BS EN 12452:2012

BSI Standards Publication

Copper and copper alloys — Rolled, finned, seamless tubes for heat exchangers

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National foreword

This British Standard is the UK implementation of EN 12452:2012. It supersedes BS EN 12452:1999 which is withdrawn.

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

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

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

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

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Date	Text affected

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NORME EUROPÉENNE

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EN 12452

May 2012

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Supersedes EN 12452:1999

English Version

Copper and copper alloys - Rolled, finned, seamless tubes for heat exchangers

Cuivre et alliages de cuivre - Tubes sans soudure à ailettes pour échangeurs thermiques

Kupfer und Kupferlegierungen - Nahtlose, gewalzte Rippenrohre für Wärmeaustauscher

This European Standard was approved by CEN on 20 April 2012.

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Contents

Page

Foreword

This document (EN 12452:2012) has been prepared by Technical Committee CEN/TC 133 “Copper and copper alloys”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2012, and conflicting national standards shall be withdrawn at the latest by November 2012.

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 12452:1999.

This document 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 Pressure Equipment Directive (PED).

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

In comparison with EN 12452:1999, the following significant technical changes were made:

a) addition of material condition R250 for Cu-DHP;

b) replacement of sampling rate in Table 6.

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

EN 12452:1999, *Copper and copper alloys — Rolled, finned, seamless tubes for heat exchangers*

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

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

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

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

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

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

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

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

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

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

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard specifies the composition, property requirements and tolerances on dimensions and form for rolled, finned, seamless copper and copper alloy tubes for heat exchangers. It is applicable to copper and copper alloy tubes supplied in the size range from 6 mm up to and including 35 mm outside diameter; from 1 mm up to and including 3 mm wall thickness of the unfinned section; and with fin height up to and including 1,5 mm.

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

2 Normative references

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

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

EN 1971-1, *Copper and copper alloys — Eddy current test for measuring defects on seamless round copper and copper alloy tubes — Part 1: Test with an encircling test coil on the outer surface*

EN 1971-2, *Copper and copper alloys — Eddy current test for measuring defects on seamless round copper and copper alloy tubes — Part 2: Test with an internal probe on the inner surface*

EN 10204:2004, *Metallic products — Types of inspection documents*

EN 16090, *Copper and copper alloys — Estimation of average grain size by ultrasound*

EN ISO 196, *Wrought copper and copper alloys — Detection of residual stress — Mercury (I) nitrate test (ISO 196)*

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

EN ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method (ISO 6507-1)*

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

EN ISO 8493, *Metallic materials — Tube — Drift-expanding test (ISO 8493)*

ISO 6957, *Copper alloys — Ammonia test for stress corrosion resistance*

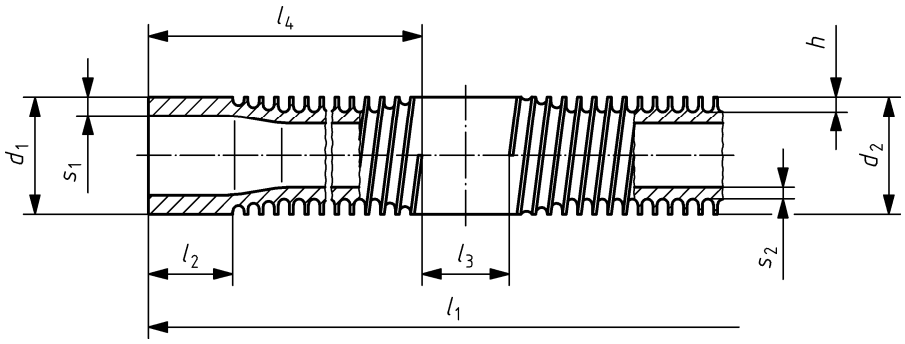
3 Terms and definitions

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

3.1
rolled finned tube
tube having a series of helical integral fins on the outside surface, produced by cold forming

Note 1 to entry: See Figure 1.

The inside surface can be specially shaped.



where

d_1 is the outside diameter of unfinned section;

d_2 is the outside diameter of finned section;

l_1 is the total tube length;

l_2 is the length of unfinned tube end;

l_3 is the length of unfinned intermediate section;

l_4 is the distance from tube end to the unfinned intermediate section;

h is the fin height;

s_1 is the wall thickness of unfinned section;

s_2 is the wall thickness of finned section.

