

To assist in the attainment of these ends, it is recommended that full consultation be made between the purchaser and the manufacturer at the stages of enquiry and ordering.

The practices described are based on those recommended in EN 1559-1.

A.2 Drawings

The purchaser should make available to the manufacturer the necessary drawing(s) of the raw casting and/or of the final finished casting. The enquiry and order should clearly identify the relevant drawings.

The drawings should preferably conform to international or European Standards.

If modifications to the purchaser's drawings are deemed necessary to take account of the moulding or casting process, or to facilitate fettling, or for similar production matters, they should be agreed between the manufacturer and the purchaser. This should include agreement on whether a tapered feature is to be added, subtracted or averaged (see EN 1559-1).

A.3 Patterns

If the purchaser is making available to the manufacturer pattern equipment, permanent moulds, tooling etc., their identification should be detailed on the order.

The manufacturer should check by visual examination that the pattern equipment etc. is usable and complete.

However, it is normal practice for the purchaser then to assume responsibility for the dimensions and suitability for the purposes of the pattern equipment, permanent moulds, tooling etc. supplied, unless at the time of ordering the castings, express instructions have been given to the manufacturer to inspect and dimensionally check the equipment.

A.4 Tolerances

Where applicable, casting tolerances should be specified on the drawings, or otherwise agreed between the purchaser and the manufacturer. In default of specific instructions, general tolerances for castings given in ISO 8062 should be assumed to apply.

A.5 Machining allowances

The surfaces to be machined, the machining allowances and datum surfaces for machining and for dimensional checks should be specified in the drawings. If pattern equipment is being supplied, any surfaces to be machined should be clearly indicated on the patterns themselves, where possible, or on accompanying drawings.

The manufacturer of the castings should satisfy himself that sufficient allowances have been made in the dimensions of the castings for any subsequent machining specified in the drawings or by the purchaser. Modifications to machining allowances should be agreed between the manufacturer and the purchaser.

A.6 Heat treatment

With some alloys, such as those given in Tables 31 to 40, a homogenizing heat treatment may sometimes enhance properties such as resistance to corrosion. Heat treatment may also be applied to castings for the purpose of relieving internal stresses. Agreement should be reached between the purchaser and the manufacturer when placing the order for any heat treatment schedule to be applied to the castings.

A.7 Trial sample

In the case of an order for a number of castings, the purchaser may request a trial sample. A deviation in the trial sample from the stated dimensional tolerances, or mass if this is specified, should be reconciled between the purchaser and the manufacturer and, if necessary, new values agreed before bulk production commences.

A.8 Defect rectification by welding

Rectification of casting defects by welding is technically satisfactory for some alloys. If welding is to be carried out, the manufacturer should first obtain the purchaser's agreement. Approved operators and procedures should be used, to ensure that the properties of the weld metal and of the heat affected zone are in sufficient correspondence with the requirements of the parent metal as not to impair the serviceability of the casting.

Where corrosion resistance is an important characteristic it is usually necessary to subject the casting to a post-weld heat treatment, in order to achieve the optimum metallurgical structure. The necessary heat treatment should be agreed between the manufacturer and the purchaser.

A.9 Fabrication welding

If the castings are to form part of a welded assembly, this should be stated on the purchaser's order.

Annex B
(informative)

Optional supplementary inspection procedures for ingots and castings

B.1 Introduction

The following optional inspection procedures are available:

a) for ingots:

- tensile testing (see B.3.1);

b) for castings:

- analysis at a rate to be agreed between the purchaser and the supplier (see B.2);
- tensile testing at an increased rate to that specified in 7.3.3 (see B.3.2);
- electrical conductivity testing of Cu-C (CC040A), and CuCr1-C (CC140C) (see B.4);
- dezincification resistance testing, at an increased rate to that specified in 7.5 (see B.5);
- proof machining (see B.6);
- pressure testing (see B.7);
- penetrant surface flaw detection (see B.8); and
- radiographic examination (see B.9).

