INTERNATIONAL STANDARD

ISO 9328-1

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Steel flat products for pressure purposes — Technical delivery conditions —

Part 1: General requirements

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

Partie 1: Exigences générales

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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 9328-1 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 9328-1:1991), all clauses and Table 4 of which have been technically revised. Further, Annexes A and B, and Tables 1 and 2 have been deleted; Figure 1 is now in tabular form and Table 3 is in two parts (Tables 2 and 3).

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

— *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 with a bullet (●) contain information relating to agreements which are to be made at the time of enquiry and order. The clauses marked with a triangular bullet (▲) contain information relating to agreements which may be made at the time of enquiry and order.

Steel flat products for pressure purposes — Technical delivery conditions —

Part 1: General requirements

1 Scope

This part of ISO 9328 specifies the general technical delivery conditions for steel flat products (plate/sheet and strip) used principally for the construction of pressure equipment.

The general technical delivery requirements in ISO 404 also apply to products supplied in accordance with 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 148:1983, *Steel — Charpy impact test (V-notch)*

ISO 377:1997 *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing*

ISO 404:1992, *Steel and steel products — General technical delivery requirements*

ISO 783:1999, *Metallic materials — Tensile testing at elevated temperature*

ISO 2566-1:1984, *Steel — Conversion of elongation values — Part 1: Carbon and low alloy steels*

ISO 2566-2:1984, *Steel — Conversion of elongation values — Part 2: Austenitic steels*

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 4885:1996, *Ferrous products — Heat treatments — Vocabulary*

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/TS 4949, *Steel names based on letter symbols*

ISO 6892:1998, *Metallic materials — Tensile testing at ambient temperature*

ISO 6929:1987, *Steel products — Definitions and classification*

ISO 7452:2002, *Hot-rolled structural steel plates — Tolerances on dimensions and shape*

ISO 7778:1983, *Steel plate with specified through-thickness characteristics*

ISO 7788:1985, *Steel — Surface finish of hot-rolled plates and wide flats — Delivery requirements*

ISO 9034:1987, *Hot-rolled structural steel wide flats — Tolerances on dimensions and shape*

ISO 9328-2, *Steel flat products for pressure purposes — Technical delivery conditions — Part 2: Non-alloy and alloy steels with specified elevated temperature properties*

ISO 9328-3, *Steel flat products for pressure purposes — Technical delivery conditions — Part 3: Weldable fine grain steels, normalized*

ISO 9328-4, *Steel flat products for pressure purposes — Technical delivery conditions — Part 4: Nickel-alloy steels with specified low temperature properties*

ISO 9328-5, *Steel flat products for pressure purposes – Technical delivery conditions — Part 5: Weldable fine grain steels, thermomechanically rolled*

ISO 9328-6, *Steel flat products for pressure purposes — Technical delivery conditions — Part 6: Weldable fine grain steels, quenched and tempered*

ISO 9328-7:— [1)], *Steel flat products for pressure purposes — Technical delivery conditions — Part 7: Stainless steels*

ISO 9444:2002, *Continuously hot-rolled stainless steel strip, plate/sheet and cut lengths — Tolerances on dimensions and form*

ISO 9445:2002, *Continuously cold-rolled stainless steel narrow strip, wide strip, plate/sheet and cut lengths — Tolerances on dimensions and form*

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

ISO 14284:1996, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition*

ISO 15510:2003, *Stainless steels — Chemical composition*

ISO 18286, *Hot rolled stainless steel plates — Tolerances on dimensions and shape*

3 Terms and definitions

For the purpose of this document the terms and definitions in ISO 4885, ISO 4948-1, ISO 4948-2 and ISO 6929 as well as the following apply.

Additionally to the definitions for thermomechanical treatment and quenching and tempering in ISO 4885 the following should be noted:

a) Thermomechanical rolling (symbol M) may include processes of increased cooling rates with or without tempering, including self-tempering but excluding definitively direct quenching and tempering.

b) Quenching and tempering (symbol QT) also includes direct hardening plus tempering.

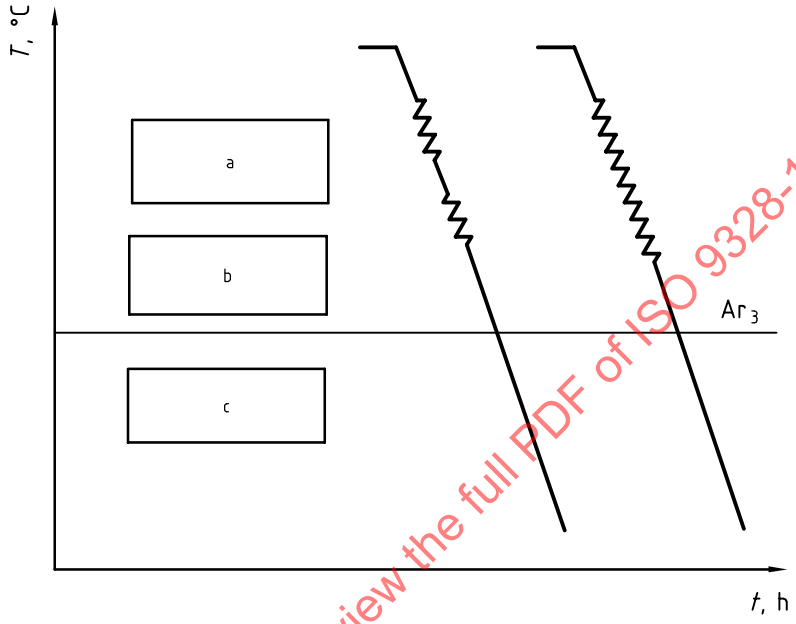
NOTE In international publications for both the normalizing, as well as the thermomechanical rolling, the expression “controlled rolling” may be found. However in view of the different applicability of the products a distinction of the terms is necessary.

