BS ISO 16143-4:2023

BSI Standards Publication

Stainless steels for general purposes

Part 4: Bright products

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National foreword

This British Standard is the UK implementation of ISO 16143-4:2023.

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

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Part 4: Bright products

Aciers inoxydables pour usage général —

Partie 4: Produits transformés à froid

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 4, *Heat treatable and alloy steels*.

This first edition of ISO 16143-4, together with ISO 683-7, cancels and replaces ISO 683-18:2014, which has been technically revised.

The main changes are as follows:

— ISO 683-18 was split into ISO 683-7 for non-alloy and alloy steels and into ISO 16143-4 for stainless steels;

— three austenitic steel grades, three austenitic-ferritic steel grades, two ferritic steel grades and two martensitic steel grades were added;

— definition for out-of-round was modified with two new definitions on ovality and out-of-shape;

— editorial revision.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Stainless steels for general purposes —

Part 4: Bright products

1 Scope

This document specifies the technical delivery requirements for bright products made of stainless steels in the form of bars in the drawn, peeled/turned or additionally ground condition and they are intended for mechanical purposes, for example for machine parts, and/or for use at high temperature including creep-resistant applications.

NOTE 1 Bright steel products made of corrosion-resistant stainless steel are manufactured from steels mentioned in ISO 16143-2, and bright steel products intended for high-temperature purposes are manufactured from steels mentioned in ISO 4955.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 148-1, *Metallic materials — Charpy pendulum impact test — Part 1: Test method*

ISO 286-2, *Geometrical product specifications (GPS) — ISO code system for tolerances on linear sizes — Part 2: Tables of standard tolerance classes and limit deviations for holes and shafts*

ISO 377, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing*

ISO 404, *Steel and steel products — General technical delivery requirements*

ISO 4885, *Ferrous materials — Heat treatments — Vocabulary*

ISO 4948-1, *Steels — Classification — Part 1: Classification of steels into unalloyed and alloy steels based on chemical composition*

ISO 4948-2, *Steels — Classification — Part 2: Classification of unalloyed and alloy steels according to main quality classes and main property or application characteristics*

ISO 4955, *Heat-resistant steels*

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

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

ISO 6892-2, *Metallic materials — Tensile testing — Part 2: Method of test at elevated temperature*

ISO 6929, *Steel products — Vocabulary*

ISO 10474, *Steel and steel products — Inspection documents*

ISO 14284, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition*

ISO 15510, *Stainless steels — Chemical composition*

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ISO 16143-2, *Stainless steels for general purposes — Part 2: Corrosion-resistant semi-finished products, bars, rods and sections*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 377, ISO 4885, ISO 4948-1, ISO 4948-2, ISO 4955, ISO 6929, ISO 14284, ISO 15510, ISO 16143-2 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
bright product
drawn or peeled/turned product with smoother surface quality and better dimensional accuracy in comparison to hot-rolled product

3.2
drawn product
product of various cross-sectional shapes obtained, after descaling, by cold drawing of a hot-rolled product, on a drawing bench (cold formation without removing material)

Note 1 to entry: This operation gives the product special features with respect to shape, dimensional accuracy and surface finish. Products in lengths are delivered straightened, products of small cross-section may also be supplied in coils.

3.3
peeled/turned product
round bar produced by peeling or turning where the product can be further processed by straightening and polishing

Note 1 to entry: This operation gives the bar special features with respect to shape, dimensional accuracy and surface finish. The removal of metal is carried out in such a way that the bright product is generally free from rolling defects and surface decarburization.

3.4
product in the ground condition
ground product
drawn or peeled/turned round bar given an improved surface quality and dimensional accuracy by grinding or by grinding and polishing

3.5
thickness
nominal dimension of the product

Note 1 to entry: That means:

a) the diameter in the case of rounds;

b) the lateral length in the case of squares;

c) the width over flats in the case of hexagons;

d) the shorter lateral length in the case of flats (rectangular bars) and wide-flats.

For special sections, 'thickness' shall be defined at the time of enquiry and order.

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3.6
ovality
difference between the smallest and largest dimension measured across the pairs of opposing points at a common cross-section

3.7
out of shape
deviation from the nominal section profile

EXAMPLE Parallelism, perpendicularity and twist.

3.8
ruling section
that section for which the specified mechanical properties apply

Note 1 to entry: Independent of the actual shape and dimensions of the cross-section of the product, the size of its ruling section is always given by a diameter. This corresponds to the diameter of an "equivalent round bar". That is a round bar which will show the same cooling rate as the actual ruling section of the product concerned at its position for taking the test pieces, when being cooled from austenitizing temperature.

3.9
stainless steel
steel with at least 10,5 % (mass fraction) Cr and a maximum of 1,2 % (mass fraction) C

Note 1 to entry: For the classification of stainless steels according to their structure, composition and application, see ISO 15510:2014, Annex C.