If a purchaser wishes to exercise any one or more of these options, then the full details should be agreed with the supplier at the time of enquiry and/or order and clearly stated on the order [see 5 p)].

B.2 Analysis of castings

The minimum inspection requirements for the analysis of non-continuous castings are specified in 7.2.3.3.

As an option, the purchaser may request analysis up to a maximum rate of one analysis per cast. When exercising this option, the purchaser should state the rate of analysis required and whether an analysis certificate is needed.

B.3 Tensile testing of ingots and castings

B.3.1 Ingots

If this option is specified by the purchaser, the supplier should carry out tensile tests at the rate of one test to represent each cast of ingots. The sample is to be taken from remelted ingots and the test bars should be separately cast into a sand mould, or, if the ingots are intended for permanent mould casting, into a chill mould.

B.3.2 Castings

The minimum inspection requirements for the tensile testing of non-continuous castings are specified in 7.3.3. An increased rate of tensile testing for castings in those alloys covered by 7.3.3 b), up to a maximum of one test per cast, is available as an inspection option. When requesting this option, the purchaser should state the rate of testing. The tests should be carried out in accordance with 8.2.

B.4 Electrical conductivity testing of Cu-C (CC040A) and CuCr1-C (CC140C) castings

When this option is specified by the purchaser, the supplier should carry out the test in accordance with 8.3, at a rate of testing to be agreed between the purchaser and the supplier.

B.5 Dezincification resistance testing of castings in alloys specified in Table 6 and Table 7

The minimum inspection requirements for dezincification resistance testing of castings in alloys specified in Table 6 and Table 7 and produced by permanent mould casting or pressure die casting, are specified in 7.5. An increased rate of testing, up to a maximum of one sampling unit for each pattern of casting and for each batch or heat treatment batch, is available as an inspection option. When exercising this option, the purchaser should state the rate of testing required.

B.6 Proof machining

Frequently the soundness of castings which are intended to be wholly or partially machined cannot be assessed adequately in the as cast state. In such circumstances the purchaser may specify that the castings be partially or fully machined by the supplier before inspection, to permit a better assessment.

Visual inspection of the proof machined surfaces is normally sufficient to identify significant defects, but proof machining may be combined with pressure testing or penetrant surface flaw detection.

If the proof machining option is invoked, the surface or surfaces to be machined before inspection should be agreed between the purchaser and the supplier and detailed on the purchaser's drawing. The purchaser should also state the proportion of the castings ordered that is to be proof machined and the criteria for acceptance.

B.7 Pressure testing

Where castings form a part of a component subject to internal pressure, the purchaser may request that they should be pressure tested to confirm that leakage does not occur. The pressure test conditions, the production stage at which the test is to be performed and the proportion of castings to be tested should be stated on the purchaser's enquiry and order.

In general, either a hydraulic test or a pneumatic test may be used for pressure testing, as agreed between the purchaser and the supplier.

WARNING — Pressure testing of components is a potentially hazardous operation. Attention is drawn to the need to ensure that all appropriate safety precautions are taken when testing.

When the pressure testing option is invoked by the purchaser [see 5 p)], the hydraulic or pneumatic testing should be carried out in accordance with the exact procedures agreed between the purchaser and the supplier, but typical procedures are as follows:

a) Hydraulic test

Blank off the castings by suitable means and subject them to the hydrostatic pressure agreed between the purchaser and the supplier. Maintain the pressure for the agreed time. (A minimum of 5 min is recommended.)

NOTE Water is the preferred test medium, but other media may be used subject to agreement between the purchaser and the supplier.

Any casting from which leakage occurs should be deemed to have failed the test.

b) Pneumatic test

Blank off the castings by suitable means. Submerge them to a depth of not more than 150 mm in clean water and subject them to the pneumatic pressure agreed between the purchaser and the supplier. Maintain the test pressure for the agreed time.

NOTE Air is the usual test medium, but other gases may be used subject to agreement between the purchaser and the supplier.