1) To be published.

3.1
normalizing rolling
rolling process in which final deformation is carried out in a certain temperature range leading to a material condition equivalent to that obtained after normalizing so that the specified values of the mechanical properties are retained even after normalizing

See Figure 1.

NOTE The symbol for this delivery condition and for the normalized condition is N.



Key

T is the temperature in degrees Celsius
t is the time in hours
Ar_3 is the temperature at which ferrite starts to form on cooling
a Recrystallized austenite region.
b Non-recrystallized austenite region.
c Austenite plus ferrite region.

Figure 1 — Time-temperature scheme of normalizing rolling

4 Classification and designation

4.1 Classification

4.1.1 The classification of the steel grades in accordance with ISO 4948-1 and ISO 4948-2 is given in ISO 9328-2, ISO 9328-3, ISO 9328-4, ISO 9328-5, ISO 9328-6 or ISO 9328-7 depending on the steel grade's chemical composition and treatment condition.

4.1.2 Steels covered in ISO 9328-7 are additionally classified according to their structure into:

— ferritic steels;

— martensitic steels;

— austenitic steels;

— austenitic-ferritic steels.

For more details see ISO 15510.

4.2 Designation

The steel grades specified in the individual parts of ISO 9328 are designated with steel names in accordance with ISO/TS 4949.

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 required;

b) the type of flat product;

c) the International Standard specifying the tolerances on dimensions, shape and mass (see 6.7) and, if the relevant International Standard permits the purchaser certain options, e.g. regarding edge finishes or tolerance classes, specific information on these aspects;

d) the nominal dimensions of the product;

e) the number of this International Standard, i.e. ISO 9328-1 and that of the relevant part, i.e. Part 2, 3, 4, 5, 6 or 7;

f) the steel name;

g) the delivery condition, if it differs from the usual condition specified in the individual parts of ISO 9328; for stainless steels, the process route selected from the relevant table of ISO 9328-7;

h) whether impact testing is required, and the test direction (see 7.2.1 and 9.4);

i) inspection document to be issued (see 7.1).

5.2 Options

A number of options are specified in this part of ISO 9328 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).

a) Specification of the steelmaking process (see 6.1);

b) mechanical properties after additional heat treatment (see 6.4.1);

c) specification of special classes for the reduction of area (see 6.4.2);

d) additional tests (see 6.6 and 7.2.2);

e) deviating frequency of testing (see 8.1.1 and 8.1.3);

f) deviating delivery condition (see 8.2.1.3);

g) specification of an analytical method (see 9.1);

h) temperature of the tensile test at elevated temperature (see 9.3);

i) deviating testing temperature for the impact test (see 9.4);

j) marking method (see 10.1);

k) special marking (see 10.2 and 10.3);

l) information to be given by marking (see Table 1).

Table 1 — Marking of the products

Marking of	Symbol[a]	Marking of	Symbol[a]
Manufacturer's name, trade mark or logo	+	Direction of rolling [b]	(+)
The number of this International Standard	(+)	Nominal thickness	(+)
Steel name	+	Nominal dimensions other than thickness	(+)
Type of finish	(+)	Inspector's mark	+ [c]
Identification number [d]	+ [e]	Purchaser's order No.	(+)

[a] +: the marking shall be applied; (+): the marking shall be applied if so agreed, or at the manufacturer's discretion.

[b] The direction of rolling is normally obvious from the shape of the product and the position of the marking. Marking may either be longitudinally applied by roller stamping or it may be near to one end of the piece and transverse to the rolling direction.

A specific separate indication of the principal rolling direction will not normally be required, but may be requested by the customer.

[c] The inspector's mark may be omitted if the relevant inspector can be identified in another way.

[d] The numbers or letters used for identification shall allow the product(s) to be related to the relevant inspection certificate or inspection report.

[e] This shall permit the traceability of the cast number.

6 Requirements

6.1 Steelmaking process

▲ **6.1.1** Unless a special steelmaking process has been agreed upon at the time of enquiry and order, the steelmaking process for steels in accordance with this part of ISO 9328 shall be at the discretion of the manufacturer. If a special steelmaking process has been specified this shall be reported in the inspection document.

6.1.2 Steels other than stainless steels shall be fully killed.

6.2 Delivery condition

See 3 and 3.1 and the individual parts of ISO 9328.

