BRITISH STANDARD

BS 2872:1989

Specification for

Copper and copper alloy forging stock and forgings

UDC 669.3:621.73:620.1:001.4

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Non-ferrous Metals Standards Policy Committee (NFM/-) to Technical Committee NFM/34, upon which the following bodies were represented:

British Bathroom Council
British Cable Makers' Confederation
British Gas plc
British Malleable Tube Fittings Association
British Non-ferrous Metals Federation
British Valve and Actuator Manufacturers' Association
Copper Development Association
London Metal Exchange
Non-ferrous Metal Stockists
Society of British Aerospace Companies Limited
Coopted members

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

British Plumbing Fittings Manufacturers' Association
British Telecommunications plc
British Turned-parts Manufacturers' Association
Copper Smelters' and Refiners' Association
Electronic Engineering Association
Spring Research and Manufacturers' Association
Telecommunication Engineering and Manufacturing Association

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Contents

Foreword

This British Standard has been prepared under the direction of the Non-ferrous Metals Standards Policy Committee. It is the second metric revision of BS 2872, which was originally published in 1962 and subsequently revised in 1969 and it supersedes the 1969 edition, which is withdrawn. It is one in a series of standards for copper and copper alloys in various wrought forms, intended for general engineering purposes. The others in the series are:

BS 2870, *Specification for rolled copper and copper alloys: sheet, strip and foil.*

BS 2871, *Specification for copper and copper alloys. Tubes.*

BS 2873, *Specification for copper and copper alloys. Wire.*

BS 2874, *Specification for copper and copper alloy rods and sections (other than forging stock).*

BS 2875, *Specification for copper and copper alloys. Plate.*

In this revision, due regard has been given to the work of the International Organization for Standardization (ISO) and in particular to Technical Committee ISO/TC 26, Copper and copper alloys, in respect of chemical compositions, testing requirements, properties and dimensional tolerances. Whenever possible and appropriate, the requirements of this British Standard have been aligned with those of corresponding international standards.

Certain alloys that are considered to be in sufficient demand to warrant inclusion have been added. The additions are:

C 101, *electrolytic, tough pitch high conductivity copper.*

C 102, *fire refined, tough pitch high conductivity copper.*

C 106, *phosphorus deoxidized, non-arsenical copper.*

C 111, *copper-sulphur.*

C 112, *copper-cobalt-beryllium.*

C 113, *copper-nickel-phosphorus.*

CC 101, *copper-chromium.*

CC 102, *copper-chromium-zirconium.*

CA 107, *copper-aluminium-silicon.*

CN 102 90/10, *copper-nickel-iron.*

CN 107 70/30, *copper nickel-iron.*

CZ 135, *high tensile brass with silicon.*

CZ 136, *manganese brass.*

The alloy previously known as CZ 123 in BS 2872 has been redesignated CZ 137 to avoid confusion with the similar but purer alloy CZ 123 which is included in BS 2870 and BS 2875.

The demand for four of the alloys included in the last edition of this standard is considered to be insufficient to warrant their retention and they have consequently been withdrawn. The alloys withdrawn are CA 103, CA 106, NS 101 and CS 101.

In this revision the standard has been divided into three sections:

a) section one specifies the general requirements applicable to both forging stock and forgings for the alloys in this standard;

b) section two specifies those requirements which are specific to forging stock;

c) section three specifies those requirements which are specific to forgings.

In this revision, and for the purposes of this standard only, each of the alloys has been placed in one of two alloy groups, designated A and B according to their difficulty of fabrication. This alloy grouping is shown in Table 5 and use has been made of the alloy groups in specifying the dimensional tolerances for forging rod in Table 6. Prior to this revision the dimensional tolerances for forging rod had not been specified, but were subject to agreement between the manufacturer and the purchaser. The dimensional tolerances specified in Table 6 for groups A and B are identical with the "normal" tolerances specified in BS 2874 for groups I and II alloys and for group III alloys respectively.

All mechanical properties have been reviewed and revised where appropriate.

The former Appendix C is now considered redundant and has been omitted from this revision. The forgeability test, which was a requirement of the previous edition, has been made an optional test in this edition.

In previous editions of this standard, clauses have been included entitled "Inspection" and "Facilities for testing". As these clauses are contractual and not relevant to the standard for the product, they have been omitted from this revision.

Technical Committee TC133, Copper and copper alloy products, of the European Committee for Standardization (CEN) is about to embark on a programme of work to develop European Standards (ENs) for copper and copper alloy products. In due course, TC133 should produce an EN for forging stock and forgings. When this EN is approved by the CEN member bodies it will be fully implemented as a British Standard, either by amending or by revising this standard.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 20, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. Forging stock and forgings

1 Scope

This British Standard specifies requirements for the chemical composition, tensile properties and other characteristics for wrought or cast copper and copper alloy forging stock, having a diameter or width across flats greater than 6 mm, and for forgings of these materials.

It applies to forging stock and forgings supplied in the grades of copper and copper alloys listed in Table 1 to Table 4 and the material conditions given in clause **5** for forging stock and in clause **12** for forgings.

Details of information to be supplied by the purchaser are given in Appendix A.

NOTE 1 Table 9 in Appendix B indicates the alloys included in the whole series of copper and copper alloy standards, BS 2870 to BS 2875. This gives nominal compositions, product forms specified and related ISO designations.

NOTE 2 For the convenience of users of this standard, Table 10 in Appendix C gives conversion factors for stress values in SI and imperial units. Throughout this standard, values for the tensile strength and proof stress requirements are stated in newtons per square millimetre (N/mm^2), this unit now being in common use in the industry.

NOTE 3 The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this British Standard the following definitions apply.

2.1
forging stock

extruded, rolled, drawn or cast material intended for the production of forgings, usually in the form of rod or sections

2.2
rod

a solid product of round, square, rectangular or regular polygonal cross section, uniform throughout its length, usually supplied in straight lengths, and which if rectangular in cross section has a thickness that exceeds one-tenth of the width

2.3
forging(s)

a shape produced by hammering or pressing, usually when hot, between open or closed dies, including hammering between flat surfaces. The term "forging" includes the processes of forging, drop forging, hot stamping, and hot pressing; the term "forgings" includes the products resulting from any of these processes of manufacture

2.4
wrought

a material is considered to be wrought when it has been subjected to sufficient mechanical and thermal treatment to eradicate or change substantially the original structure, usually cast

2.5
cast

cast material is material which has solidified from the liquid state in a mould, and which has not subsequently been worked to eradicate or change substantially the cast structure

3 General requirements

Forging stock shall comply with the general requirements specified in clause **4** and with the specific requirements for forging stock specified in clauses **5** to **8**.

NOTE A forgeability test on the forging stock supplied may be requested by the purchaser (see item d) of **A.2**).

Forgings shall comply with the general requirements specified in clause **4** and with the specific requirements for forgings specified in clauses **12** to **16**.

Where tests are carried out to verify that the forging stock or forgings comply with the requirements for chemical composition (see clause **4**), tensile properties (see clauses **6** and **13**), or resistance to dezincification (see clauses **7** and **15**), the sampling and test methods shall be in accordance with clauses **9**, **10** and **11** for forging stock and with clauses **17** and **18** for forgings.

The results obtained from chemical analysis and tensile tests shall be rounded to the last place of figures specified as limits, by the application of the rounding rule in accordance with BS 1957 (see Appendix D).

When mercurous nitrate testing for the residual stress in forgings is called for, the sampling shall be in accordance with **17.4**.

4 Chemical composition

The chemical composition of the forging stock and forgings shall be as given for the appropriate material in Table 1 to Table 4.

Section 2. Forging stock

5 Material condition

Wrought forging stock shall be supplied in the condition resulting from one of the following final production processes:

a) hot working;

b) cold working;

c) annealing.

NOTE At the request of the purchaser, the supplier should state whether the forging stock supplied is wrought or cast.

6 Tensile properties

The tensile properties of forging stock in the size range 6 mm to 80 mm shall be as given in Table 1 to Table 4 when tested in accordance with Appendix E.

NOTE 1 The tensile property requirements for forging stock outside this size range should be agreed between the purchaser and the supplier.

NOTE 2 Attention is drawn to the options available to the supplier of the forging stock concerning the preparation of the tensile test samples given in **10.1**.

7 Resistance to dezincification (applicable to alloy CZ 132 only)

When a sample of forging stock in alloy CZ 132, prepared in accordance with **10.2**, is subjected to the dezincification resistance test carried out in accordance with Appendix F, the maximum depth of penetration shall be as follows.

a) For wrought forging stock:

parallel to the direction of extrusion, rolling or drawing:	200 µm
perpendicular to the direction of extrusion, rolling or drawing:	100 µm

b) For cast forging stock:

in any direction:	100 µm

NOTE If a sample representative of the batch passes this test, it indicates that forgings produced from the batch of forging stock and correctly heat treated will pass the dezincification test requirement for forgings. The forging manufacturer should, however, still verify this by testing the forgings (see clause **15**).

8 Tolerances on dimensions

NOTE 1 Each alloy in this standard has been allotted to one of two groups, designated A and B, for tolerancing purposes. A list of the alloys and groupings, which are specific to this standard, is given in Table 5.

The diameter of round forging stock shall be within the tolerances given in Table 6 for the appropriate alloy group and size.

NOTE 2 The dimensional tolerances to be applied to round forging stock outside the range of sizes given in Table 6, and to forging stock of other shapes, should be agreed between the purchaser and the supplier.

9 Selection of test samples

9.1 General

When tests are required to be carried out to verify that a batch of forging stock complies with this standard (see items a) and c) of **A.2**), samples for chemical analysis and tensile tests shall be taken in accordance with **9.2**.

NOTE 1 If the supplier of the forging stock is also the producer of the forgings, the requirements of this clause may be dispensed with and those in clause **17** taken to apply.

NOTE 2 No sampling requirements for forging stock are specified in this standard for the dezincification resistance test (alloy CZ 132 only). When the purchaser requires this test to be carried out, the sampling requirements should be agreed between the supplier and the purchaser at the time of the enquiry and order (see item c) of **A.2**).

9.2 Samples for analysis and tensile testing

For sampling, the forging stock shall be grouped into the batch sizes (masses) given in Table 7.

For each test, i.e. analysis and tensile, one sample shall be taken at random from each batch and from any remaining part of a batch.

10 Preparation of test samples

10.1 Tensile test samples

10.1.1 *Materials other than C 112, C 113, CC 101, CC 102 and CZ 132.* Test samples in alloys other than C 112, C 113, CC 101, CC 102 and CZ 132, selected in accordance with **9.2**, shall, at the option of the supplier, be prepared in accordance with a), b) or c) as follows:

a) directly from wrought forging stock produced by hot working; or

b) from wrought forging stock subsequently annealed at a temperature of not less than 500 °C for not less than 30 min; or

c) from wrought, or cast, forging stock subsequently hot forged either to approximately 65 % of the original cross-sectional area, or upset forged by at least 50 % of its original length.

NOTE The method of preparation of the test sample, i.e. whether in accordance with a), b) or c) of **10.1.1**, should be stated, together with the tensile test results obtained, on any Certificate of Conformity supplied with the forging stock (see a) of **A.2** and b) of **A.3**).

10.1.2 *Materials C 112, C 113, CC 101 and CC 102.* Test samples in alloys C 112, C 113, CC 101 and CC 102, selected in accordance with **9.2** shall, at the option of the supplier, be prepared in accordance with a) or b) as follows:

a) directly from wrought forging stock produced by hot working; or

b) from wrought or cast forging stock subsequently hot forged either to approximately 65 % of the original cross-sectional area, or upset forged by at least 50 % of its original length.

Samples prepared as in a) or b) above shall then be solution treated and precipitation hardened in conditions specified by the supplier before testing.

NOTE The method of preparation of the test sample, i.e. whether in accordance with a) or b) of **10.1.2**, should be stated, together with the tensile test results obtained, on any Certificate of Conformity supplied with the forging stock (see a) of **A.2** and b) of **A.3**).

10.1.3 *Material CZ 132.* Test samples in alloy CZ 132, selected in accordance with **9.2**, shall be heat treated in the temperature range 450 °C to 550 °C before testing.

10.2 Dezincification resistance test samples

Test samples of forging stock in alloy CZ 132 shall be heat treated in the temperature range 450 °C to 550 °C before testing.

11 Retests for forging stock

11.1 Analysis and tensile properties

Should any of the test pieces fail the test for analysis or tensile properties two further samples from the same batch shall be permitted to be selected for retesting that particular property. One of these further samples shall be taken from the same length of forging stock as that from which the original failed test sample was taken, unless that length had been withdrawn by the supplier.

Should both of the further samples pass the retest, the batch represented shall be deemed to comply with that particular requirement of this standard. Should either of the further samples fail the test, the batch represented shall be deemed not to comply with this standard.

11.2 Dezincification resistance test (alloy CZ 132 only)

Should any of the test pieces fail the dezincification resistance test, further samples from the same batch shall be permitted to be taken for retests. The number of samples taken for the retests shall be twice the number first selected (see note 2 to **9.1**).

Should all of the further samples pass the test, the batch represented shall be deemed to comply with the dezincification resistance requirements of this standard. Should any one of the further samples fail the test, the batch represented shall be deemed not to comply with this standard.

Section 3. Forgings

12 Material condition

12.1 All materials except C 112, C 113, CC 101, CC 102 and CZ 132

Forgings produced in all materials except C 112, C 113, CC 101, CC 102 and CZ 132 shall be supplied in the M condition ("as manufactured"), unless otherwise specified.

12.2 Materials C 112, C 113, CC 101 and CC 102

Forgings produced in alloys C 112, C 113, CC 101 or CC 102 shall be solution treated and precipitation hardened at an elevated temperature as the final thermal operations after forging unless un-heat treated forgings are specifically requested by the purchaser (see item d) of **A.1**).

NOTE 1 Material in the solution treated and precipitation hardened condition is designated "TF". The properties specified in Table 2 are for material in this TF condition.

NOTE 2 For some types of forging, the manufacturer may, at his discretion, carry out a cold working operation either between solution treatment and precipitation or, exceptionally, after precipitation, to give enhanced mechanical properties.

NOTE 3 During subsequent processing operations, including final assembly of finished components, the purchaser should avoid heating the forgings above the following temperatures:

C 112	copper-cobalt-beryllium	500 °C
C 113	copper-nickel-phosphorus	475 °C
CC 101	copper-chromium	500 °C
CC 102	copper-chromium-zirconium	525 °C

These temperature maxima are given for information only; they are based on the lowest temperature that, if maintained for 2 h, would give a reduction in hardness equivalent to 20 % of the difference between the hardest condition, as received, and the softest possible condition of the alloy.

12.3 Material CZ 132

Forgings produced in alloy CZ 132 shall be heat treated in the range 450 °C to 550 °C as the final thermal operation after forging. CZ 132 forgings which have undergone this heat treatment are described as being in the M condition ("as manufactured").

NOTE Heating the CZ 132 M condition forgings above 525 °C should be avoided in any subsequent operation, including final assembly of finished components.

13 Tensile properties

When tested in accordance with Appendix E, the tensile properties of the forgings shall comply with Table 1 to Table 4.