Figure 1 — Rolled finned tube

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

[SOURCE: EN 1057:2006+A1:2010, 3.6]

4 Designations

4.1 Material

4.1.1 General

The material is designated either by symbol or by number (see Table 1).

4.1.2 Symbol

The material symbol designation is based on the designation system given in ISO 1190-1.

NOTE Although material symbol designations used in this European Standard might be the same as those in other standards using the designation system given in ISO 1190-1, the detailed composition requirements are not necessarily the same.

4.1.3 Number

The material number designation is in accordance with the system given in EN 1412.

4.2 Material condition

For the purposes of this European Standard, the following designations, which are in accordance with the system given in EN 1173, apply for the material condition:

R... Material condition designated by the minimum value of tensile strength requirement for the product with mandatory tensile property requirements;

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

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

NOTE Products in the R... or H... condition can be specially processed (i.e. mechanically or thermally stress relieved) in order to lower the residual stress level to improve the resistance to stress corrosion (see 6.6.2).

Exact conversion between material conditions designated R... and H... is not possible.

Except when the suffix S is used, the material condition is designated by only one of the above designations.

4.3 Product

The product designation provides a standardized pattern of designation from which a rapid and unequivocal description of a product can be conveyed in communication. It provides mutual comprehension at the international level with regard to products which meet the requirements of the relevant European Standard.

The product designation is no substitute for the full content of the standard.

The product designation for products to this European Standard shall consist of:

— denomination (Tube);

— number of this European Standard (EN 12452);

— material designation, either symbol or number (see Table 1);

— material condition designation (see Table 2);

— nominal cross-sectional dimensions expressed as outside diameter and wall thickness of the tube before finning (see 6.3);

— fin pitch (N), (number of fins per inch) and fin height (H).

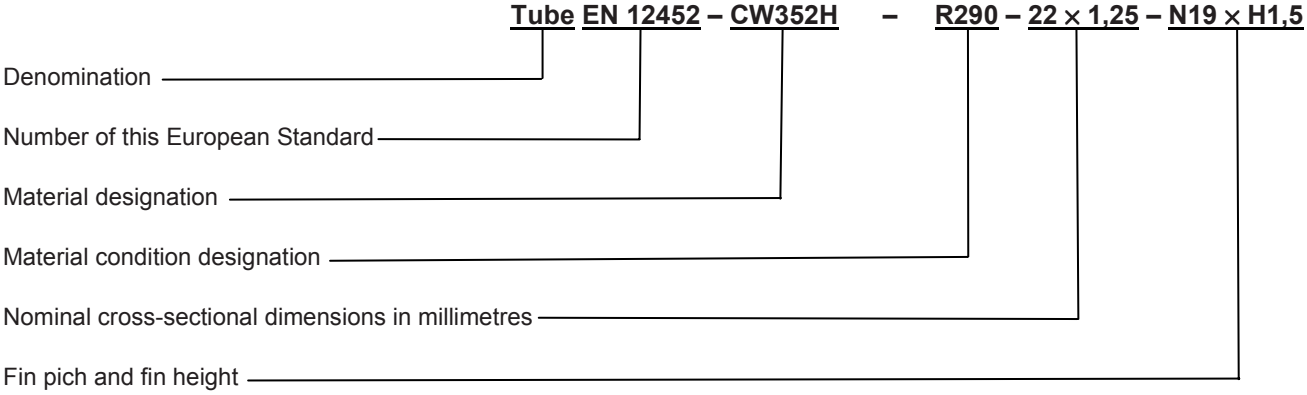
The derivation of a product designation is shown in the following example.