[SOURCE: ISO 15510:2014, 3.1]

4 Classification and designation

4.1 Classification

The classification of the relevant steel grades is allocated in accordance with ISO 4948-1 and ISO 4948-2.

Stainless steels covered by this document are further classified according to their structure into

— austenitic steels,

— austenitic-ferritic steels,

— ferritic steels,

— martensitic steels, or

— precipitation-hardening steels.

4.2 Designation

For the steel grades covered by this document, the steel names given in the relevant tables are allocated in accordance with ISO/TS 4949.

NOTE Designation of steels covered by this document and of comparable grades covered in various other designation systems are given in Annex E.

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5 Information to be supplied by the purchaser

5.1 Mandatory information

The manufacturer shall obtain the following information from the purchaser at the time of enquiry and order:

a) quantity (mass, number of bars) to be delivered;

b) shape of the product (e. g. round, hexagon, square, flat);

c) the dimensions and tolerances of the product, see 7.6 and Table 3 and Tables 11 to 13;

d) a reference to this document, i.e. ISO 16143-4:2023;

e) the designation of the steel grade;

f) if for the relevant steel more than one heat treatment condition is possible (for the martensitic and precipitation hardening steels of Table 7), the symbol for the desired heat treatment conditions;

g) the desired condition (see symbols in Table 2) for steel grades ordered according to Tables 5 to 7 or the cold worked hardened condition for steel grades ordered according to Table 8;

h) standard designation for a test report 2.2 or, if required, any other type of inspection document in accordance with ISO 10474.

5.2 Options/Supplementary or special requirements

A number of options are specified in this document and listed below.

a) reference testing for products used in the quenched and tempered condition, only for martensitic and precipitation hardening steels ordered in the annealed condition (see 8.3.1 and C.2);

b) non-destructive testing (see 7.5 and C.3);

c) the disposition of tolerances in accordance with 7.6 and C.4;

d) bar end conditions may be specified at the time of enquiry and order in accordance with C.5;

e) product analysis (see 7.2, Table 1 and C.6);

f) any requirement to special marking (see Clauses 10 and C.7);

g) any additionally requirement concerning the surface condition, i.e. ground surface +G or polished surface +PL for round bars (see 6.2.2 and Table 3);

h) surface quality class if another than the standard class is requested (see 7.6 and Table 4);

i) verification of the straightness (see 7.6, Tables 12 and 13 and Annex D);

j) impact test at a temperature lower than room temperature (see 9.2.2).

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5.3 Ordering example

3 t round bars with nominal diameter 80 mm, tolerance h8, stock length 6 000 mm made of steel grade X5CrNi18–10 according to this document in process route +2G, surface quality class 3 and a certificate 3.1 as specified in ISO 10474.

3 t round bars 80 h8 × stock 6 000

steel grade ISO 16143-4 - X5CrNi18–10+2G

Inspection certificate ISO 10474 - 3.1

6 Manufacturing process

6.1 General

The manufacturing process of the steel and of the products is, with the restrictions given by the requirements in 6.2 and 6.3, left to the discretion of the manufacturer.

6.2 Treatment and surface condition at delivery

6.2.1 Treatment condition

The treatment and heat-treatment condition (if any) at the time of delivery shall conform with the condition agreed in the order and shall be one of the conditions indicated in Table 2.

6.2.2 Surface conditions

The surface condition and the tolerance classes on bright steel products shall conform with Table 3. One of the classes written in brackets can be agreed at the time of enquiry and order if requested by the purchaser.

6.3 Traceability of the cast

Each product shall be traceable to the cast, see Clause 10.

7 Requirements

7.1 General

Combination of usual treatment conditions at the time of delivery and requirements concerning chemical composition and mechanical properties are shown in Table 2.

In addition to this document, the general technical delivery requirements of ISO 404 shall apply.

Further steel grades are suitable for manufacturing bright products listed in other standards, e.g. ISO 15510. They can also be used, but in this case the mechanical properties shall be agreed at the time of enquiry and order.

7.2 Chemical composition

The chemical composition of the steels determined by the cast analysis, shall conform to ISO 16143-2 and ISO 4955. The grades and the chemical composition of the steels are also listed for information in this document, see Annex A.

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Permissible deviations between the limiting values for cast analysis and the values for product analysis are given in the corresponding table of ISO 16143-2 and ISO 4955. The product analysis shall be carried out when specified at the time of enquiry and order (see C.6).

7.3 Mechanical properties

For steels ordered in one of the treatment conditions in Table 2, the requirements for mechanical properties specified in Tables 5 to 7 apply (except for stainless steel bars ordered in condition +2D for which the mechanical properties are to be found in ISO 16143-2 and ISO 4955). The mechanical property values given in Tables 5 to 7 apply to test pieces that have been taken and prepared in accordance with Figure 1.