Any casting from which bubbling occurs should be deemed to have failed the test.

B.8 Penetrant surface flaw detection

The detection of surface defects may be aided by the use of penetrants, usually containing a dye-stuff. The purchaser may request penetrant testing of either as cast surfaces or proof machined surfaces.

The test should be carried out in accordance with EN 1371-1 or EN 1371-2.

When this option is specified by the purchaser [see 5 p)], the conditions of the test, the proportion of castings to be tested, and the acceptance criteria should be agreed between the purchaser and the supplier and stated on the purchaser's enquiry or order.

NOTE Because of the difficulties of interpretation, liquid penetrant testing is not applicable to pressure die cast components, nor is it recommended for the alloys given in Tables 17 to 30.

As cast surfaces to be subjected to penetrant testing should be cleaned thoroughly by shot blasting or comparable methods in order to remove all visible residues before testing.

B.9 Radiographic examination

If the option for radiographic examination of castings for the detection of interior faults is specified [see 5 p)], the regions to be examined should be marked on the purchaser's drawing and the radiographic techniques and standards of acceptance should be agreed between the purchaser and the supplier and stated on the order.

It should be made clear whether radiographic examination of the defined areas is to be carried out on all castings supplied to a particular order, or whether radiographic examination is to be confined to the first castings produced to the order, or whether a specified proportion of the castings is to be radiographically examined.

The purchaser should state if he or his representative requires to approve the radiographs produced and/or if he requires that the appropriate radiographs should accompany each batch of castings delivered.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of the EU Pressure Equipment Directive (PED) 97/23/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 97/23/EC.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

For this harmonised supporting standard for materials, presumption of conformity to the Essential Requirements of the Directive is limited to technical data of the material in the standard and does not presume adequacy of the material to specific equipment. Consequently the technical data stated in the material standard should be assessed against the design requirements of the specific equipment to verify that the Essential Requirements of the Pressure Equipment Directive (PED) are satisfied.

Table ZA.1 — Correspondence between this European Standard and Directive 97/23/EC

Clause/ subclause of this EN	Subject	Qualifying remark/note
6.2	Material properties	Annex I, 4.1 (a) of the Directive
9	Conformity of material and manufacturer's certified documentation	Annex I, 4.3 of the Directive

NOTE Brittle fracture prevention: copper, having a face-centered cubic crystal structure, does not suffer a transition from ductile to brittle failure like some other materials.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

[1] EN 1371-1, *Founding — Liquid penetrant inspection — Part 1: Sand, gravity die and low pressure die castings*

[2] EN 1371-2, *Founding — Liquid penetrant inspection — Part 2: Investment castings*

[3] EN 1412, *Copper and copper alloys — European numbering system*

[4] EN 1559-1, *Founding — Technical conditions of delivery — Part 1: General*

[5] EN 1976, *Copper and copper alloys — Cast unwrought copper products*

[6] EN 1981, *Copper and copper alloys — Master alloys*

[7] EN ISO 9001, *Quality management systems — Requirements (ISO 9001:2000)*

[8] ISO 31-0:1992, *Quantities and units — Part 0: General principles*

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

[10] ISO 8062, *Castings — System of dimensional tolerances and machining allowances*

[11] EN 1370, *Founding — Surface roughness inspection by visualtactile comparators*

blank

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: +44 (0)20 8996 9000. Fax: +44 (0)20 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: +44 (0)20 8996 9001. Fax: +44 (0)20 8996 7001. Email: orders@bsi-global.com. Standards are also available from the BSI website at http://www.bsi-global.com.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: +44 (0)20 8996 7111. Fax: +44 (0)20 8996 7048. Email: info@bsi-global.com.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: +44 (0)20 8996 7002. Fax: +44 (0)20 8996 7001. Email: membership@bsi-global.com.

Information regarding online access to British Standards via British Standards Online can be found at http://www.bsi-global.com/bsonline.

Further information about BSI is available on the BSI website at http://www.bsi-global.com.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL