BS EN 10222-1:2017

BSI Standards Publication

Steel forgings for pressure purposes

Part 1: General requirements for open die forgings

bsi.

National foreword

This British Standard is the UK implementation of EN 10222-1:2017. It supersedes BS EN 10222-1:1998, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/111, Steel Castings and Forgings.

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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Steel forgings for pressure purposes - Part 1: General requirements for open die forgings

Pièces forgées en acier pour appareils à pression - Partie 1: Prescriptions générales concernant les pièces obtenues par forgeage libre

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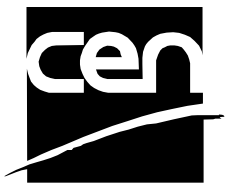

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European foreword

This document (EN 10222-1:2017) has been prepared by Technical Committee ECISS/TC 111 “Steel castings and forgings”, the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by October 2017, and conflicting national standards shall be withdrawn at the latest by October 2017.

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

This document supersedes EN 10222-1:1998.

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 2014/68/EU.

For relationship with EU Directive 2014/68/EU, see informative Annex ZA, which is an integral part of this document.

EN 10222 consists of the following parts under the general title “Steel forgings for pressure purposes”:

— *Part 1: General requirements for open die forgings*

— *Part 2: Ferritic and martensitic steels with specified elevated temperature properties*

— *Part 3: Nickel steels with specified low temperature properties*

— *Part 4: Weldable fine grain steels with high proof strength*

— *Part 5: Martensitic, austenitic and austenitic-ferritic stainless steels.*

Annex C provide details about significant changes to the versions EN 10222-1:1998.

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

1 Scope

This Part of this European Standard specifies the general technical delivery conditions for open die steel forgings, ring rolled products and forged bars for pressure purposes.

NOTE Once this standard is published in the EU Official Journal (OJEU) under Directive 2014/68/EU, presumption of conformity to the Essential Safety Requirements (ESRs) of Directive 2014/68/EU is limited to technical data of materials in this standard and does not presume adequacy of the material to a specific item of equipment. Consequently, the assessment of the technical data stated in this material standard against the design requirements of this specific item of equipment to verify that the ESRs of Directive 2014/68/EU are satisfied, needs to be done. The series EN 10222–1 to EN 10222–5 is structured so that the data related to different materials is in the part allocated for that material. The presumption of conformity to the Essential Safety Requirements of Directive 2014/68/EU depends on both the text in part 1 and the data in part 2, 3, 4 or 5.

General information on technical delivery conditions is given in EN 10021.

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 10020:2000, *Definition and classification of grades of steel*

EN 10021:2006, *General technical delivery conditions for steel products*

EN 10027-1, *Designation systems for steels - Part 1: Steel names*

EN 10027-2, *Designation systems for steels - Part 2: Numerical system*

EN 10052:1993, *Vocabulary of heat treatment terms for ferrous products*

EN 10079:2007, *Definition of steel products*

EN 10168:2004, *Steel products - Inspection documents - List of information and description*

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

EN 10222-2:2017, *Ferritic and martensitic steels with specified elevated temperature properties*

EN 10222-3:2017, *Nickel steels with specified low temperature properties*

EN 10222-4:2017, *Weldable fine grain steels with high proof strength*

EN 10222-5:2017, *Martensitic, austenitic and austenitic-ferritic stainless steels*

EN 10228-1:2016, *Non-destructive testing of steel forgings - Part 1: Magnetic particle inspection*

EN 10228-2:2016, *Non-destructive testing of steel forgings - Part 2: Penetrant testing*

EN 10228-3:2016, *Non-destructive testing of steel forgings - Part 3: Ultrasonic testing of ferritic or martensitic steel forgings*

EN 10228-4:2016, *Non-destructive testing of steel forgings - Part 4: Ultrasonic testing of austenitic and austenitic-ferritic stainless steel forgings*

EN ISO 148-1:2016, *Metallic materials - Charpy pendulum impact test - Part 1: Test method (ISO 148-1:2016)*

EN ISO 377:2013, *Steel and steel products - Location and preparation of samples and test pieces for mechanical testing (ISO 377:2013, Corrected version 2015-06-01)*

EN ISO 3651-2:1998, *Determination of resistance to intergranular corrosion of stainless steels - Part 2: Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels - Corrosion test in media containing sulfuric acid (ISO 3651-2:1998)*

EN ISO 6892-1:2016, *Metallic materials - Tensile testing - Part 1: Method of test at room temperature (ISO 6892-1:2016)*

EN ISO 6892-2:2011, *Metallic materials - Tensile testing - Part 2: Method of test at elevated temperature (ISO 6892-2:2011)*

EN ISO 9606-1:2013, *Qualification testing of welders - Fusion welding - Part 1: Steels (ISO 9606-1:2012 including Cor 1:2012)*

EN ISO 14284:2002, *Steel and iron - Sampling and preparation of samples for the determination of chemical composition (ISO 14284:1996)*

EN ISO 15607:2003, *Specification and qualification of welding procedures for metallic materials - General rules (ISO 15607:2003)*

EN ISO 15609-1:2004, *Specification and qualification of welding procedures for metallic materials - Welding procedure specification - Part 1: Arc welding (ISO 15609-1:2004)*

EN ISO 15614-1:2004, *Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1:2004)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 10020:2000, EN 10021:2006, EN 10052:1993, EN 10079:2007 and the following apply.

3.1
batch
forgings of similar dimensions from the same cast, made by the same forging procedure and from the same heat treatment charge

3.2
purchaser
person or organization that orders products in accordance with this European Standard

Note 1 to entry The purchaser is not necessarily, but may be, a manufacturer of pressure equipment in accordance with the EU Directive listed in Annex ZA.

Note 2 to entry Where a purchaser has responsibilities under this EU Directive, this standard will provide a presumption of conformity with the essential requirements of the Directive so identified in Annex ZA.

4 Classification and designation

4.1 Classification

The classification of the steel grades in accordance with EN 10020 is given in the specific parts of the EN 10222 series.

4.2 Designation

The steel grades specified in the individual parts of the EN 10222 series are designated with steel names and steel numbers. The steel names have been allocated in accordance with EN 10027-1. The corresponding steel numbers have been allocated in accordance with EN 10027-2.

5 Information to be supplied by the purchaser

5.1 Mandatory information

The following information shall be supplied by the purchaser at the time of enquiry and order:

a) the quantity of forgings required;

b) the forging dimensions, or the drawing number(s) containing the dimensions, tolerances on dimensions, shape and surface finish, to which the forgings shall conform;

c) number of the relevant part of this European Standard;

d) steel name or steel number of the material of which the forgings are made (see Clause 4);

e) delivery condition, where alternatives are possible or where it differs from those specified in the other parts of the EN 10222 series;

f) the type of inspection document in accordance with EN 10204:2004 (see 7.1.1);

g) the extent of dimensional inspection and visual testing for batches including more than 25 pieces.

5.2 Options

A number of options are specified in this part of the EN 10222 series and listed below. If the purchaser does not indicate a wish to implement any of these options at the time of enquiry and order, the products shall be supplied in accordance with the basic specification (see 5.1).

1) Steelmaking process (see 6.1.1);

2) Hot working process and degree of hot working (see 6.2.1);

3) Information on the forging procedure and the calculated forging reduction (see 6.2.2);

4) Limits on residual incidental elements other than those specified in the relevant part of the EN 10222 series (see 6.4.1.3 and 6.4.1.4);

5) maximum carbon equivalent value for steel grades of EN 10222-2 and EN 10222-4 (see 6.4.1.5);

6) greater tolerances to chemical composition (see 6.4.2.2);

7) content of residual elements (see 6.4.2.3);

8) magnetic particle testing and/or penetrant testing (see 6.7, Table 1, 9.6 and 9.7);

9) requirements and test conditions for the ultrasonic test (see 6.8, Table 1, and 9.8);

10) optional tests (see Table 1);

11) deviating test unit (see 8.1.1 and/or 8.1.4);

12) test temperature for the tensile test at elevated temperature (see 9.4);

13) deviating test temperature for the impact test (see 9.5, paragraph 2);

14) deviating of direction of test pieces for impact test (see 9.5, paragraph 4);

15) deviating extent of testing and test duration for the hydrostatic test (see 9.10);

16) simulated post-weld heat treatment of samples (see 6.3.2);

17) verification of the surface condition (see 6.7.3);

18) sample location for complex pieces (see 8.1.5);

19) if applicable, lowered number of the test units of a batch or part of a batch (of final product) (see Table 2, footnote a);

20) optional impact test for austenitic stainless steels according to EN 10222-5 (see Table 1).

6 Requirements

6.1 Steelmaking

6.1.1 The steel shall be produced by an electric process or one of the basic oxygen processes.

Specific requirements for the steelmaking process may be agreed at the time of the enquiry and order.

6.1.2 The steel shall be fully killed.

6.2 Manufacture of the product

6.2.1 Hot working

The choice of hot working process shall be at the discretion of the manufacturer.

For the hot working process and/or the degree of hot working, special agreements may be made at the time of the enquiry and order.

6.2.2 Forging reduction

The forging shall receive a sufficient forging reduction to completely consolidate the forging and remove the cast structure.

Information on the forging procedure, on the calculated forging reduction and the rules for calculating this ratio may be agreed at the time of enquiry and order.

6.3 Heat treatment

6.3.1 General

The forgings shall be heat treated as specified in the relevant part of the EN 10222 series, unless otherwise agreed there for the relevant steel grade at the time of enquiry and order.

6.3.2 Simulated post-weld heat treatment of samples

If the purchaser intends to incorporate the forging or fabrication in a welded vessel or structure and applies a post-weld heat treatment, samples that have received heat treatment in accordance with 6.3.1 shall also be subjected to a heat treatment that simulates the post-weld heat treatment to be applied to the welded vessel or structure by the purchaser. The post-weld heat treatment and the mechanical properties to be obtained after testing these samples in accordance with Clause 9 shall be agreed between the purchaser and the manufacturer.

NOTE 1 If any additional or unforeseen post-weld heat treatment is applied by the purchaser, the heat treatment temperature cannot exceed the temperature of the final heat treatment, i.e. either tempering or post-weld heat treatment applied to the samples.

NOTE 2 If required, the purchaser can be supplied with additional test samples cut from the forging after heat treatment in accordance with 6.3.1 with a view to subjecting these samples to additional heat treatment and subsequent mechanical testing for information purposes.

NOTE 3 The samples for simulation of post-weld heat treatment exclude test materials supplied for welding tests and can receive the heat treatments referred to in 6.3.1.

6.4 Chemical composition

6.4.1 Cast analysis

6.4.1.1 The cast analysis reported by the steel producer shall apply and comply with the requirements of the individual parts of the EN 10222 series

6.4.1.2 Elements not listed in the composition tables in the relevant part of the EN 10222 series shall not be intentionally added without the agreement of the purchaser except for finishing the cast.

6.4.1.3 Limits on residual incidental elements other than those specified in the relevant part of the EN 10222 series may be agreed at the time of enquiry and order.

6.4.1.4 If so agreed at the time of enquiry and order, the residual elements specified in the order shall be declared on the manufacturer's certificate.

6.4.1.5 If so agreed at the time of enquiry and order, forgings in accordance with EN 10222-2 and EN 10222-4 shall be supplied with a specific maximum carbon equivalent value. The relevant value is based upon cast analysis. The carbon equivalent value (CEV) shall be calculated using the following formula:

$$CEV = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15} \% \quad (1)$$

6.4.2 Product analysis

6.4.2.1 The permissible product analysis tolerances on the limiting values given for the cast analysis are specified in the individual parts of the EN 10222 series. Further restriction to composition may be imposed by the purchaser by the use of the carbon equivalent values (see 6.4.1.5).

6.4.2.2 Greater tolerances to composition may be agreed for large forgings at the time of enquiry and order.

6.4.2.3 If so agreed at the time of enquiry and order, the content of residual elements specified in the order (see 6.4.1.3) shall be declared on the manufacturer's certificate.

6.5 Mechanical properties

The mechanical properties obtained from the test pieces, selected, prepared and tested in accordance with Clauses 8 and 9 and Table 1 shall comply with the values specified in the relevant part of the EN 10222 series or with the agreements according to 6.3.2.

6.6 Weldability

The steels in this European Standard are generally regarded as being weldable.

NOTE Welding can be carried out in accordance with EN ISO 9606-1:2013, EN ISO 15607:2003, EN ISO 15609-1:2004 and EN ISO 15614-1:2004.

6.7 Surface condition

6.7.1 General

The forgings shall be sound and free from defects that preclude their intended use.

The agreed requirements for surface finish shall be compatible with the requirements for non-destructive testing.

6.7.2 Removal of surface defects

6.7.2.1 Conformity to 6.7.1

Before the forgings are despatched or presented for acceptance, surface defects shall be removed in order to conform to 6.7.1.

6.7.2.2 Chipping and/or grinding

Surface defects shall be removed by chipping and/or grinding providing the residual thickness meets the minimum tolerance and that the resulting depression does not undercut the rest of the surface. If the thickness is to be reduced to below the minimum tolerance, repair shall only be carried out following agreement with the purchaser.

6.7.2.3 Chipping and/or grinding and resurfacing by welding

If resurfacing by welding is agreed by the purchaser, prior to the repair being carried out, larger surface defects shall be removed by chipping and/or grinding followed by resurfacing by welding and levelling the weld.

NOTE The welding operations carried out can be in accordance with the published standard e.g. EN ISO 9606-1, EN ISO 15607:2003, EN ISO 15609-1:2004 and EN ISO 15614-1:2004.

6.7.3 Verification of the surface condition

Where appropriate, requirements together with the conditions for their verification may be agreed at the time of enquiry and order (see Table 1 and 9.6 and 9.7).

6.8 Internal soundness

Where appropriate, requirements together with the conditions for their verification may be agreed at the time of enquiry and order (see Table 1 and 9.8).

6.9 Dimensions, shape, tolerances and nominal mass

The dimensions and shape of the product shall conform to the tolerances stated in the order.

Any calculation of the nominal mass of the product shall be based on the following density values:

— non alloy quality and alloy special steels in EN 10222-2, EN 10222-3 and EN 10222-4, 7,85 kg/dm^3;

— X8Ni9: 7,89 kg/dm^3;

— martensitic stainless steels: 7,7 kg/dm^3;

— austenitic stainless CrNi steels: 7,9 kg/dm^3;

— austenitic stainless CrNiMo steels: 8,0 kg/dm^3;

— austenitic-ferritic stainless steels: 7,8 kg/dm^3.

7 Inspection

7.1 Types of inspection and inspection documents

7.1.1 The compliance with the requirements of the order shall be checked for products in accordance with this European Standard by specific inspection (see EN 10021:2006).

The purchaser shall specify the required type of inspection document (3.1 or 3.2) in accordance with EN 10204:2004.

If an inspection document 3.1 is specified, the manufacturer shall operate a quality assurance system, certified by a competent Body established within the European Community and having undergone a specific assessment for materials.

NOTE See Directive 2014/68/EU, Annex I, section 4.3, third paragraph and for further information the guidelines of the EU Commission for its interpretation (see e.g. Guidelines 7/2 and 7/16 [1]).

If an inspection certificate 3.2 is specified, the purchaser shall notify the manufacturer of the name and address of the organization or person who is to carry out the inspection and produce the inspection document. It shall also be agreed which party shall issue the certificate.

7.1.2 The inspection document shall include, in accordance with EN 10168:2004, the following codes and information:

A	commercial transactions and parties involved;
B	description of products to which the inspection certificate applies (including details of the heat treatment given to the forgings and, where repairs have been performed, extent and location of such repairs);
C03	test temperature;
C10-C29	tensile test at room temperature and, if applicable, at elevated temperatures;
C40-C43	impact test;

C70 steelmaking process;

C71-C92 cast analysis and, if applicable, product analysis (including residual element content, where specified);

D01 marking, dimensional and visual inspection and, if applicable, verification of the resistance to intergranular corrosion;

D02-D50 non-destructive tests (NDT), if applicable;

Z validation.

7.2 Tests to be carried out

The mandatory and optional tests to be carried out, and the extent of testing are specified in Table 1.

Table 1 — Type of tests and extent of testing

Type of inspection and test		Extent of testing	Refer to
Mandatory tests	Cast analysis	1 per cast	6.4.1
	Tensile test at room temperature	1 per test unit	7.2.1, 8.2.2 and 9.3
	Impact test (by agreement at time of enquiry and order the testing of impact properties may be optional for austenitic stainless steels according to EN 10222–5, see 5.2 Option 20).	1 per test unit	7.2.1, 8.2.2 and 9.5
	Dimensional inspection	each product[c]	6.9 and 9.11
	Visual testing	each product[c]	6.7.2 and 9.12
Optional tests	Product analysis	1 per cast	6.4.2, 7.2.1 and 9.2
	Tensile test for (simultaneous) verification of one, all, or any combination of $R_{p0,2}$, $R_{p1,0}$ and R_m at elevated temperature	1 per test unit[b]	8.2.2 and 9.4
	Additional impact test at different temperatures	a	7.2.1, 8.2.2 and 9.5
	Magnetic particle testing	a	6.7.3 and 9.6
	Penetrant testing	a	6.7.3 and 9.7
	Ultrasonic testing for verification of internal soundness	a	6.8 and 9.8
	Test for resistance to intergranular corrosion for steels of EN 10222–5	a	9.9
	Hydrostatic test for hollow sections	each product[b]	9.10

a As agreed.

b Unless otherwise agreed.

c For batches greater as 25 pieces, the extent of inspection shall be agreed at time of enquiry and order.

7.2.1 Test units consist of forgings up to the maximum masses given in Table 2.

Forgings greater than those unit masses shall be sampled individually.

The minimum number of samples shall be in accordance with 8.1 according to the mass and/or size of the forging.

Table 2 — Maximum test masses

Maximum test mass of	**Non-alloy steels according to** EN 10222–2 **All steels according to** EN 10222–4 **Austenitic steels according to** EN 10222–5 [kg]	**Other steels** [kg]
Final individual product	1 000	500
Batch or part of a batch (of final product)[a]	6 000	3 000
[a] If agreed at time of enquiry and order the maximum number of test units of a batch may be lowered according to the application (see 5.2, Option 19).		

8 Sampling

8.1 Selection of samples

8.1.1 General

Samples shall be provided by one of the following methods:

a) for small forgings (up to 1 000 kg), if so agreed with the purchaser, as separately forged samples forged from the bars, billets or ingots from which the forgings have been made. The samples shall receive nominally the same hot working reduction and have nominally the same equivalent diameter as the ruling section of the forgings they represent, as defined in Annex A;

b) for prolongations of the forgings having a diameter or section approximately equal to the ruling section of the forging at the time of heat treatment (see Annex A). Integral samples shall not be parted from the forging until all heat treatments are completed except as in 8.1.6;

c) from additional forgings.

8.1.2 Separate samples or additional forging

Separate samples or additional forgings shall be heat treated with the batch they represent.

8.1.3 Forgings up to and including 1 000 kg mass (≤5 m in length)

For forgings up to and including 1 000 kg mass, samples shall be provided according to 8.1.1 a), b) or c).

8.1.4 Forgings from 1 000 kg up to and including 4 000 kg mass (≤5 m in length)

For forgings from 1 000 kg up to and including 4 000 kg, samples shall be provided according to method 8.1.1 b) or c). A sample shall be taken from one end of each forging.

8.1.5 Forgings over 4000 kg or greater than 5 m in length (any mass)

For forgings over 4000 kg or greater than 5 m in length (any mass), samples shall be provided according to method 8.1.1 b) or c). A sample shall be taken from each end of each forging in two diametrically opposite areas.

For forgings whose diameter exceeds the length of the axis, such as discs or rings, test samples shall be provided by increasing the outside diameter, length or thickness of the forgings or by reducing the inside diameter of the forgings, as applicable.

NOTE For shapes needing clarifications to the sample location, agreements can be made at time of enquiry and order.

Examples of the mounting of prolongation and the location of test pieces are given in Annex B.

8.1.6 Forgings for closed hollow vessels

In the case of forgings for closed hollow vessels, the samples shall be cut off before closing (i.e. either by hot working or welding on ends) and shall be subjected to the same heat treatment as the vessels themselves. In the case of open hollow vessels a sample shall be cut off after completion of the heat treatment. The number of samples taken from these forgings shall conform to the relevant requirements of 8.1.3, 8.1.4 and 8.1.5.

8.2 Preparation of samples and test pieces

8.2.1 Sample preparation shall be in accordance with the requirements of EN ISO 377:2013 and EN ISO 14284:2002.

Samples for the chemical analysis shall be taken either from the test pieces used for the verification of the mechanical properties or from drillings from the same location. Deviating locations shall be agreed between purchaser and manufacturer, as shall also the permissible deviations in the product analysis, taking into account the heterogeneity of the product.

In addition, the requirements in 8.2.2 shall apply for sampling and sample preparation for the mechanical tests.

8.2.2 For forgings with $t \geq 60$ mm, the samples, as in Figure 1, shall be taken so that the axis of the test pieces shall be at a distance of $t/4$ from the heat treated surface (with a minimum of 20 mm and a maximum of 80 mm), and $t/2$ from the end (where t is the equivalent thickness t_{eq} or the thickness of the ruling section t_R of the forging at the time of heat treatment, see Annex A).

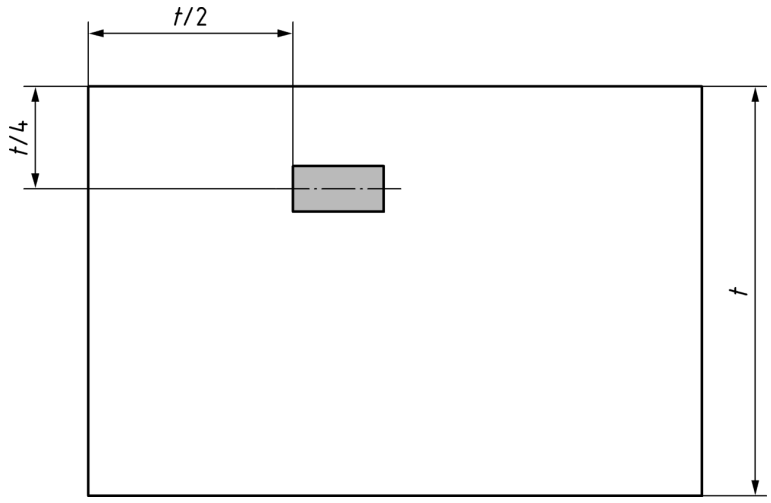


Figure 1 — Position of test piece

For forgings with t < 60 mm the samples shall be taken close to the heat treated surface.

For integral samples according to 8.1.1 b, the end of the forging shall be protected by means of a thermal buffer, the height of which shall be at least equal to $t/2$ (maximum 90 mm). This thermal buffer, the width of which shall at least equal t, shall be welded to the part before heat treatment.

The direction of test pieces shall be:

— Circular or rectangular cross section, t_{eq} < 160mm: axial;

— Circular or rectangular cross section, t_{eq} ≥ 160mm: transverse to main forging direction;

— Ring and discs, all dimensions: tangential;

— Hollow sections, t_{eq} < 16mm: axial;

— Hollow sections, t_{eq} ≥ 16mm: tangential.

For other profiles and if requested by the purchaser at the time of enquiry and order, additional test pieces shall be prepared for different directions and positions.

From each sample the following test pieces shall be prepared:

a) one (room temperature) tensile test piece which shall be of type and dimensions complying with the requirements of EN ISO 6892-1:2016;

b) three impact test pieces as specified in EN ISO 148-1:2016. The axis of the notch shall be perpendicular to the nearest surface of the forging;

c) if an elevated temperature tensile test is required, the test piece shall be cut from a position on the sample adjacent to one of the room temperature tensile test pieces, and prepared in accordance with the requirements of EN ISO 6892-2:2011.

9 Test methods

9.1 General

The manufacturer shall take suitable measures to prevent materials becoming mixed up and to ensure traceability.

9.2 Chemical analysis

Unless otherwise agreed at the time of enquiry and order, the choice of a suitable physical or chemical analytical method for the product analysis shall be at the discretion of the manufacturer. In cases of dispute, the analysis shall be carried out by a laboratory approved by both parties. In this case, the analysis method to be used shall be agreed taking into account the relevant existing European Standards. The list of available European Standards is given in CEN/TR 10261.

For the product analysis, unless otherwise agreed at the time of enquiry and order, one test piece per cast shall be taken for determining the elements indicated with numerical values for the particular steel grade in the relevant tables of the specific parts of the EN 10222 series.

9.3 Tensile test at room temperature

Tensile test at room temperature shall be carried out in accordance with the requirements of EN ISO 6892-1:2016. The yield strength to be determined shall be the upper yield strength (R_{eH}) or if this is

not pronounced, the 0,2 % proof strength ($R_{p0,2}$); for austenitic steels in accordance with EN 10222-5 additionally $R_{p1,0}$.

9.4 Tensile test at elevated temperatures

$R_{p0,2}$, R_m values and for austenitic steels in accordance with EN 10222-5 additionally $R_{p1,0}$ values at elevated temperature shall be determined in accordance with EN ISO 6892-2:2011.

Unless a test temperature for which a value is specified for the relevant product has been agreed at the time of enquiry and order, the test shall be carried out at 300 °C except for austenitic-ferritic steels of EN 10222-5 for which the test shall be carried out at 250 °C.

9.5 Impact test

The impact test shall be carried out in accordance with EN ISO 148-1:2016 at 20°C (unless otherwise agreed), on V-notched test pieces and by using a 2 mm striker (KV_2). The specifications of the individual parts of the EN 10222 series shall apply.

Where minimum impact energy values are specified for several temperatures, verification of the impact energy, unless otherwise agreed at the time of enquiry and order, shall be carried out at the temperature for which the value of 27 J is specified.

Where the minimum impact energy value specified at the lowest temperature is higher than 27 J, this higher value shall be verified.

Unless otherwise agreed at the time of enquiry and order, the impact energy values shall be verified for test pieces taken in accordance with 8.2.2.

The minimum impact values given in the individual parts of the EN 10222 series apply for the mean of three test pieces. One individual value may be lower than the specified value provided that it is not less than 70 % of this value.

If the above conditions are not met, an additional set of three test pieces shall be taken from the same sample and shall be tested. In order to regard the test unit as acceptable after testing the second set, the following requirements shall be met:

a) mean value of six tests shall be equal to or greater than the specified value;

b) not more than two of the six individual values shall be less than the specified value;

c) not more than one of the six individual values shall be less than 70 % of the specified value.

If these requirements are not met, the sample product shall be rejected and re-tests shall be carried out on the remainder of the test unit.

9.6 Magnetic particle testing

In case of magnetic particle testing, the test shall be carried out in accordance with EN 10228-1:2016.

The acceptance criteria shall be agreed at the time of enquiry and order. The quantity of forgings tested shall be a statistically controlled sample or 100 % as agreed between purchaser and supplier.

9.7 Penetrant testing

In case of penetrant testing, the test shall be carried out in accordance with EN 10228-2:2016.

The acceptance criteria shall be agreed at the time of the enquiry and order. The quantity of forgings tested shall be a statistically controlled sample or 100 % as agreed between purchaser and supplier.

9.8 Ultrasonic testing

In case of ultrasonic testing, the test shall be carried out in accordance with EN 10228-3:2016 or EN 10228-4:2016.

The acceptance criteria shall be agreed at the time of enquiry and order. The quantity of forgings tested shall be a statistically controlled sample or 100 % as agreed between purchaser and supplier.

9.9 Resistance to intergranular corrosion

Intergranular corrosion testing shall be carried out in accordance with EN ISO 3651-2:1998, unless otherwise specified in the order.

9.10 Hydrostatic testing

Every forging shall be tested, unless otherwise agreed between the purchaser and the manufacturer.

Details of the test procedure, including the test temperature and pressure shall be agreed between the purchaser and manufacturer. In no case shall the nominal strength produced by the hydrostatic test exceed 90 % of the specified minimum yield strength R_{eH} of the steel or where the steel does not exhibit a pronounced yield point, 90 % of the 0,2 % proof strength $R_{p0,2}$.

The test pressure shall be maintained for a time to be agreed between the purchaser and manufacturer.

9.11 Dimensional measurement

The dimensions of the products shall be checked for conformity with 6.9.

9.12 Visual testing

The surface condition of the products shall be checked for conformity with 6.7, by visual testing without optical aids.

NOTE Other surface control methods can be agreed between the purchaser and manufacturer.

10 Retests

10.1 General

Retests shall be carried out in accordance with EN 10021:2006.

10.2 Re-heat treatment

The manufacturer shall have the right to repeat the heat treatment of any material, including material already found not to fulfil the test requirements, and resubmit it for testing. No forging shall be fully re-heat treated more than twice.

11 Marking

11.1 Unless otherwise agreed, each forging, or batch of forgings, as appropriate, shall be legibly marked to show:

a) the manufacturer's name or trade mark;

b) the identification reference numbers of other identification marks by which the forgings can be related to the manufacturer's certificate;

c) the mark of the inspection representative, if required (see Clause 7).

11.2 The mark shall be placed in the area indicated on the forging drawing, or at the discretion of the supplier, if not shown on the forging drawing.

11.3 If stamping is not permissible the mark shall be made by using a permanent paint, neutral with regard to the steel to which it is applied. Any restriction regarding the composition shall be specified by the purchaser at the time of enquiry and order.

NOTE In the choice of paints, legal requirements of CEC or national countries can be taken into account.

11.4 For small forgings that are boxed, the information required by 11.1 may be marked on the box, or on a tag securely attached to the box, in which the forgings are shipped. In these cases also suitable measures shall be taken in order to prevent materials becoming mixed up.

Annex A
(normative)

Ruling section and equivalent thickness

A.1 General

This annex covers definitions for the term "Ruling section" (t_R) and "equivalent thickness" (t_{eq}) and describes methods for the determination of t_{eq}.

A.2 Definitions

A.2.1 Ruling section (t_R)

The section for which the mechanical properties are specified.

A.2.2 Equivalent thickness (t_{eq})

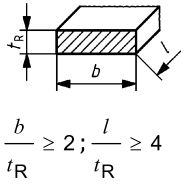
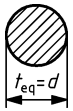
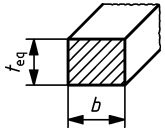
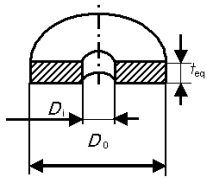
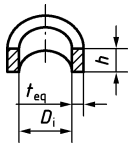
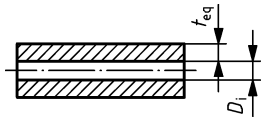
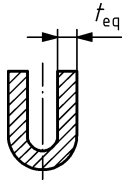
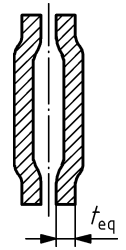
That thickness of a section of a shape X for which the same properties as for the thickness t_R of the ruling section can be expected when the same heat treatment, sampling and testing conditions are applied.

A.3 Determination of the equivalent thickness

A.3.1 Thicknesses equivalent to the thicknesses given in the tables for the mechanical properties in the relevant Parts of this European Standard shall, unless otherwise agreed at the time of the enquiry and order, be read off from Table A.1 (see A.3.2).

A.3.2 If for the shape of the section of the ordered product no equivalent thicknesses are given in Table A.1, the thickness of the ruling section ranges stated in the relevant part of this European Standard which is applicable for the relevant section shall be agreed at the time of the enquiry and order.

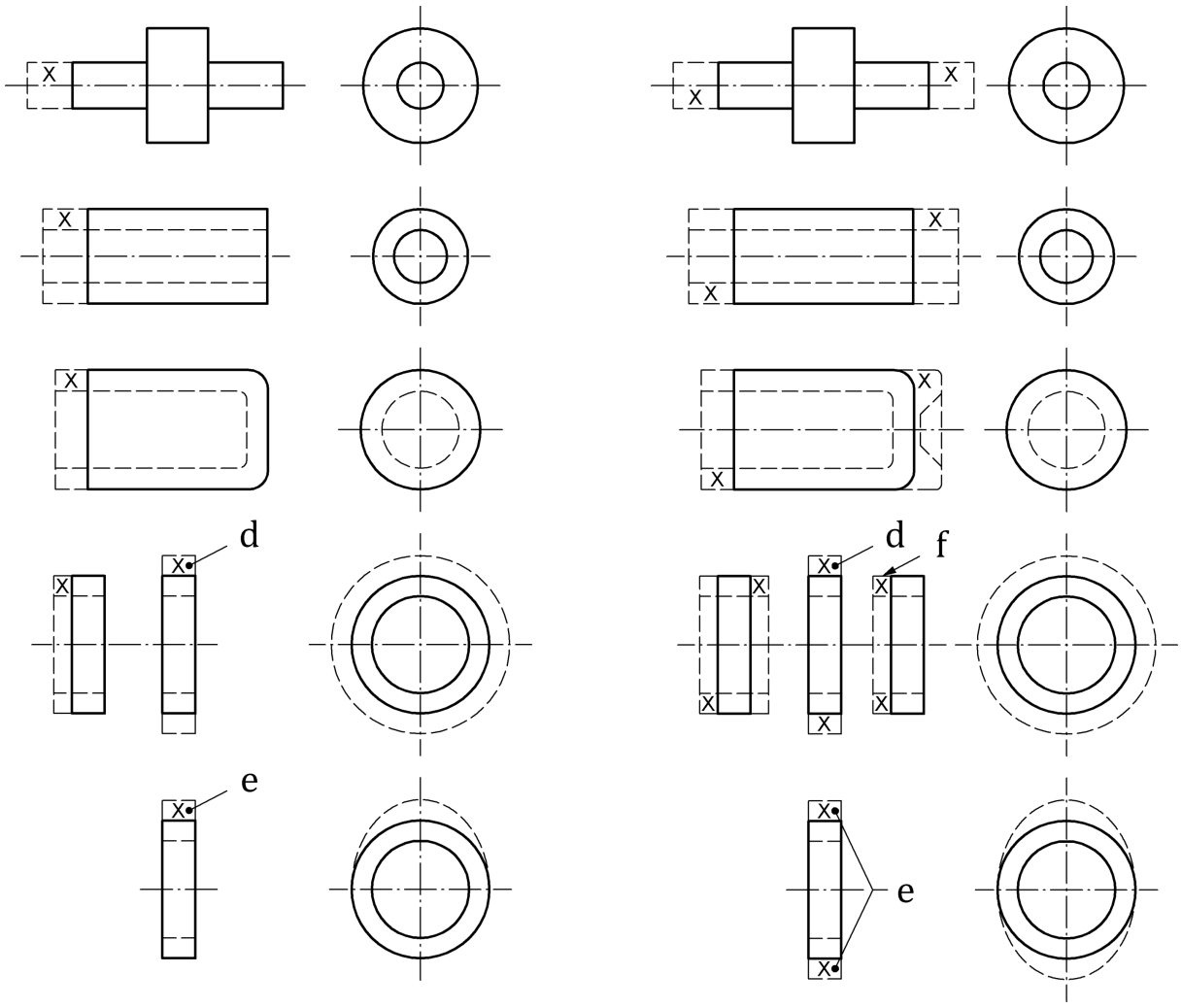
Table A.1 — Equivalent thickness for sections of shapes different from the ruling section[a]