NOTE In practice the tensile test is normally carried out on the forging stock from which the forgings are manufactured but, at the option of the supplier, may occasionally be carried out on the forgings themselves (see **17.2**). If a purchaser specifically requires the test to be carried out on the forgings then the details of the test and the rate of sampling should be subject to agreement between the purchaser and the supplier.

14 Residual stress

Batches of forgings shall be supplied as either a) or b), as follows.

a) Specially processed to achieve a residual (internal) stress level which is sufficiently low to pass the mercurous nitrate test given in Appendix G. When samples of such forgings are tested in accordance with Appendix G they shall show no evidence of cracking upon immediate examination with the unaided eye, corrected for normal vision if necessary.

b) Not specially processed or tested as in a).

If no option is expressed by the purchaser (see item b) of **A.2**), forgings of type b) shall be supplied.

NOTE Care should be taken that subsequent fabrication operations carried out in producing components, or assemblies, from forgings that have passed this test do not introduce levels of internal stress which could cause failure.

15 Resistance to dezincification (applicable to forgings in CZ 132 only)

When forgings in alloy CZ 132 selected and prepared in accordance with **17.3** are subjected to the dezincification resistance test carried out in accordance with Appendix F, the maximum depth of penetration shall be 100 μm in any direction in the forging.

16 Tolerances on dimensions

The forgings shall be made to the dimensions specified on the order or drawing and subject to the dimensional tolerances agreed between the purchaser and the supplier.

17 Selection and preparation of test samples

17.1 General

When tests are required to be carried out to verify that a batch of forgings complies with this standard (see items a), b) and c) of **A.2**), samples for analysis, tensile, dezincification resistance and mercurous nitrate tests shall be taken in accordance with **17.2**, **17.3** and **17.4**.

NOTE No sampling requirements for forgings are specified in this standard for testing for analysis, dezincification resistance or residual stress. When the purchaser requires these tests to be carried out on forgings, the sampling requirements including provision for retests, should be agreed between the supplier and the purchaser at the time of the enquiry and order (see item c) of **A.2**).

17.2 Samples for analysis and tensile strength

When analysis tests are required they shall be carried out either on a sample of the actual forgings (see note to **17.1**) or on samples of the forging stock from which the forgings have been manufactured. In the latter case, the samples shall be selected in accordance with **9.2**.

When tensile tests are required they shall be carried out either on samples of the forging stock from which the forgings have been manufactured, or, at the option of the supplier, on the actual finished forgings, if these are of sufficient size. In the former case, the samples shall be selected from the forging stock in accordance with **9.2**. In the latter case the samples shall be selected from the finished forgings at a rate of one sample forging per batch, the size of the batch being in accordance with Table 8.

Samples for tensile tests from forging stock in materials other than C 112, C 113, CC 101, CC 102 and CZ 132 shall be prepared in accordance with **10.1.1**, before testing.

Samples for tensile tests from forging stock in materials C 112, C 113, CC 101 or CC 102 shall be prepared in accordance with **10.1.2** and from forging stock in material CZ 132, in accordance with **10.1.3**. The samples shall then be heat treated in the same furnace at the same time as the forgings they represent, before testing.

17.3 Samples for dezincification resistance test (for forgings in CZ 132)

Samples for dezincification resistance testing shall be cut from finished, heat treated forgings (see note to **17.1**).

The samples should not be further treated before testing.

17.4 Samples for mercurous nitrate test (for residual stress)

The mercurous nitrate test for residual stress shall be carried out on whole finished forging(s) taken from the batch represented (see note to **17.1**). The selected samples, which constitute the test specimens, shall not be further prepared before testing and shall not be marked for identification by indenting.

18 Retests for forgings

Should any of the test pieces prepared from the above samples fail any particular test, further samples from the same batch shall be selected for testing. The number of samples taken for retests shall be twice the number first selected. One of these further samples shall be from the same length of forging stock or from the same forging as that from which the original failed sample was taken, unless in the former case that length has been withdrawn.

Should all the further samples pass the test, the batch represented shall be deemed to comply with the requirements of this standard for that test. Should any one of the further samples fail, then the batch represented shall be deemed not to comply with this standard.

NOTE If a batch of forgings:

a) in C 112, C 113, CC 101, CC 102 or CZ 132 fails the tensile test;

b) in CZ 132 fails the dezincification resistance test; or

c) if any material fails the mercurous nitrate test.

the supplier has the option to heat treat further the whole batch and to resubmit the batch for all the tests called for on the order.

Table 1 — Chemical composition and tensile properties of coppers

BS designation	Material	Chemical composition												Tensile properties for forging stock and forgings			Nearest ISO designation
		Cu	Sn	Pb	Fe	Ni	As	Sb	P	Se	Te	Bi	Total impurities	Tensile strength min.	0.2 % proof stress min.	Elongation on $5.65\sqrt{S_o}$ min.	
		%	%	%	%	%	%	%	%	%	%	%	%	N/mm^2	N/mm^2	%	
C 101	Electrolytic tough pitch high conductivity copper	**99.90** min. (including silver)	—	0.005	—	—	—	—	—	—	—	0.0010	0.03 (excluding O and Ag)	150	—	20	Cu-ETP
C 102	Fire refined tough pitch high conductivity copper	**99.90** min. (including silver)	—	0.005	—	—	—	—	—	—	—	0.0025	0.04 (excluding O and Ag)	150	—	20	Cu-FRHC
C 106	Phosphorus deoxidized non-arsenical copper	**99.85** min. (including silver)	0.01	0.010	0.030	0.10	0.05	0.01	**0.013–0.050**	Se + Te 0.020	0.010	0.0030	0.06 (excluding Ag, As, Ni and P)	150	—	20	Cu-DHP

NOTE For essential alloying elements, limits are in bold type. Unless otherwise stated, figures in the total impurities column include those that are not in bold type. Unless otherwise indicated all single limits are maxima.

Table 2 — Chemical composition and tensile properties of alloyed coppers

BS designation	Material	Chemical composition														Tensile properties for forging stock and forgings			Nearest ISO designation
		Cu	Ni	P	Cr	Co	Be	Zr	Bi	Fe	Sb	S	Si	Sn	Total impurities	Tensile strength min	0.2 % proof stress min	Elongation on 5.65 $\sqrt{S_o}$ min	
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	N/mm^2	N/mm^2	%	
C 111	Copper-sulphur	**Rem.**	—	—	—	—	—	—	—	—	—	**0.3–0.6**	—	—	0.2	150	—	20	Cu S
C 112	Copper-cobalt-beryllium	**Rem.**	Ni + Fe 0.5	—	—	**2.0–2.8**	**0.4–0.7**	—	—	0.10	—	—	0.2	—	0.5 (excluding Fe, Ni and Si)	620[a]	—	9[a]	CuCo2Be
C 113	Copper-nickel-phosphorus	**Rem.**	**0.8-1.2**	**0.16–0.25**	—	—	—	—	—	—	—	0.2	—	—	0.03 (excluding S)	380[a]	—	18[a]	—
CC 101	Copper-chromium	**Rem.**	0.02	0.01	**0.3–1.4**	—	—	—	0.001	0.08	0.002	0.08	0.2	0.008	0.05 (excluding Fe, S and Si)	360[a]	—	17[a]	CuCr1
CC 102	Copper-chromium zirconium	**Rem.**	0.02	0.01	**0.5–1.4**	—	—	**0.02–0.2**	0.001	0.08	0.002	—	0.2	0.008	0.05 (excluding Fe and Si)	360[a]	—	17[a]	CuCr1Zr

NOTE For essential alloying elements, limits are in bold type. Unless otherwise stated, figures in the total impurities column include those that are not in bold type. Unless otherwise indicated all single limit are maxima.