For stainless steel bars which are intentionally cold work hardened in order to increase their 0,2-proof strength to a specific level, the mechanical properties at room temperature as specified in Table 8 apply. For these products, the mechanical properties are prime, with the condition a secondary property.

An impact test shall be performed for peeled/turned bars if mentioned in the tables of mechanical properties. For cold drawn bars (+2H, +2H+2G. +2H+2P), requirements on impact tests can normally not be performed since there are no reference values, unless impact test and Charpy values are agreed at the time of enquiry and order. Additional requirements concerning the impact energy and the verification at temperatures other than room temperature (0 °C, –20 °C and –40 °C) can be agreed at the time of enquiry and order.

7.4 Internal soundness

Where appropriate, requirements relating to the internal soundness of the products shall be agreed at the time of enquiry and order (see C.3).

7.5 Shape, dimensions and tolerances

The tolerance class on thickness (and width for flats) shall conform with the requirements agreed at the time of enquiry and order and shall be in accordance with Table 3. If there is no agreement on the tolerance class, the bright products are delivered with the standard tolerance class given in Table 3. The tolerance class and the corresponding tolerances are given in Table 9 for rounds, squares and hexagons and in Table 10 for drawn flats. Where specified by the purchaser at the time of enquiry and order, the disposition tolerances specified in Table 9 shall be in accordance with C.4.

Unless otherwise agreed at the time of enquiry and order, the length and the tolerance on length shall be as specified in Table 11.

Maximum deviation from 'ovality' shall be not more than half the specified tolerance range and in any case never above the upper limit of the tolerance. Any requirements concerning out of shape may be agreed at the time of enquiry and order together with the measurement method.

For the evaluation of straightness, automatic methods can be used at the discretion of the manufacturer. Where specified at the time of enquiry and order and in cases of dispute, an agreed number of bars shall be evaluated for straightness in accordance with one of the methods specified in Annex D. The tolerances specified in Tables 12 and 13 shall apply.

Non-round bars (i.e. square, hexagon and flat) in widths ≤150 mm may have an undefined profile within a distance of 0,2 mm of the hypothetical edge and flats in widths >150 mm within a distance of 0,5 mm, unless otherwise agreed. For widths >150 mm, sharp corners can specifically be ordered.

7.6 Surface quality

Bright products shall have a smooth, scale free surface. Bright products in the final heat-treated condition shall be free from loose surface scale; their surface might be discoloured or darker. For hexagons, squares, flats and profiles with special cross-sections, one cannot achieve – for manufacturing reasons – the same quality of surface finish as for round cross-sections.

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Since surface discontinuities (cracks, overlapping, scale, isolated pores, pits, grooves, etc.) cannot be completely avoided during manufacturing (hot and cold forming, heat treatments, handling and storage) and since they are retained when drawing, agreements shall be made regarding surface quality. The surface quality of the products shall be one of the classes in accordance with Table 4.

Cold drawn bars are normally delivered in class 1, while peeled/turned bars as well as ground/polished bars are delivered in class 3. Different classes may be agreed at the time of enquiry and order.

For flats, squares in sizes greater than 20 mm and hexagons in sizes greater than 50 mm, the maximum possible depth of surface discontinuities shall be agreed at the time of enquiry and order.

NOTE Where automatic testing of the surface is applied, 50 mm of each end of the bar is not normally covered.

Surface defects cannot be eliminated without removal of material. Products in the 'technically crack free by manufacture' condition are only available in the peeled/turned and/or ground conditions.

8 Inspection

8.1 Testing procedures and types of documents

8.1.1 Products conforming with this document shall be ordered and delivered with one of the inspection documents specified in ISO 10474. The type of document shall be agreed upon at the time of enquiry and order. If the order does not contain any specification of this type, a test report 2.2 shall be issued.

8.1.2 If, in accordance with the agreements made at the time of enquiry and order, a test report 2.2 must be provided, this shall cover the following information:

a) confirmation that the material complies with the requirements of the order;

b) results of the cast analysis for all elements specified for the steel type concerned.

8.1.3 If, in accordance with the agreements in the order, an inspection certificate 3.1 or 3.2 to ISO 10474 is to be provided, the specific inspections and tests described in 8.3 and Clause 9 shall be carried out and the results shall be confirmed in the inspection certificate.

In addition, the inspection certificate shall cover:

a) confirmation that the material complies with the requirements of the order;

b) results of the cast analysis for all elements specified for the steel type concerned;

c) the result of all inspections and tests ordered by supplementary requirements (see Annex C);

d) the symbol letters or numbers relating the inspection certificate, test pieces and products to each other.