EXAMPLE Tube conforming to this European Standard, in material designated either CuNi10Fe1Mn or CW352H, in material condition R290, with nominal outside diameter 22 mm, nominal wall thickness 1,25 mm, number of fins per inch 19 and fin height 1,5 mm, shall be designated as follows:

Tube EN 12452 – CuNi10Fe1Mn – R290 – 22 × 1,25 – N19 × H1,5

or

Tube EN 12452 – CW352H – R290 – 22 × 1,25 – N19 × H1,5



5 Ordering information

In order to facilitate the enquiry, order and confirmation of order procedures between the purchaser and the supplier, the purchaser shall state on his enquiry and order the following information:

a) quantity of product required (number of pieces or length);

b) denomination (Tube);

c) number of this European Standard (EN 12452);

d) material designation (see Table 1);

e) material condition designation (see 4.2 and Table 2);

f) nominal cross-sectional dimensions (outside diameter × wall thickness);

g) fin pitch (N) and fin height (H);

h) lengths: total tube length (l_1 in Figure 1), length of unfinned tube ends, if required (l_2 in Figure 1), length and location of unfinned intermediate section, if required (l_3 and l_4 in Figure 1).

NOTE 1 It is recommended that the product designation, as described in 4.3, be used for items b) to g).

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

i) whether a specially shaped inside surface is required;

NOTE 2 Details should be agreed between the purchaser and the supplier.

j) whether the tubes are for subsequent welding applications (see Table 1);

k) whether the tubes are for sea water application (see Table 1), and if so, the composition limits required;

l) which test method is to be used for the freedom from defects test, if the choice is not to be left to the discretion of the manufacturer;

m) whether deburring is required (see 6.5);

n) whether eddy current test sensitivity other than that specified in Annex A is required (see A.1.6);

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

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

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

EXAMPLE Ordering details for 100 tubes conforming to EN 12452, in material designated either CuNi10Fe1Mn or CW352H, in material condition R290, with nominal outside diameter 22 mm, nominal wall thickness 1,25 mm, number of fins per inch 19, fin height 1,5 mm and nominal length 3 000 mm:

100 pieces Tube EN 12452 – CuNi10Fe1Mn – R290 – 22 × 1,25 – N19 × H1,5
– nominal length 3 000 mm

or

100 pieces Tube EN 12452 – CW352H – R290 – 22 × 1,25 – N19 × H1,5
– nominal length 3 000 mm

6 Requirements

6.1 Composition

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

6.2 Mechanical properties

The properties shall conform to the appropriate requirements given in Table 2. The tests shall be carried out in accordance with 8.2 (tensile test) or 8.3 (hardness test).

NOTE After the fins have been rolled, the finned sections of the tube are in a work-hardened or "as finned" condition. Tubes made from materials liable to stress corrosion cracking [CuZn20Al2As (CW702R) and CuZn28Sn1As (CW706R)] are given a stress relieving anneal after the fins have been rolled (see 6.6.2).

6.3 Dimensions and tolerances

6.3.1 General

The geometrical properties of the tubes are defined by outside diameter, wall thickness, fin height, fin pitch and length.

The dimensional tolerances are applied on the outside diameter, wall thickness, fin height, length and fin pitch, if not otherwise agreed between the purchaser and the supplier.

6.3.2 Outside diameter

The outside diameter of the tubes, including deviation from circular form, at any unfinned cross-section, shall conform to the tolerances given in Table 3. The diameter over the fins shall not exceed the permissible outside diameter of the unfinned section of the tubes, at any point.

6.3.3 Wall thickness

The wall thickness, measured at any point, beneath the fins and in the unfinned sections, shall not differ by more than ± 10 % from the nominal wall thickness stated on the order [see Clause 5, list entry f)].

6.3.4 Fin height

The fin height outside the length of transition taper shall not differ by more than ± 10 % from the nominal fin height stated on the order [see Clause 5, list entry g)].

6.3.5 Length

The total length (l_1 in Figure 1) of the tubes shall conform to the tolerances given in Table 4.

The length of the unfinned ends l_2, as measured from the tube end to the first fin disc impression (i.e. the first detectable deformation by a fin rolling tool), shall not differ by more than $^{+5}_{0}$ mm from the nominal length stated on the order [see Clause 5, list entry h)].

The length(s) of the unfinned section(s) l_3, as measured from the first nearest fin disc impression, shall not differ by more than $^{+5}_{0}$ mm from the nominal length stated on the order [see Clause 5, list entry h)].

The distance from tube end to unfinned intermediate section(s) l_4 shall not differ by more than ± 3 mm from the nominal length stated on the order [see Clause 5, list entry h)].

The length of the unfinned portions should exceed the dimensions stated in the drawing by no more than 12 mm.

6.3.6 Fin pitch

The number of fins per inch shall conform to the tolerances given in Table 5.

6.4 Tolerances on form

6.4.1 Deviation from circular form

The deviation from circular form is included in the tolerance on diameter given in Table 3.

6.4.2 Straightness

The depth of the arc measured in any 1 m portion of length shall be not greater than 3 mm.

6.5 Surface quality

The external and internal surfaces of the unfinned tubes shall be clean and smooth and shall display neither manufacturing flaws nor mechanical damage which would be detrimental to the intended application.

The tubes may have a superficial film of drawing lubricant or, if annealed or thermally stress relieved, a superficial, dull, iridescent oxide film, securely adhered to both the internal and external surfaces.

Discontinuous irregularities on the external and internal surfaces of the tubes are permitted if they are within the dimensional tolerances. Cracks in the fins are permitted as long as they do not interfere with the thickness of finned section (s_2 in Figure 1).

If deburring of the cut ends of the tubes is required, it shall be agreed between the purchaser and the supplier [see Clause 5, list entry m)].

6.6 Technological requirements

6.6.1 Drift expanding

No crack shall be visible to the unaided eye, corrected for normal vision if necessary, when the unfinned sections of the tubes in the annealed condition are tested in accordance with 8.4.1.

6.6.2 Residual stress level

No crack shall be visible to the unaided eye, corrected for normal vision if necessary, when CuZn20Al2As (CW702R) or CuZn28Sn1As (CW706R) alloy tubes in the stress relieved condition are tested in accordance with 8.4.2. Cracking associated with the end of a sample shall be ignored.

6.6.3 Grain size

The average grain size in the unfinned section of tubes shall be in the range 0,010 mm up to and including 0,050 mm. The test shall be carried out in accordance with 8.4.3.

6.6.4 Freedom from defects

When tested in accordance with 8.5 the tubes shall be leak tight and shall have no detrimental defects.

7 Sampling

7.1 General

For the purpose of demonstrating conformity of this European Standard to the requirements of Clause 6, the sampling rate to be taken at random shall be in accordance with Table 6.

Results may be used from analyses carried out at an earlier stage of manufacturing the product, e.g. at the casting stage, if the material identity is maintained.

NOTE For the purpose of demonstrating maintained material identity it is recommended to certify the quality management system of the manufacturer, e.g. as conforming to EN ISO 9001.

7.2 Analysis

The sampling rate shall be in accordance with Table 6. A test sample, depending on the analytical technique to be employed, shall be prepared from each sampling unit and used for the determination of the composition.

NOTE 1 When preparing the test sample, care should be taken to avoid contaminating or overheating the test sample. Carbide tipped tools are recommended; steel tools, if used, should be made of magnetic material to assist in the subsequent removal of extraneous iron. If the test samples are in finely divided form (e.g. drillings, millings), they should be treated carefully with a strong magnet to remove any particles of iron introduced during preparation.

NOTE 2 In cases of dispute concerning the results of analysis, the full procedure given in ISO 1811-2 should be followed.

7.3 Mechanical tests and stress corrosion resistance test

The sampling rate shall be in accordance with Table 6. Sampling units shall be selected from the finished products. The test samples shall be cut from the sampling units. Test samples, and test pieces prepared from them, shall not be subjected to any further treatment, other than any machining operations necessary in the preparation of the test pieces.

8 Test methods

8.1 Analysis

Analysis shall be carried out on the test pieces, or test portions, prepared from the test samples obtained in accordance with 7.2. Except in cases of dispute, the analytical methods used shall be chemical or spectrographic according to EN or ISO standards in force. For expression of results, the rounding rules given in 8.7 shall be used.

NOTE In cases of dispute concerning the results of analysis, the method of analysis to be used should be chemical.

8.2 Tensile test

Prior to finning operations, the tube shall conform to the requirements for tensile properties prescribed in Table 2. The tensile properties shall be determined in accordance with EN ISO 6892-1 on test pieces obtained in accordance with 7.3.