[a] The tensile properties specified are applicable to material in the solution treated and precipitation hardened (TF) condition.

Table 3 — Chemical composition and tensile properties of brasses

BS designation	Material	Chemical composition											Tensile properties for forging stock and forgings			Nearest ISO designation
		Cu	Sn	Pb	Fe	Al	Mn	As	Ni	Si	Zn	Total impurities	Tensile strength min.	0.2 % proof stress min.	Elongation on $5.65\sqrt{S_o}$ min.	
		%	%	%	%	%	%	%	%	%	%	%	N/mm^2	N/mm^2	%	
CZ 109	Lead free 60/40 brass	**59.0–62.0**	—	0.1	—	—	—	—	—	—	**Rem.**	0.3 (excluding Pb)	310	—	25	CuZn40
CZ 112	Naval brass	**61.0–63.5**	**1.0–1.4**	—	—	—	—	—	—	—	**Rem.**	0.7	340	—	15	CuZn38Sn1
CZ 114	High tensile brass	**56.5–58.5**	**0.2–0.8**	**0.5–1.5**	**0.3–1.0**	1.5	**0.5–2.0**	—	—	—	**Rem.**	0.5 (excluding Al)	460	180	15	CuZn39AlFeMn
CZ 115	High tensile brass (restricted aluminium)	**56.5–58.5**	**0.2–0.8**	**0.5–1.5**	**0.3–1.0**	0.1	**0.5–2.0**	—	—	—	**Rem.**	0.5	460	180	15	CuZn39AlFeMn
CZ 116	High tensile brass	**64.0–68.0**	—	—	**0.25–1.2**	**4.0–5.0**	**0.3–2.0**	—	—	—	**Rem.**	0.5	540	280	12	—
CZ 121 Pb3	Leaded brass 58 % Cu 3 % Pb	**56.5–58.5**	—	**2.5–3.5**	0.3	—	—	—	—	—	**Rem.**	0.7	350	—	25	CuZn39Pb3
CZ 121 Pb4	Leaded brass 58 % Cu 3 % Pb	**56.5–58.5**	—	**3.5–4.5**	0.3	—	—	—	—	—	**Rem.**	0.7	350	—	25	CuZn38Pb4

NOTE For essential alloying elements, limits are in bold type. Unless otherwise stated, figures in the total impurities column include those that are not in bold type. Unless otherwise indicated all single limits are maxima.

Table 3 — Chemical composition and tensile properties of brasses

BS designation	Material	Chemical composition											Tensile properties for forging stock and forgings			Nearest ISO designation
		Cu	Sn	Pb	Fe	Al	Mn	As	Ni	Si	Zn	Total impurities	Tensile strength min.	0.2 % proof stress min.	Elongation on $5.65\sqrt{S_o}$ min.	
		%	%	%	%	%	%	%	%	%	%	%	N/mm^2	N/mm^2	%	
CZ 122	Leaded brass 58 % Cu 2 % Pb	**56.5–58.5**	—	**1.5–2.5**	0.3	—	—	—	—	—	**Rem.**	0.7	350	—	25	CuZn40Pb2
CZ 128	Leaded brass 60 % Cu 2 % Pb	**58.5–61.0**	—	**1.5–2.5**	0.2	—	—	—	—	—	**Rem.**	0.5	350	—	25	CuZn38Pb2
CZ 129	Leaded brass 60 % Cu 1 % Pb	**58.5–61.0**	—	**0.8–1.5**	0.2	—	—	—	—	—	**Rem.**	0.5	350	—	25	CuZn39Pb1
CZ 132	Dezincification resistant brass	**Rem.**	0.2	**1.7–2.8**	0.2	—	—	**0.08–0.15**	—	—	**35.0–37.0**	0.5	280	—	30	—
CZ 135	High tensile brass with silicon	**57.0–60.0**	0.3	0.8	0.5	**1.0–2.0**	**1.5–3.5**	—	0.2	**0.3–1.3**	**Rem.**	0.5 (excluding Sn, Pb, Fe and Ni)	550	200	15	CuZn37Mn3 A12Si
CZ 136	Manganese brass	**56.0–59.0**	—	3.0	—	—	**0.5–1.5**	—	—	—	**Rem.**	0.7 (excluding Pb)	350	—	25	—
CZ 137	Leaded brass 60 % Cu 0.5 %Pb	**58.5–61.0**	—	**0.3–0.8**	0.2	—	—	—	—	—	**Rem.**	0.5	350	—	25	CuZn40Pb

NOTE For essential alloying elements, limits are in bold type. Unless otherwise stated, figures in the total impurities column include those that are not in bold type. Unless otherwise indicated all single limits are maxima.

Table 4 — Chemical composition and tensile properties of aluminium bronzes and copper-nickel alloys

BS designation	Material	Chemical composition											Total impurities	Tensile properties for forging stock and forgings			Nearest ISO designation
		Cu	Sn	Pb	Fe	Al	Mn	Ni	Si	Zn	S	C		Tensile strength min.	0.2 % proof stress min.	Elongation on $5.65\sqrt{S_o}$ min.	
		%	%	%	%	%	%	%	%	%	%	%	%	N/mm^2	N/mm^2	%	
CA 104	10 % aluminium bronze (copper-aluminium-iron-nickel)	**Rem.**	0.10	0.05	**4.0–5.5**	**8.5–11.0**	0.50	**4.0–5.5**	0.2	0.40	—	—	0.5 (excluding Mn)	700	350	14	CuAl10Ni5Fe4
CA 107	Copper-aluminium-silicon	**Rem.**	0.10	0.05[a]	**0.5–0.7**	**6.0–6.4**	0.10	0.10	**2.0–2.4**	0.40	—	—	0.5	520	220	20	CuAl7Si2
CN 102	90/10 copper-nickel-iron	**Rem.**	—	0.01	**1.00–2.00**	—	**0.50–1.00**	**10.0–11.0**	—	—[b]	0.05	0.05	0.30[b]	280	100	27	CuNi10Fe1Mn
CN 107	70/30 copper-nickel-iron	**Rem.**	—	0.01	**0.40–1.00**	—	**0.50–1.50**	**30.0–32.0**	—	—	0.08	0.06	0.30	310	100	27	CuNi30Mn1Fe

NOTE For essential alloying elements, limits are in bold type. Unless otherwise stated, figures in the total impurities column include those that are not in bold type. Unless otherwise indicated all single limits are maxima.

[a] For welding, lead should be 0.01% max.

[b] For welding, the zinc should be 0.15 % maximum and the phosphorus 0.020 % maximum (see item f) of **A.2**).

Table 5 — Alloy groups for tolerances on forging stock

BS designation	Alloy group
C 101	B
C 102	B
C 106	B
C 111	B
C 112	B
C 113	B
CC 101	B
CC 102	B
CZ 109	A
CZ 112	A
CZ 114	A
CZ 115	A
CZ 116	A
CZ 121 Pb3	A
CZ 121 Pb4	A
CZ 122	A
CZ 128	A
CZ 129	A
CZ 132	A
CZ 135	A
CZ 136	A
CZ 137	A
CA 104	B
CA 107	B
CN 102	B
CN 107	B

Table 6 — Dimensional tolerances for round forging stock

Specified diameter		Alloy group	
Over	Up to and including	Group A	Group B
mm	mm	mm	mm
6	10	± 0.08	± 0.18
10	18	± 0.14	± 0.22
18	30	± 0.16	± 0.26
30	50	± 0.20	± 0.32
50	80	± 0.37	± 0.60

Table 7 — Nominal batch sizes (masses) for sampling forging stock

Ordered nominal dimension of forging stock		Nominal batch size (mass)
Over	Up to including	
mm	mm	kg
—	12	300
12	40	600
40	80	1 200
80	—	2 500

Table 8 — Nominal batch sizes (masses) for sampling forgings

Mass of individual forgings in batch		Nominal batch size (mass)
Over	Up to and including	
kg	kg	kg
—	0.5	300
0.5	2.0	600
2.0	10.0	1 200
10.0	—	2 500

Appendix A Information to be supplied by the purchaser

A.1 It is essential that the following information is supplied by the purchaser in the enquiry and/or order to assist the manufacturer in supplying the correct material:

a) the designation of the material required (see Table 1 to Table 4);

b) the nominal dimensions for forging stock and a toleranced drawing for forgings;

c) the quantity of material required (see Appendix H for information on quantity tolerances for forgings);

d) for forgings, the condition required if different from that given in clause **12**.

