
**Steel flat products for pressure
purposes — Technical delivery
conditions —**

Part 2:

**Non-alloy and alloy steels with specified
elevated temperature properties**

iTeh STANDARD PREVIEW

*Produits plats en acier pour service sous pression — Conditions
techniques de livraison —*

*Partie 2: Aciers non alliés et aciers alliés avec caractéristiques
spécifiées à température élevée*

<https://standards.iteh.ai/catalog/standards/sist/e1994468-868a-452d-83ec-420fd40a225e/iso-9328-2-2004>



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 9328-2 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 10, *Steel for pressure purposes*.

This second edition cancels and replaces the first edition (ISO 9328-2:1991) which has been technically revised.

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ISO 9328 consists of the following parts, under the general title *Steel flat products for pressure purposes — Technical delivery conditions*:

- [ISO 9328-2:2004](https://standards.iteh.ai/catalog/standards/sist/e19944b8-868a-452d-83ec-420fd40a225e/iso-9328-2-2004)
<https://standards.iteh.ai/catalog/standards/sist/e19944b8-868a-452d-83ec-420fd40a225e/iso-9328-2-2004>
- *Part 1: General requirements*
 - *Part 2: Non-alloy and alloy steels with specified elevated temperature properties*
 - *Part 3: Weldable fine grain steels, normalized*
 - *Part 4: Nickel-alloy steels with specified low temperature properties*
 - *Part 5: Weldable fine grain steels, thermomechanically rolled*
 - *Part 6: Weldable fine grain steels, quenched and tempered*
 - *Part 7: Stainless steels*

NOTE The clauses marked by a point (●) contain information relating to agreements that shall be made at the time of enquiry and order. Clauses and paragraphs marked by two points (●●) contain information relating to agreements that may be made at the time of enquiry and order.

Introduction

In comparison with its first edition (ISO 9328-2:1991) this part of ISO 9328 takes into consideration partly deviating and additional requirements, thus offering the possibility of specifying products in accordance with European design codes and ASME type design codes.

Main further alterations are: deletion of the grade P315/PH315, specification of additional alloy grades, partly decreased maximum phosphorus and sulfur contents, partly increased minimum impact values, information on processing and options for evaluation of resistance to hydrogen-induced cracking and for the step cooling test.

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Steel flat products for pressure purposes — Technical delivery conditions —

Part 2: Non-alloy and alloy steels with specified elevated temperature properties

1 Scope

This part of ISO 9328 specifies the technical delivery conditions for plates and strip for pressure equipment made of non-alloy and alloy steels as specified in Tables A.1 and B.1. The requirements and definitions of ISO 9328-1 also apply to this part of ISO 9328.

2 Normative references

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

ISO 4948-1:1982, *Steels — Classification — Part 1: Classification of steels into unalloyed and alloy steels based on chemical composition*

ISO 4948-2:1981, *Steels — Classification — Part 2: Classification of unalloyed and alloy steels according to main quality classes and main property or application characteristics*

ISO 9328-1:2003, *Steel plates and strips for pressure purposes — Technical delivery conditions — Part 1: General requirements*

ISO 10474:1991, *Steel and steel products — Inspection documents*

3 Terms and definitions

For the purposes of this document the terms and definitions given in ISO 9328-1 apply.

4 Classification and designation

4.1 Classification

In accordance with ISO 4948-1 and ISO 4948-2, steel grades P235GH, P265GH, P295GH and P355GH (see Annex A) and PT410GH, PT450GH and PT480GH (see Annex B) are non-alloy quality steels. All other grades covered by this part of ISO 9328 are alloyed special steels.

4.2 Designation

See ISO 9328-1.

NOTE 1 Non-alloy grades in Annex A are classified according to their yield strength, non-alloy grades in Annex B are classified according to their tensile strength.

NOTE 2 Information on the designation of comparable steel grades in national or regional standards is given in Annex C.

5 Information to be supplied by the purchaser

5.1 Mandatory information

See ISO 9328-1 and 6.2.3.

5.2 Options

A number of options is specified in this part of ISO 9328. These are listed below under a) to q). Additionally, the relevant options of ISO 9328-1 apply. 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 ISO 9328-1).