8.3 Hardness test

Hardness shall be determined on the test pieces prepared from the test samples obtained in accordance with 7.3. The test shall be carried out in accordance with EN ISO 6507-1 and the indentation made on the outside surface, unless otherwise agreed.

8.4 Technological tests

8.4.1 Drift expanding test

When required, the drift expanding test shall be carried out in accordance with EN ISO 8493. The outside diameter of the tube end shall be expanded by 25 % using a conical mandrel with an angle of 45°.

8.4.2 Stress corrosion resistance test

The test method given in either EN ISO 196 or ISO 6957 shall be used on the test pieces prepared from the test samples obtained in accordance with 7.3. The choice as to which of these tests are used shall be at the discretion of the supplier.

8.4.3 Average grain size determination

The estimation of average grain size shall be carried out in accordance with EN ISO 2624 or EN 16090.

8.5 Freedom from defects tests

Each tube shall be subjected to one of the following tests:

— eddy current test: in accordance with EN 1971-1 or EN 1971-2 and the calibration requirements specified in A.1;

— hydrostatic test: in accordance with the method described in A.2;

— pneumatic test: in accordance with the method described in A.3.

If not otherwise agreed between the purchaser and the supplier, the decisions regarding which of the test methods are to be used and the method of testing shall be at the discretion of the manufacturer.

8.6 Retests

8.6.1 Analysis, tensile, hardness, drift expanding and grain size tests

If there is a failure of one, or more than one, of the tests in 8.1, 8.2, 8.3, 8.4.1 or 8.4.3, two test samples from the same inspection lot shall be permitted to be selected for retesting the failed property (properties). One of these test samples shall be taken from the same sampling unit as that from which the original failed test piece was taken, unless that sampling unit is no longer available, or has been withdrawn by the manufacturer.

If the test pieces from both test samples pass the appropriate test(s), then the inspection lot represented shall be deemed to conform to the particular requirement(s) of this European Standard. If a test piece fails a test, the inspection lot represented shall be deemed not to conform to this European Standard.

8.6.2 Stress corrosion resistance test

If a test piece fails the test, the inspection lot represented by the failed test piece shall be permitted to be subjected to a stress relieving treatment. A further test sample shall then be selected in accordance with 7.3.

If a test piece from the further test sample passes the test, the stress relieved material shall be deemed to conform to the requirements of this European Standard for residual stress level; it shall then be subjected to all the other tests called for on the purchase order, except for analysis. If the test piece from the further test sample fails the test, the stress relieved material shall be deemed not to conform to this European Standard.

8.7 Rounding of results

For the purpose of determining conformity to the limits specified in this standard, an observed or a calculated value obtained from a test shall be rounded in accordance with the following procedure, which is based upon the guidance given in ISO 80000-1:2009, Annex B. It shall be rounded in one step to the same number of figures used to express the specified limit in this European Standard. Except for tensile strength and 0,2 % proof strength, the rounding interval shall be 10 N/mm^2 [1)] and for elongation the value shall be rounded to the nearest 1 %.

The following rules shall be used for rounding:

a) if the figure immediately after the last figure to be retained is less than 5, the last figure to be retained shall be kept unchanged;

b) if the figure immediately after the last figure to be retained is equal to or greater than 5, the last figure to be retained shall be increased by one.

9 Declaration of conformity and inspection documentation

9.1 Declaration of conformity

When requested by the purchaser [see Clause 5, list entry o)] and agreed with the supplier, the supplier shall issue for the products the appropriate declaration of conformity in accordance with EN 1655.

9.2 Inspection documentation

When requested by the purchaser [see Clause 5, list entry p)] and agreed with the supplier, the supplier shall issue for the products the appropriate inspection document in accordance with EN 10204:2004.

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

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

10 Marking, packaging, labelling

Unless otherwise specified by the purchaser and agreed by the supplier, the marking, packaging and labelling shall be left to the discretion of the supplier [see Clause 5, list entry q)].