A.2 The purchaser should also be aware of the importance of including the following information in the enquiry and/or order, as appropriate:

a) whether tensile tests are to be carried out (see **9.1** and **17.1**);

b) for forgings, whether they are required to pass the mercurous nitrate test (see clause **14**);

c) whether other tests are to be carried out (see **9.1** and **17.1**), and if the testing for the dezincification resistance of forging stock or forgings in CZ 132, or the testing of forgings for analysis or residual stress is required, the batch size to be used, the method of selection of samples and the provisions for retests, if permitted, for these tests;

d) whether a forgeability test is required on the forging stock and if so, the procedure for the selection and preparation of the sample, the test procedure and temperature, and the criteria for acceptance (which should be agreed with the supplier);

e) whether a statement of compliance, or a certificate of conformity of the forging stock or forgings is required (see **A.3**);

f) for alloy CN 102, whether the material is to be welded (see footnote to Table 4).

A.3 In normal commercial practice, two levels of certification of the quality of the product are available at the request of the purchaser (see item e) of **A.2**), as follows.

a) *Statement of compliance.* This is usually available from the supplier when traceability of the product is not a requirement. The goods will have been manufactured to comply with the conditions and requirements of the purchaser in accordance with the supplier's quality control procedures. The goods supplied may not themselves have been tested before delivery.

b) *Certificate of conformity.* This is normally supplied with material for which the purchaser has requested traceability to a manufacturing batch. The certificate is issued on the basis of tests, requested by the purchaser, having been carried out on the manufacturing batch from which the material supplied has been taken.

Appendix B Designations, nominal compositions and product forms specified for alloys in the BS 2870 to BS 2875 series

Designations, nominal compositions and product forms specified for alloys in the BS 2870 to BS 2875 series are given in Table 9.

Table 9 — Designations, nominal compositions and product forms specified for alloys in the BS 2870 to BS 2875 series

BS designation	Material description	Nominal composition	Specified in BS								Nearest ISO designation
			2870	2871			2872	2873	2874	2875	
				Pt 1	Pt 2	Pt 3					
C 101	Electrolytic, tough pitch high conductivity copper	99.90 % min. Cu	✓		✓		✓	✓	✓	✓	Cu-ETP
C 102	Fire refined, tough pitch high conductivity copper	99.90 % min. Cu	✓		✓		✓	✓	✓	✓	Cu-FRHC
C 103	Oxygen free, high conductivity copper	99.95 % min. Cu	✓		✓			✓	✓	✓	Cu-OF
C 104	Tough pitch non-arsenical copper	99.85 % min. Cu	✓							✓	Cu-FRTP
C 105	Tough pitch arsenical copper	99.20 % min. Cu, 0.4 % As								✓	
C 106	Phosphorus deoxidized, non-arsenical copper	99.85 % min. Cu, 0.04 % P	✓	✓	✓	✓	✓	✓	✓	✓	Cu-DHP
C 107	Phosphorus deoxidized, arsenical copper	99.20 % min. Cu, 0.4 % As, 0.04 % P			✓					✓	
C 108	Copper-cadmium	Cu-0.8 % Cd						✓		✓	CuCd1
C 109	Copper-tellurium	Cu-0.5 % Te							✓		CuTe
C 111	Copper-sulphur	Cu-0.4 % S					✓		✓		CuS
C 112	Copper-cobalt-beryllium	Cu-2.4 % Co, 0.5 % Be					✓		✓		CuCo2Be
C 113	Copper-nickel-phosphorus	Cu-1.0 % Ni, 0.2 % P					✓		✓		
CA 102	7 % aluminium bronze (Cu-Al)	Cu-7 % Al				✓				✓	CuAl7
CA 104	10 % aluminium bronze (Cu-Al-Fe-Ni)	Cu-10 % Al, 5 % Fe, 5 % Ni	✓				✓		✓		CuAl10Ni5Fe4
CA 105	10 % aluminium bronze (Cu-Al-Ni-Fe-Mn)	Cu-9.5 % Al, 5 % Ni, 2 % Fe, 1 % Mn								✓	CuAl10Fe3
CA 106	7 % aluminium bronze (Cu-Al-Fe)	Cu-7 % Al, 2 % Fe								✓	CuAl8Fe3
CA 107	6 % aluminium-silicon bronze (Cu-Al-Si)	Cu-6 % Al, 2 % Si, 0.6 % Fe					✓		✓		CuAl7Si2
CB 101	Copper-beryllium	Cu-1.8 % Be	✓					✓			CuBe1.7
CC 101	Copper-chromium	Cu-1 % Cr	✓				✓		✓		CuCr1
CC 102	Copper-chromium-zirconium	Cu-1 % Cr, 0.1 % Zr	✓				✓		✓		CuCr1Zr
CN 101	95/5 copper-nickel-iron	Cu-5 % Ni, 1.1 % Fe, 0.5 % Mn								✓	
CN 102	90/10 copper-nickel-iron	Cu-10 % Ni, 1.5 % Fe, 0.7 % Mn	✓		✓	✓	✓		✓	✓	CuNi10Fe1Mn
CN 104	80/20 copper-nickel	Cu-20 % Ni, 0.3 % Mn	✓								
CN 105	75/25 copper-nickel	Cu-25 % Ni, 0.3 % Mn	✓								CuNi25
CN 107	70/30 copper-nickel	Cu-30 % Ni, 1 % Mn, 0.7 % Fe	✓		✓	✓	✓		✓	✓	CuNi30Mn1Fe
CN 108	66/30/2/2 copper-nickel-iron-manganese	Cu-30 % Ni, 2 % Fe, 2 % Mn				✓					CuNi30Fe2Mn2

NOTE The product forms indicated take account of the alloys to be included in the revisions of BS 2871-1:1971, BS 2871-2:1972 and BS 2871-3:1972 which are in preparation.