8.2 Frequency of testing

The amount of testing, the sampling conditions and the test methods to be applied for the verification of the requirements shall be in accordance with the prescriptions of Table 1.

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Table 1 — Test conditions for the verification of the requirements given in Tables 5 to 8

No.	Requirements	Amount of testing			Sampling and sample preparation	Test method to be used
		Test unit[a]	Number of [b]			
			samples per test unit	tests per sample		
1	Chemical composition	C	The cast analysis is given by the manufacturer (m); for product analysis, see C.7 (o)		ISO 14284	See list in ISO/ TR 9769[c]
2	Mechanical properties				ISO 377	Tensile test[d] ISO 6892-1 Impact test ISO 148-1
2.1	Cold drawn or peeled and heat treated	C+D	1	1 tensile (m)		
2.2	Annealed and cold drawn or peeled	C+D+T	1	1 tensile (m)		
2.3	Solution annealed, quenched and tempered and cold drawn or peeled	C+D+T	1	1 tensile (m) and 3 CVN [f] (o)		
3	Hardness[e]				ISO 6506-1	Brinell hardness test ISO 6506-1
3.1	Heat-treated and peeled	C+D+T	1	1 (m)		
3.2	Heat-treated and cold drawn	C+D+T	1	1 (m)		

NOTE Verification of the requirements is only necessary if an inspection certificate is ordered.

[a] The tests shall be carried out separately for each cast as indicated by 'C', each dimension as indicated by 'D', and each heat-treatment batch as indicated by 'T'. Products with different thickness may be grouped if the differences in thickness do not affect the properties.

[b] Tests marked with an “m” (mandatory) shall be carried out as specific tests. In all cases, those marked with an “o” (optional) shall be carried out as specific tests only if agreed at ordering.

[c] For routine testing, other methods are also available (e.g. spectrographic).

[d] In cases of dispute, the tensile test shall be carried out on proportional test pieces having a gauge length of $L_0 = 5{,}65 \sqrt{S_0}$, where S_0 is the original cross-section area.

[e] Unless otherwise agreed at the order, the manufacturer shall decide whether to use the tensile test or hardness test. In the case of dispute the tensile test shall be done.

[f] For nominal thickness ≥16 mm, standard test pieces 10 mm x 10 mm shall be machined. For thicknesses <16 mm, the test shall only be done if test pieces with reduced widths and Charpy-V-notch (CVN) values are agreed at the time of enquiry and order.

8.3 Specific inspection and testing

8.3.1 Verification of the mechanical properties

For steels ordered in one of the process routes in Table 2, the mechanical properties shall be verified. For martensitic and precipitation-hardening (see Table 7) ordered in the annealed condition, the requirements given for the quenched and tempered condition (+QT) is only to be verified if the supplementary requirement specified in C.2 is ordered.

8.3.2 Visual and dimensional inspection

A sufficient number of products shall be inspected to ensure the compliance with the specification.

Dimensional inspection shall be carried out as follows:

a) for bars in manufacturing or stock length: not less than 150 mm from the end of the bar;

b) for bars cut to length: not less than 10 mm from the end of the bar.

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If agreed at the time of enquiry and order, dimensional inspection shall be done for bars in manufacturing or stock length for nominal diameter > 100 mm, not less than 250 mm from both ends of the bar."

9 Test methods

9.1 Chemical analysis

The choice of a suitable physical or chemical analytical method for the analysis shall be at the discretion of the manufacturer. In cases of dispute, the method for product analysis used shall be agreed taking into account the relevant existing International Standards.

The list of available International Standards on chemical analysis is given in ISO/TR 9769.

9.2 Mechanical tests

9.2.1 Tensile test and hardness test

The tensile test shall be carried out in accordance with ISO 6892-1.

Unless otherwise agreed, the tensile strength, the 0,2 %-proof strength and elongation after fracture shall be determined. If a tensile test at elevated temperature has been ordered, this shall be carried out in accordance with ISO 6892-2.

The Brinell hardness test (only for martensitic and precipitation hardening steels) shall be carried out in accordance with ISO 6506-1.

9.2.2 Impact test

The Charpy-V-notch (CVN) impact test shall be carried out in accordance with ISO 148-1.

The average values of a set of three test pieces shall be equal to or greater than the specified value. One individual value may be below the specified value, provided that it is not less than 70 % of that value.

If these conditions are not satisfied, additional tests can be done according to ISO 404 on the assessment of results of sequential tests.

9.3 Verification of dimensions

The ovality shall be carried out by the two-point measuring method. Other methods shall be agreed at the time of enquiry and order.

9.4 Retests

Retests and criteria should be as specified in ISO 404.

10 Marking

The manufacturer shall mark the products or the bundles or boxes containing the products in a suitable way, so that the identification of the cast, the steel type and the origin of the delivery is possible (see C.7).

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