- a) Tests in the simulated normalized condition (see 6.2.2);
- b) products delivered untreated (see 6.2.4);
- c) maximum carbon equivalent value for P235GH, P265GH, P295GH and P355GH (see 6.3.3);
- d) hydrogen-induced cracking (HIC) test in accordance with Annex G (see 6.10);
- e) step cooling test in accordance with Annex H (see 6.11);
- f) mid-thickness test pieces for the impact test (see Clause 8);
- g) lower copper content and maximum tin content (see Table A.1, footnote b);
- h) minimum chromium content of 0,80 % (see Table A.1, footnote f);
- i) maximum carbon content of 0,17 % for product thicknesses greater than 150 mm (see Table A.1, footnote g);
- j) mechanical properties for product thicknesses > 250 mm (see Table A.2, footnote a);
- k) specification of the delivery condition +QT where the usual delivery condition is +NT (see Table A.2, footnote c and Table A.3, footnote c);
- l) additional impact energy values (see Table A.2, footnote f);
- m) $R_{p0,2}$ values at elevated temperature for increased product thicknesses (see Table A.3, footnote b);
- n) increased carbon content for grades PT410GH, PT450GH and PT480GH (see Table B.1, footnote b);
- o) Al additions not permitted (see Table B.1, footnote c);
- p) specification of the delivery condition +NT for the grade 14CrMo9-10 and of the delivery condition +QT for the grades 14CrMoV9-10 and 13CrMoV12-10 (see Table B.2, footnote g);
- q) requirement for impact tests and values (see Table B.2, footnote j).

5.3 Example for ordering

10 plates with nominal dimensions, thickness = 50 mm, width = 2 000 mm, length = 10 000 mm, made of a steel grade with the name 16Mo3 as specified in ISO 9328-2, to be delivered untreated, inspection document 3.1.B as specified in ISO 10474:1991 is designated as follows:

10 plates – 50 × 2 000 × 10 000 – ISO 9328-2 16Mo3+AR – Inspection document 3.1.B

6 Requirements

6.1 Steelmaking process

See ISO 9328-1.

6.2 Delivery condition

6.2.1 Unless otherwise agreed upon at the time of enquiry and order, the products covered by this part of ISO 9328 shall be supplied in the usual conditions given in Tables A.2 and B.2.

6.2.2 •• Normalizing may, at the discretion of manufacturer, be replaced with normalizing rolling for the steel grades P235GH, P265GH, P295GH and P355GH (see Annex A). In this case, tests in the simulated normalized condition with an agreed frequency of testing may be agreed upon at the time of enquiry and order, to verify that the specified properties are complied with.

6.2.3 • For products made of steel grades PT410GH, PT450GH, PT480GH, 19MnMo4-5, 19MnMo5-5 and 19MnMoNi5-5 (see Table B.2), the requested delivery condition normalized (+N) or untreated (+AR) (but see 6.2.5) or, where applicable, quenched and tempered (+QT) shall be specified at the time of enquiry and order.

6.2.4 •• If so agreed upon at the time of enquiry and order, products made of steel grades P235GH, P265GH, P295GH, P355GH and 16Mo3 (see Table A.2) may also be delivered in the untreated condition (but see 6.2.5). Products made of one of the other alloy grades may be supplied in the tempered or normalized condition or in the untreated condition if so agreed.

NOTE Annex D contains heat treatment information for the purchaser.

6.2.5 For products delivered untreated in accordance with 6.2.3 and 6.2.4, testing shall be carried out on test pieces in the usual delivery condition as indicated in Tables A.2 and B.2.

NOTE The testing of the test pieces in a simulated heat-treated condition does not discharge the processor from the obligation of providing proof of the specified properties in the finished product.

6.3 Chemical composition

6.3.1 The requirements of Tables A.1 and B.1 shall apply for the chemical composition according to the cast analysis.

6.3.2 The product analysis shall not deviate from the specified values for the cast analysis as specified in Tables A.1 and B.1 by more than the values given in Table 1.

6.3.3 •• A maximum value for the carbon equivalent may be agreed upon at the time of enquiry and order for steel grades P235GH, P265GH, P295GH and P355GH (see Annex A) and PT410GH, PT450GH and PT480GH (see Annex B). In this case, the following formula shall apply for calculation of the carbon equivalent value (CEV):

$$CEV = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

Table 1 — Permissible product analysis tolerances on the limiting values given in Tables A.1 and B.1 for the cast analysis