Table 9 — Designations, nominal compositions and product forms specified for alloys in the BS 2870 to BS 2875 series

BS designation	Material description	Nominal composition	Specified in BS								Nearest ISO designation
			2870	2871			2872	2873	2874	2875	
				Pt 1	Pt 2	Pt 3					
CS 101	Copper-silicon (silicon bronze)	Cu-3 % Si, 1 % Mn					✓	✓	✓		CuSi3Mn1
CZ 101	90/10 brass	90 % Cu, remainder Zn	✓					✓			CuZn10
CZ 102	85/15 brass	85 % Cu, remainder Zn	✓					✓			CuZn15
CZ 103	80/20 brass	80 % Cu, remainder Zn	✓					✓			CuZn20
CZ 104	Leaded 80/20 brass	80 % Cu, 0.5 % Pb, remainder Zn							✓		
CZ 105	70/30 arsenical brass	71 % Cu, 0.04 % As, remainder Zn								✓	CuZn30As
CZ 106	70/30 brass	70 % Cu, remainder Zn	✓					✓		✓	CuZn30
CZ 107	2/1 brass	66 % Cu, remainder Zn	✓					✓			CuZn35
CZ 108	Common brass	63 % Cu, remainder Zn	✓		✓			✓			CuZn37
CZ 109	Lead free 60/40 brass	60 % Cu, remainder Zn					✓		✓		CuZn40
CZ 110	Aluminium brass	77 % Cu, 2 % Al, 0.04 % As, remainder Zn	✓		✓	✓				✓	CuZn20Al2
CZ 111	Admiralty brass	71 % Cu, 1.2 % Sn, 0.04 % As, remainder Zn				✓					CuZn28Sn1
CZ 112	Naval brass	62 % Cu, 1.2 % Sn, remainder Zn	✓				✓		✓	✓	CuZn38Sn1
CZ 114	High tensile brass	58 % Cu, 1 % Pb, 1 % Mn, 1 % Al, 0.7 % Fe, 0.5 % Sn, remainder Zn					✓		✓		CuZn39AlFeMn
CZ 115	High tensile brass (restricted aluminium)	58 % Cu, 1 % Pb, 1 % Mn, 0.7 % Fe, 0.5 % Sn, remainder Zn					✓		✓		CuZn39AlFeMn
CZ 116	High tensile brass	65 % Cu, 4.5 % Al, 1 % Mn, 1 % Fe, remainder Zn					✓		✓		
CZ 118	Leaded brass, 64 % copper, 1 % lead	64 % Cu, 1 % Pb, remainder Zn	✓								CuZn35Pb1
CZ 119	Leaded brass, 62 % copper, 2 % lead	62 % Cu, 2 % Pb, remainder Zn	✓		✓			✓			CuZn37Pb2
CZ 120	Leaded brass, 59 % copper, 2 % lead	59 % Cu, 2 % Pb, remainder Zn	✓								CuZn38Pb2
CZ 121 Pb3	Leaded brass, 58 % copper, 3 % lead	58 % Cu, 3 % Pb, remainder Zn					✓		✓		CuZn39Pb3
CZ 121 Pb4	Leaded brass, 58 % copper, 4 % lead	58 % Cu, 4 % Pb, remainder Zn					✓		✓		CuZn38Pb4
CZ 122	Leaded brass, 58 % copper, 2 % lead	58 % Cu, 2 % Pb, remainder Zn					✓		✓		CuZn40Pb2
CZ 123	60/40 brass, low lead	60 % Cu, 0.5 % Pb, remainder Zn	✓							✓	CuZn40Pb
CZ 124	Leaded brass, 62 % copper, 3 % lead	62 % Cu, 3 % Pb, remainder Zn							✓		CuZn36Pb3
CZ 125	Cap copper	96 % Cu, remainder Zn	✓								CuZn5
CZ 126	Special 70/30 arsenical brass	70 % Cu, 0.04 % As, remainder Zn			✓	✓					CuZn30As
CZ 127	Aluminium-nickel-silicon-brass	83 % Cu, 1 % Al, 1 % Ni, 1 % Si, remainder Zn			✓						

Table 9 — Designations, nominal compositions and product forms specified for alloys in the BS 2870 to BS 2875 series

BS designation	Material description	Nominal composition	Specified in BS							Nearest ISO designation
			2870	2871			2872	2873	2874	2875	
				Pt 1	Pt 2	Pt 3					
CZ 128	Leaded brass, 60 % copper, 2 % lead	60 % Cu, 2 % Pb, remainder Zn					✓		✓		CuZn38Pb2
CZ 129	Leaded brass, 60% copper, 1 % lead	60 % Cu, 1 % Pb, remainder Zn					✓		✓		CuZn39Pb1
CZ 130	Leaded brass for sections	56 % Cu, 3 % Pb, 0.3 % Al, remainder Zn							✓		CuZn43Pb2
CZ 131	Leaded brass, 62 % copper, 2 % lead	62 % Cu, 2 % Pb, remainder Zn							✓		CuZn37Pb2
CZ 132	Dezincification resistant brass	62 % Cu, 2 % Pb, 0.1 % As, remainder Zn					✓		✓		
CZ 133	Naval brass (uninhibited)	60 % Cu, 0.7 % Sn, remainder Zn							✓		
CZ 134	Naval brass (high leaded)	60 % Cu, 2 % Pb, 0.7 % Sn, remainder Zn							✓		
CZ 135	High tensile brass with silicon	58 % Cu, 2 % Mn, 1.5 % Al, 1 % Si, remainder Zn					✓		✓		CuZn37Mn3Al2Si
CZ 136	Manganese brass	57 % Cu, 2 % Pb, 1 % Mn, remainder Zn					✓		✓		
CZ 137	Leaded brass, 60 % copper, 0.5 % lead	60 % Cu, 0.5 % Pb, remainder Zn					✓		✓		CuZn40Pb
NS 101	Leaded, 10 % nickel brass	45 % Cu, 10 % Ni, 2 % Pb, 0.3 % Mn, remainder Zn							✓		CuNi10Zn42Pb2
NS 103	10 % nickel silver	63 % Cu, 10 % Ni, 0.2 % Mn, remainder Zn	✓					✓			CuNi10Zn27
NS 104	12 % nickel silver	63 % Cu, 12 % Ni, 0.2 % Mn, remainder Zn	✓					✓			CuNi12Zn24
NS 105	15 % nickel silver	63 % Cu, 15 % Ni, 0.2 % Mn, remainder Zn	✓					✓			CuNi15Zn21
NS 106	18 % nickel silver	63 % Cu, 18 % Ni, 0.2 % Mn, remainder Zn	✓					✓			CuNi18Zn20
NS 107	18 % nickel silver (low copper)	55 % Cu, 18 % Ni, 0.2 % Mn, remainder Zn	✓					✓			CuNi18Zn27
NS 108	20 % nickel silver	63 % Cu, 20 % Ni, 0.3 % Mn, remainder Zn						✓			
NS 109	25 % nickel silver	57 % Cu, 25 % Ni, 0.5 % Mn, remainder Zn						✓			
NS 111	Leaded 10 % nickel silver	60 % Cu, 10 % Ni, 1.5 % Pb, 0.3 % Mn, remainder Zn	✓								CuNi10Zn28Pb1
PB 101	4 % phosphor bronze	Cu-4 % Sn, 0.2 % P	✓							✓	CuSn4
PB 102	5 % phosphor bronze	Cu-5 % Sn, 0.2 % P	✓					✓	✓	✓	CuSn5
PB 103	7 % phosphor bronze	Cu-7 % Sn, 0.2 % P	✓					✓			CuSn6
PB 104	8 % phosphor bronze	Cu-8 % Sn, 0.2 % P							✓		CuSn8

Appendix C Conversion of stress units

Conversions of stress in N/mm^2 to kgf/mm^2, $tonf/in^2$ and lbf/in^2 are given in Table 10.