Table 1 — Composition of copper and copper alloys

Material designation		Composition % (mass fraction)															Density [a] g/cm^3
Symbol	Number	Element	Cu	Al	As	C	Co	Fe	Mn	Ni	P	Pb	S	Sn	Zn	others total	approx.
Cu-DHP	**CW024A**	min.	99,90 [b]	—	–	—	—	—	—	—	0,015	—	—	—	—	—	8,9
		max.	—	—	–	—	—	—	—	—	0,040	—	—	—	—	—	
CuNi10Fe1Mn [c]	**CW352H** [c]	min.	Rem.	—	–	—	—	1,0 [e]	0,5	9,0	—	—	—	—	—	—	8,9
		max.	—	—	–	0,05	0,1 [d]	2,0 [e]	1,0	11,0	0,02	0,02	0,05	0,03	0,5	0,2	
CuNi30Mn1Fe [c]	**CW354H** [c]	min.	Rem.	—	—	—	—	0,4	0,5	30,0	—	—	—	—	—	—	8,9
		max.	—	—	—	0,05	0,1 [d]	1,0	1,5	32,0	0,02	0,02	0,05	0,05	0,5	0,2	
CuZn20Al2As	**CW702R**	min.	76,0	1,8	0,02	—	—	—	—	—	—	—	—	—	Rem.	—	8,4
		max.	79,0	2,3	0,06	—	—	0,07	0,1	0,1	0,01	0,05	—	—	—	0,3	
CuZn28Sn1As	**CW706R**	min.	70,0	—	0,02	—	—	—	—	—	—	—	—	0,9	Rem.	—	8,5
		max.	72,5	—	0,06	—	—	0,07	0,1	0,1	0,01	0,05	—	1,3	—	0,3	

[a] For information only.
[b] Including Ag, up to a maximum of 0,015 %.
[c] When the product is for subsequent welding applications, and is so specified by the purchaser [see Clause 5, list entry j)], Zn shall be max 0,2 %, and S shall be max 0,02 %.
[d] Co max. 0,1 % is counted as Ni.
[e] For sea water applications, the composition limits shall be agreed between the purchaser and the supplier [see Clause 5, list entry k)].

Table 2 — Mechanical properties of copper and copper alloy tubes before fining

Designations		Material condition [a]	Tensile strength R_m N/mm² (MPa)	0,2% proof strength $R_{p0,2}$ N/mm² (MPa)	Elongation A %	Hardness HV
Material						
Symbol	Number		min	min	min	min
Cu-DHP	**CW024A**	R220	220	40	40	—
		R250	250	150	20	
		H040	—	—	—	40
CuNi10Fe1Mn	**CW352H**	R290	290	90	30	—
		H070	—	—	—	70
CuNi30Mn1Fe	**CW354H**	R370	370	120	35	—
		H085	—	—	—	85
CuZn20Al2As	**CW702R**	R340S	340	120	55	—
		H060S	—	—	—	60
CuZn28Sn1As	**CW706R**	R320S	320	100	55	—
		H060S	—	—	—	60

[a] Annealed.

Table 3 — Tolerances on outside diameter

Dimensions in millimetres

Nominal outside diameter		Tolerances on diameter including deviation from circular form
over	up to and including	
6 [a]	26	0 - 0,20
26	35	0 - 0,30

[a] Including 6 mm.

Table 4 — Tolerances on length

Nominal length mm		Tolerances
over	up to and including	
—	4 000	+ 4 mm 0
4 000	8 000	+ 1 ‰ 0
8 000	—	+ 0,7 ‰ [a] 0

[a] But not less than 8 mm.

Table 5 — Tolerances on fin pitch

Number of fins per inch		Tolerance on number
over	up to and including	
16 [a]	25	± 1
25	40	± 2
NOTE 1 inch is equivalent to 25,4 mm.		
[a] Including 16.		

Table 6 — Sampling rate

Quantity of tubes in the inspection lot	Number of samples required for testing
per 600 tubes or 4 500 kg	2 samples
or fraction of either, whichever constitutes the greater weight	min 2 samples per order

Annex A
(normative)

Freedom from defects tests

A.1 Eddy current test

A.1.1 General

The eddy current test method described in this annex has the objective to detect significant inhomogeneities in copper and copper alloy finned tubes.

A.1.2 Test apparatus

The eddy current continuous process with encircling test coils or rotating systems shall be employed. The mechanical arrangement shall permit tubes to pass through the test coil as concentrically and vibration-free as possible. The test speed shall be constant within ± 10 %. The signal shall be evaluated by means of a recorder, monitor or similar.