Element	Specified value in the cast analysis according to Tables A.1 and B.1	Permissible deviation ^a of the product analysis
	% by mass	% by mass
C	≤ 0,31	± 0,02
Si	≤ 0,35	± 0,05
	> 0,35 to ≤ 1,00	± 0,06
Mn	≤ 1,00	± 0,05
	> 1,00 to ≤ 1,70	± 0,10
P	≤ 0,030	+ 0,005
S	≤ 0,015	+ 0,003
	> 0,015 to ≤ 0,030	+ 0,005
Al	≥ 0,010	± 0,005
B	≤ 0,003	± 0,000 5
Ca	≤ 0,015	+ 0,003
N	≤ 0,020	+ 0,002
	> 0,020 to ≤ 0,070	± 0,005
Cr	≤ 2,00	± 0,05
	> 2,00 to ≤ 10,00	± 0,10
Cu	≤ 0,30	± 0,05
	> 0,30 to ≤ 0,80	± 0,10
Mo	≤ 0,35	± 0,03
	> 0,35 to ≤ 1,10	+ 0,04
Nb	≤ 0,10	± 0,01
Ni	≤ 0,30	+ 0,05
	> 0,30 to ≤ 1,30	± 0,10
Cr+Cu+Mo+Ni	≤ 1,00	+ 0,05
Ti	≤ 0,035	± 0,01
V	≤ 0,05	± 0,01
	> 0,05 to ≤ 0,30	± 0,03

^a If several product analyses are carried out on one cast, and the contents of an individual element, as determined, lie outside the permissible range of the chemical composition specified for the cast analysis, then it is only allowed to exceed the permissible maximum value or fall short of the permissible minimum value, but not both for one cast.

6.4 Mechanical properties

6.4.1 The values given in Tables A.2, A.3 and B.2 (see also ISO 9328-1 and Clause 10) shall apply.

6.4.2 Annex F gives, for the grades in Annex A, mean values as preliminary data for the purchaser on 1 % (plastic) creep strain and creep rupture.

6.5 Surface condition

See ISO 9328-1.

6.6 Internal soundness

See ISO 9328-1.

6.7 Weldability

6.7.1 The steel grades specified in this part of ISO 9328 shall be suitable for welding processes in current use (see also note to 6.7.2).

6.7.2 Information on welding can be found in appropriate documents, e.g. EN 1011-1 and EN 1011-2 or IIS/IIW-382-71.

NOTE Excessive post-weld heat treatment (PWHT) conditions may decrease the mechanical properties. When, on stress relieving, the intended time-temperature parameter

$$P = T_s (20 + \lg t) \times 10^{-3}$$

where

T_s is the stress relieving temperature in kelvins, and

t is the holding time in hours,

exceeds the critical ($P_{crit.}$) values in Annex E or, where regarded as necessary in the case of Annex B steel grades, the purchaser should, in his enquiry and order, inform the manufacturer accordingly and, where appropriate, tests on simulated post-weld heat-treated samples may be agreed upon in order to check whether after such a treatment the properties specified in this part of ISO 9328 can still be regarded as valid.

6.8 Dimensions and tolerances on dimensions

See ISO 9328-1.

6.9 Calculation of mass

See ISO 9328-1.

6.10 Resistance to hydrogen-induced cracking

Carbon and low alloy steels may be susceptible to cracking when exposed to corrosive H₂S-containing environments, usually referred to as "sour service".

•• A test to evaluate the resistance to hydrogen-induced cracking in accordance with Annex G or another agreed test method may be agreed upon at the time of enquiry and order.

6.11 Embrittlement of CrMo steels

CrMo steels may tend to become brittle in service at temperatures between approximately 400 °C and 500 °C. This possible tendency for embrittlement can be simulated in the laboratory with the so-called step cooling test. In this test a specimen is exposed to a temperature-time cycle as given in Figure H.1. The shift of a transition curve before and after the step cooling test is a measure for the embrittlement.

- A step cooling test in accordance with Annex H may be agreed upon at the time of enquiry and order.

7 Inspection

7.1 Types of inspection and inspection documents

See ISO 9328-1.

7.2 Tests to be carried out

See ISO 9328-1, and 6.10 and 6.11.

7.3 Retests

See ISO 9328-1.

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8 Sampling

See ISO 9328-1.

ISO 9328-2:2004

- For the impact test, deviating from ISO 9328-1:2003, Table 3, footnote c, the preparation of test pieces taken from the mid-thickness may be agreed upon at the time of enquiry and order. In this case, test temperatures and minimum impact energy values shall also be agreed upon.

9 Test methods

9.1 See ISO 9328-1, and Annexes D and E.

9.2 For the steel grades specified in Annex B, the impact test shall only be carried out if so agreed at the time of enquiry and order. Requirements and test conditions shall then also be agreed (see Table B.2, footnote j).

10 Marking

See ISO 9328-1.