Table 10 — Conversion of stress in N/mm^2 to kgf/mm^2, $tonf/in^2$ and lbf/in^2

N/mm^2	kgf/mm^2	$tonf/in^2$	lbf/in^2	N/mm^2	kgf/mm^2	$tonf/in^2$	lbf/in^2
80	8.0	5.0	11 500	310	31.5	20.0	44 500
95	9.5	6.0	14 000	320	32.5	20.5	46 000
105	10.5	7.0	15 000	325	33.0	21.0	47 000
110	11.0	7.0	16 000	330	33.5	21.5	48 000
115	11.5	7.5	16 500	340	34.5	22.0	49 000
125	12.5	8.0	18 000	345	35.0	22.5	50 500
130	13.5	8.5	19 000	350	35.5	22.5	50 500
155	16.0	10.0	22 500	355	36.0	23.0	51 500
160	16.5	10.5	23 000	370	37.5	24.0	54 000
185	19.0	12.0	27 000	380	38.5	24.5	55 000
195	20.0	12.5	28 500	385	39.5	25.0	56 000
215	22.0	14.0	31 000	395	40.5	25.5	57 000
225	23.0	14.5	32 500	400	41.0	26.0	58 000
230	23.5	15.0	33 500	410	42.0	26.5	59 500
240	24.5	15.5	35 000	435	44.5	28.0	63 500
245	25.0	16.0	35 500	465	47.5	30.0	67 000
250	25.5	16.0	36 500	485	49.5	31.5	69 500
260	26.5	17.0	37 500	495	50.5	32.0	72 000
265	27.0	17.0	38 500	510	52.0	33.0	74 000
270	27.5	17.5	39 000	525	53.5	34.0	76 000
275	28.0	18.0	40 500	540	55.0	35.0	78 500
280	28.5	18.0	40 500	550	56.0	35.5	80 000
290	29.5	19.0	41 500	650	66.5	42.0	94 500
295	30.0	19.0	42 000	700	71.5	45.5	101 500
305	31.0	19.5	43 500				

NOTE 1 Conversions have been rounded to the following degree of accuracy: kgf/mm^2 and $tonf/in^2$ to the nearest 0.5 unit; lbf/in^2 to the nearest 500 lbf/in^2.

Conversion factors:
1 N/mm^2 = 1 MN/m^2 = 10 bar = 0.1 h bar = 0.101972 kgf/mm^2 = 0.064749 $tonf/in^2$ = 145.038 lbf/in^2.

NOTE 2 For more detailed conversions see BS 350.

Appendix D The rounding of numbers rule

For the purposes of determining compliance with compositional limits and mechanical properties (not dimensional tolerances), an observed value or a calculated value obtained from the analysis or test is rounded to the same number of decimal places as used in the relevant standard in expressing the specified limit. The following rules, based on those given in BS 1957, should be used for rounding.

a) If the figure immediately after the last figure to be retained is less than five, the last figure to be retained should be kept unchanged.

b) If the figure immediately after the last figure to be retained is either greater than five, or equal to five and followed by at least one figure other than zero, the last figure to be retained should be increased by one.

c) If the figure immediately after the last figure to be retained is equal to five and followed by zeros only, the last figure to be retained should be left unchanged if even and increased by one if odd.

Appendix E Methods for the determination of tensile properties

E.1 Tensile strength

E.1.1 *General*

Prepare the tensile test piece from the test sample of the product in accordance with **E.1.2** and **E.1.3**.

Carry out the tensile test on the prepared test piece in accordance with the method in BS 18.

E.1.2 *Shape of the test piece*

From the test sample machine a proportional test piece of circular, square or rectangular cross section to the dimensions given in BS 18.

NOTE Products having a constant cross section may be tested without being machined provided a proportional gauge length of $5.65\sqrt{S_o}$ is used.

E.1.3 *Location of the test piece in the test sample of the product*

Machine the test pieces (**E.1.2**) from the following locations in the test samples of the product.

a) For test samples from forging stock up to and including 30 mm in diameter, or minor cross-sectional dimension, machine the test piece axially.

b) For test samples from forging stock over 30 mm up to and including 75 mm in diameter, or minor cross-sectional dimension, machine the test piece so that the longitudinal axis of the test piece is parallel to, and not less than 15 mm from, the surface of the test sample.

c) For test samples from forging stock over 75 mm in diameter, or minor cross-sectional dimension, machine the test piece so that the longitudinal axis of the test piece lies midway between the surface furthest from the centre and the centre of the test sample.

d) For forgings, machine proportional test pieces to the dimensions of one of the standard machined test pieces given in BS 18, such that the axis of the test piece is parallel to the major dimension of the forging.

E.2 Test for 0.2 % proof stress

Test the test pieces, prepared in accordance with **E.1.2** and **E.1.3**, in accordance with the method for proof stress determination given in BS 18. If in determining the proof stress a small tensioning stress is applied, ensure that it is equal to approximately 20 % of the specified minimum proof stress, but does not exceed 45 N/mm^2.

Appendix F Method of test to establish dezincification resistance of material designated CZ 132

F.1 Principle

The susceptibility of a brass specimen to dezincification is determined by immersing the specimen in a controlled test solution for a fixed time, followed by microscopic examination of sections of the specimen to measure the depth of dezincification that has occurred.

F.2 Reagents

F.2.1 *Test solution.* Copper (II) chloride solution prepared by the following method. Dissolve 12.7 g $CuCl_2.2H_2O$ (analytical quality) in distilled or demineralized water and dilute to 1 000 mL. Mix well.

F.2.2 *Ethanol or methanol,* for cleaning test pieces.

F.3 Apparatus

F.3.1 *Optical microscope with scale,* to provide a suitable magnification (a combination of × 100 and × 500 is satisfactory) and a method of measurement of dezincification depth.

NOTE An eyepiece graticule calibrated using a stage graticule is satisfactory for measuring the depth.

F.3.2 *Water bath or oil bath,* thermostatically controlled to a temperature of 75 ± 3 °C.

F.3.3 *Glass beaker,* covered with plastics film or other seal of inert non-metallic material.

F.3.4 *Material for mounting specimens,* e.g. phenolic resins or materials with similar properties and not electrically conductive.

F.3.5 *Waterproof abrasive paper,* in a range of grit sizes down to 500 grade or finer.

F.3.6 *Diamond polishing paste,* grit size 1 μm or less.

F.4 Procedure

F.4.1 ***Preparation of test pieces***

Take two test pieces from each sample supplied for testing in such a way that the properties of the material are unaffected (e.g. by sawing and grinding with light pressure).

For forgings and castings take one test piece from the area with the thinnest section and one from the area with the thickest section.

For materials with a specific extrusion or rolling direction (e.g. tube, rod or section), take one test piece to expose a surface parallel to, and the other piece to expose a surface perpendicular to, the extrusion or rolling direction [see Figure 1 a)]. Cut test pieces from rod samples in such a way as to include points midway between the axis and the periphery.

For each test piece ensure that the area to be exposed to the test solution is approximately 100 mm^2. If the size of the component or the cross section of the rod to be tested is too small to provide test areas of this size take the largest possible test area.

Embed the test pieces in the mounting medium (**F.3.4**) and grind the test surface using successively finer grades of wet abrasive paper (**F.3.5**), finishing with 500 grade or finer.

F.4.2 ***Exposure of samples to the test solution***

Clean the test surfaces with ethanol or methanol (**F.2.2**). Place a beaker (**F.3.3**) containing fresh test solution (**F.2.1**) in the water bath or oil bath (**F.3.2**). Maintain the temperature of the test solution during the entire exposure at 75 ± 3 °C. Use at least 250 mL of the test solution for each 100 mm^2 of exposed test piece surface.

Place the test pieces in the beaker (**F.3.3**) containing the test solution in such a way that the test surface is vertical and at least 15 mm above the bottom of the beaker. Do not test different alloys simultaneously in the same beaker.

After 24 h, remove the test pieces from the beaker and wash in distilled or demineralized water to remove residual test solution from the surface.

F.4.3 ***Preparation of microsections for examination***

Resection each of the test pieces in the mount at right angles to the exposed test surface [see Figure 1 b)]. Embed each of these test piece sections in the mounting medium (**F.3.4**) such that the resectioned surface can be examined [see Figure 1 c)]. Grind the surfaces of these microsections using successively finer grades of wet abrasive paper (**F.3.5**), finishing with 500 grade or finer.