A.1.3 Reference standard tube

Sensitivity of the eddy current equipment shall be adjusted by means of a reference standard tube with a longitudinal groove in the fins of the following size:

— width 1 mm;

— depth 75 % of fin height, but not less than 0,8 mm;

— length 20 mm.

Tolerance on all these dimensions: ± 15 %.

The length of reference standard tube shall be chosen to ensure dynamic test conditions.

A.1.4 Instrument adjustment and performance of test with encircling coils

The running-in time of the instrument shall be in accordance with the manufacturer's instructions.

A suitable test coil corresponding to the diameter of the tube to be tested shall be chosen. The test system shall be adjusted using the reference standard tube.

For this adjustment the reference standard tube shall be passed through the coil at the speed intended for routine testing.

The artificial discontinuity shall produce a clear signal regardless of its position on the tube periphery. The test frequency shall be selected in the range 1 kHz to 20 kHz.

If the test instrument operates with phase selection, the signals from the defects to be detected shall lie within the determined phase ranges.

The test parameters used for the adjustment shall not be altered during the actual test. Testing shall be performed with this adjustment.

A.1.5 Testing of unfinned sections and transition zones

Eddy current testing of unfinned sections may be omitted when the following conditions are met:

— the total length of the unfinned sections is less than 10 % of total tube length minus the length of the unfinned tube ends;

— the intermediate sections are inspected visually;

— the tubes in the final dimension have been subjected to an eddy current test before fining.

If the total length of the unfinned sections is greater than 10 %, then the tubes shall be tested in accordance with EN 1971-1 or EN 1971-2 before finning and the transition zones between unfinned and finned sections of the tube shall be visually inspected.

A.1.6 Sorting limit

Unless otherwise agreed between the purchaser and the supplier [see Clause 5, list entry n)], the smallest signal from the artificial discontinuity shall be considered as the sorting limit. All tubes with signals equal to or greater than the sorting limit shall be considered as defective.

A.1.7 Instrument adjustment check

The adjustment of the test instrument shall be checked at regular intervals. Checks shall be made at the beginning of the test, at least every 4 h during continuous operation, at the end of the test and whenever there is a malfunction of the instrument.

If during the check, there is a drop in sensitivity ≥ 2 dB, all tubes which have been tested since the last check shall be re-tested with the correct adjustment.

A.1.8 Rejected tubes

Tubes with signals equal to or higher than sorting limits may be re-tested.

Tubes which pass this test shall be deemed to conform to this European Standard.

Tubes which fail because of signals caused by minor mechanical damage, deformation or split fins that do not interfere with the thickness of finned section s_2 may be subjected to a hydrostatic or pneumatic test and, if leak tight, shall be accepted.

A.2 Hydrostatic test

When required (see A.1.8), each tube shall withstand, without showing evidence of leakage, an internal hydrostatic pressure of 50 bar.

Any tube which shows signs of leakage or permanent increase in diameter as a result of this test, shall be deemed to have failed the test.

A.3 Pneumatic test

When required (see A.1.8), each tube shall be subjected for at least 5 s to an internal air pressure of at least 18 bar. The test method used shall permit detection of any leakage, such as having the tube under water or by the pressure differential method.

Any tube which shows signs of leakage during the test shall be deemed to have failed the test.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of 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 Union 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 harmonized 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(s)/ sub-clause(s) of this EN	Subject	Qualifying remarks/Notes
6.2	Mechanical properties	Annex I 4.1(a) of the Directive
9.2	Conformity of product and manufacturer's certified documentation	Annex I 4.3 of the Directive

NOTE Brittle fracture prevention: Copper, having a face-centred 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

EN 1057:2006+A1:2010, *Copper and copper alloys — Seamless, round copper tubes for water and gas in sanitary and heating applications*

EN 1173, *Copper and copper alloys — Material condition designation*

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

EN ISO 9001, *Quality management systems — Requirements (ISO 9001)*

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

ISO 1811-2, *Copper and copper alloys — Selection and preparation of samples for chemical analysis — Part 2: Sampling of wrought products and castings*

ISO 80000-1:2009, *Quantities and units — Part 1: General*

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