Thickness t_R of ruling section	Equivalent thickness t_{eq} in mm for								
	Bar		Disc	Ring	Cylindrical hollow section, both ends open			Cylindrical hollow section		Other sections
	Circular cross section	Rectangular cross section						Open end closed	Both ends closed	
 $\frac{b}{t_R} \geq 2 ; \frac{l}{t_R} \geq 4$	 $t_{eq}=d$	 $1 \leq \frac{b}{t_{eq}} \leq 2$	 $D_o - D_i \geq 2t_{eq}$	 $h > t_{eq}$ $D_i > 200$ mm	 $D_i > 200$ mm	$D_i \geq 80$ mm ≤ 200 mm	$D_i < 80$ mm			
	t_{eq} approximately $1,5\ t_R$	$t_{eq} \approx 1,2\ t_R$	$t_{eq} \approx t_R$	t_{eq} approximately t_R	t_{eq} approximately t_R	t_{eq} approximately $0,85 t_R$	t_{eq} approximately $0,75 t_R$	$t_{eq} \approx 0,6 t_R$		
16	25	20	16	16	16	15	12	10		By agreement (see A.3.2)
35	50	40	35	35	35	30	25	20		
50	75	60	50	50	50	40	35	30		
70	100	80	70	70	70	55	50	40		
100	150	120	100	100	100	85	75	60		
130	200	160	130	130	130	115	100	80		
160	250	200	160	160	160	140	125	100		
200	300	250	200	200	200	170	150	120		
250	375	300	250	250	250	210	180	150		
330	500	400	330	330	330	280	250	200		
400	600	480	400	400	400	340	300	240		
500	750	600	500	500	500	425	375	300		

[a] Indicated are the thickness values in the tables for mechanical properties in EN 10222–2 to EN 10222–5 for the ruling section, i.e. regular cross section with a width to thickness ratio of ≥ 2 and a length to thickness ratio of ≥ 4; both values are used together.

Annex B
(informative)

Example of the location of test pieces



a) One sample per sample product to be taken

b) Two samples per sample product to be taken

NOTE The examples for rings apply also for discs.

Key

d Diameter mounting
e Earlike mounting
f Front side mounting
x Test piece position

Figure B.1 — Examples of the mounting of prolongation and of the location of test pieces

Annex C
(informative)

Significant technical changes to the version EN 10222-1:1998

Some significant changes to the previous version of EN 10222-1:1998 are listed below:

1) Updating of the normative references;

2) The definition of “purchaser” in chapter 3 has been aligned with Annex ZA;

3) The classification and steel designation in chapter 4 have been updated;

4) Updating of the mandatory and optional information;

5) The contents of the previous Annex A have been updated and inserted in the new structure of the standard;

6) The statements for properties, testing, test methods and sampling have been technical changed (e.g. chapter 6, Table 1 and 2);

7) Inspection requirements in chapter 7 actualized;

8) The previous Annex B become Annex A;

9) New Annex B “Example of the location of test pieces” added.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2014/68/EU

This European Standard has been prepared under a Commission's standardization request M/071 to provide one voluntary means of conforming to Essential Requirements of Directive 2014/68/EU.

Once this standard is cited in the Official Journal of the European Union under that Directive, compliance with the normative 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 Directive 2014/68/EU, and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Annex I of Directive 2014/68/EU

Requirements of Directive 2014/68/EU	Clause(s)/subclause(s) of this EN	Remarks/Notes
4.1 a	6.5	Appropriate material properties
4.1 d	6.3, 6.7.1, 6.8	Suitable for the processing procedures
4.3	7.1	Inspection documentation

WARNING 1 — Presumption of conformity stays valid only as long as a reference to this European Standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

WARNING 2 — Other Union legislation may be applicable to the product(s) falling within the scope of this standard.

Bibliography

[1] Guidelines 7/2 (1999-01-29/2006-03-31) and 7/16 (2001-10-19/1999-01-29/2006-03-31) to the Directive 97/23/EC, published by EU Commission's Working Group "Pressure", see web-site of the EU Commission http://ec.europa.eu/growth/sectors/pressure-gas

[2] CEN/TR 10261, *Iron and steel - European standards for the determination of chemical composition*

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