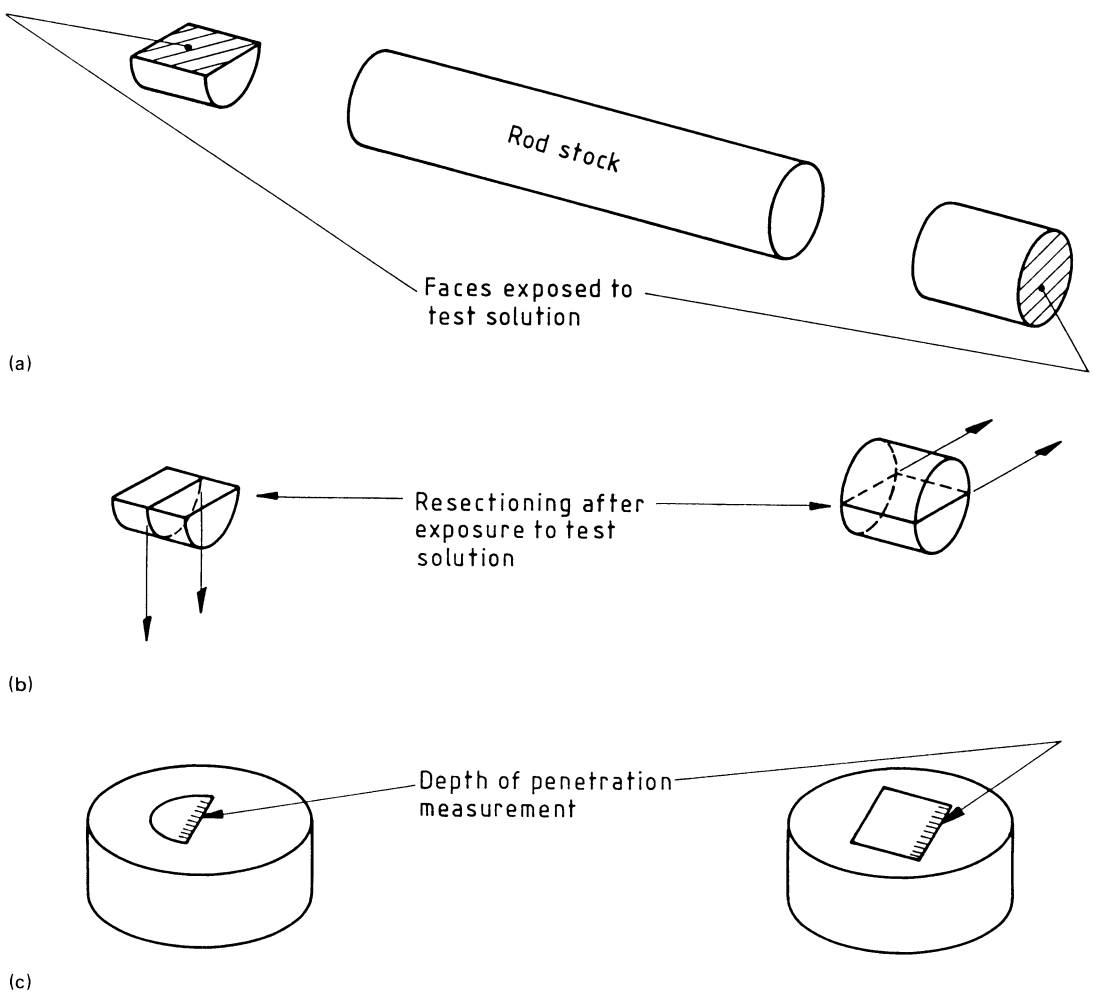

Figure 1 — Illustration of dezincification resistance test

F.4.4 ***Examination of microsections and recording of dezincification depth***

Carry out final polishing of the microsections with diamond paste of particle size 1 µm or less (**F.3.6**), using a suitable light oil lubricant. Clean the microsections in ethanol or methanol (**F.2.2**) after polishing and ensure freedom from stains and tarnishing.

Using the microscope (**F.3.1**), examine the microsection prepared from each test area and record the depth of dezincification, adjusting the degree of magnification to ensure the greatest accuracy. Examine a total length of section of 5 mm for each of the test pieces (10 mm for rod over 25 mm diameter). If this is not possible, due to the dimensions of the test area, examine the maximum possible length of the section and record this length when reporting the results.

NOTE In some cases there is a greater depth of dezincification along the line of the interface between the mounting material and the brass during exposure to the test solution (edge effect). Ensure that the measurement of the maximum depth of dezincification is at a sufficient distance from this interface for edge effects to be negligible.

Appendix G Method for the detection of residual stress by the mercurous nitrate test

G.1 Principle

The test specimen is degreased and cleaned. The presence of an unacceptable level of residual (internal) stress in the test specimen is revealed by the development of cracks when it is immersed in an acidified mercury (I) nitrate solution.

G.2 Reagents

G.2.1 *Nitric acid,* ρ 1.42 g/mL, 50 % *V/V* aqueous solution.

G.2.2 *Mercury (I) nitrate test solution.* Dissolve 11.4 g of mercury (I) nitrate dihydrate ($HgNO_3.2H_2O$) or 10.7 g of mercury (I) nitrate monohydrate ($HgNO_3.H_2O$) in approximately 40 mL distilled water acidified with 10 mL nitric acid (ρ1.42 g/mL). When the crystals are completely dissolved, dilute the solution with distilled water to 1 000 mL.

NOTE If heating is used to aid dissolution care should be exercised to prevent loss of nitric acid.

WARNING. Mercury (I) nitrate is highly toxic and should be treated with due care.

G.3 Procedure

Ensure that the test specimen is not marked for identification by indenting. During the selection and preparation of the test specimen, take precautions to ensure that it is not subjected to mechanical working that could raise the level of internal stress in the specimen, such as bending or straightening.

Degrease the specimen (e.g. in acetone). Totally immerse it in 50 % *V/V* nitric acid solution (**G.2.1**) for a period not exceeding 30 s to remove all traces of carbonaceous matter and oxide films.

Remove the specimen, wash it well in cold water and totally immerse it in the mercury (I) nitrate test solution (**G.2.2**). Use at least 1.5 mL of test solution for each 100 mm^2 of exposed surface of the specimen.

After 30 min, remove the specimen and wash it well in cold water. Wipe off excess mercury from the surface of the specimen and examine the specimen immediately for evidence of cracks with the unaided eye, corrected for normal vision if necessary.

Appendix H Quantity tolerances for forgings

Quantity tolerances for forgings, i.e. the permissible over/under-run allowed on each order, are given for information in Table 11. Any delivery quantity within the limits of over/under-run given in Table 11 should be considered as completing the order. Intermediate quantities should be assessed pro rata to the nearest smaller quantity shown in the table. The tolerances given in the table are those adopted by the National Association of Drop Forgers and Stampers, and are given for information only.

Table 11 — Quantity tolerances for forgings

Number of pieces ordered	Quantity tolerance	
	Over-run piece	Under-run piece
Up to 50	4	2
Up to 100	6	3
Up to 300	18	9
Up to 600	24	12
Up to 1 000	40	20
Up to 5 000	100	50
Up to 10 000	200	100
Up to 15 000	300	150
Up to 20 000	400	200
Any quantity over 25 000	500	250

Publications referred to

BS 18, *Method for tensile testing of metals (including aerospace materials).*
BS 350, *Conversion factors and tables.*
BS 1957, *Presentation of numerical values (fineness of expression; rounding of numbers).*
BS 2870, *Specification for rolled copper and copper alloys: sheet, strip and foil.*
BS 2871, *Specification for copper and copper alloys. Tubes.*
BS 2873, *Specification for copper and copper alloys. Wire.*
BS 2874, *Specification for copper and copper alloy rods and sections (other than forging stock).*
BS 2875, *Specification for copper and copper alloys. Plate.*

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