6.3 Chemical composition

6.3.1 Cast analysis

The cast analysis reported by the steel producer shall apply and comply with the requirements of the individual parts of ISO 9328 and shall be included in the relevant inspection document.

6.3.2 Product analysis

The permissible product analysis tolerances on the limiting values given for the cast analysis are specified in the individual parts of ISO 9328.

6.4 Mechanical properties

6.4.1 The values given in the individual parts of ISO 9328 apply for test pieces taken and prepared in accordance with 8.2.2. The values relate to the nominal thicknesses (thicknesses on ordering) of the products and apply to the usual delivery conditions.

▲ Agreement shall be reached, where appropriate, at the time of enquiry and order about the mechanical properties to be adhered to after additional heat treatment.

▲ **6.4.2** For products (except products made of stainless steel) of thickness 15 mm and above, it may be agreed at the time of enquiry and order to meet the requirements of one of the quality classes Z 15, Z 25 or Z 35 as specified in ISO 7778 characterized by minimum values for the reduction of area perpendicular to the product surface.

6.5 Surface condition

For plates, the requirements of surface quality as specified in ISO 7788 shall apply.

6.6 Internal soundness

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

▲ Special requirements together with the conditions of their verification [see 5.2 d) and 9.5.3] may be specified at the time of enquiry and order.

6.7 Dimensions and tolerances on dimensions

● The nominal dimensions and tolerances on dimensions for the products shall be agreed upon at the time of enquiry and order with reference to the dimensional standards listed below.

a) For hot-rolled (except stainless) flat products, see ISO 7452 or ISO 9034.

b) For stainless hot-rolled flat products see ISO 9444 or ISO 18286.

c) For stainless cold-rolled sheet/plate and cut lengths, cold-rolled coil and slit coil see ISO 9445.

6.8 Calculation of mass

A density of 7,85 kg/dm^3 shall be used as the basis for the calculation of the nominal mass from the nominal dimensions of all steels of ISO 9328-2 to ISO 9328-6. For density of corrosion-resisting and of austenitic creep-resisting steels, see annex A of ISO 9328-7:—.

7 Inspection

7.1 Types of inspection and inspection documents

● The compliance with the requirements of the order shall be verified for products in accordance with this part of ISO 9328 by specific inspection.

The purchaser shall state the required type of inspection documents (3.1.A, 3.1.B, 3.1.C or 3.2) in accordance with ISO 10474:1991. If an inspection document 3.1.A, 3.1.C or 3.2 is ordered, the purchaser shall notify the manufacturer of the name and the address of the organization or person who is to carry out the inspection and produce the inspection document. In the case of the inspection report 3.2, the party to issue the certificate shall be agreed upon.

7.2 Tests to be carried out

7.2.1 The following tests shall be carried out:

— tensile test at room temperature;

— impact test if ordered, but see 8.2.2.3;

— dimensional test;

— visual examination of the surface condition.

▲ **7.2.2** The following tests may be agreed:

— product analysis;

— tensile test for (simultaneous) verification of one, all or any combination of 0,2 % proof strength, 1,0 % proof strength and tensile strength at elevated temperature;

— tensile test perpendicular to the product surface (except for steels listed in ISO 9328-7);

— impact tests for austenitic steels listed in ISO 9328-7 at room temperature;

— impact tests for steels listed in ISO 9328-7 (except ferritic steels) at low temperature;

— mechanical tests after additional heat treatment;

— ultrasonic test for verification of internal soundness;

— determination of resistance to intergranular corrosion for steels listed in ISO 9328-7.

7.3 Retests

See ISO 404.

8 Sampling

8.1 Frequency of testing

▲ **8.1.1** For the product analysis, unless otherwise agreed, one test piece per cast shall be taken in order to determine those elements, indicated with numerical values for the particular steel grade, in the relevant parts of ISO 9328.

8.1.2 The test unit for products in accordance with ISO 9328-2 to ISO 9328-6 for the tensile test at room temperature and the impact test shall be as follows:

— for strip and sheet cut from strip: the coil;

— for sheet or plate: the rolled plate.

If a rolled plate or a coil is split up into several heat treatment batches for liquid quenching, then each individual batch heat treated in the same condition shall be regarded as a test unit. One sample shall be taken for preparing the test pieces indicated in 8.2.2 from each test unit.

For stainless steels see ISO 9328-7.

▲ **8.1.3** For tensile tests at elevated temperature, unless otherwise agreed, the test unit shall be the cast.

8.2 Selection and preparation of samples and test pieces

8.2.1 Sampling and sample preparation

8.2.1.1 Sampling and sample preparation shall be in accordance with the requirements of ISO 377 and ISO 14284. In addition, the requirements in 8.2.1.2 and, if applicable, 8.2.1.3 shall apply for sampling and sample preparation for the mechanical tests.

8.2.1.2 The samples shall be taken at 1/4 product width (see Table 2) for the tensile test at room temperature, the impact test and the tensile test at elevated temperature. In the case of strip, the samples shall be taken at a sufficient distance from the end of the strip.

NOTE If samples are taken from the mid-width position in accordance with the requirements for through-thickness testing as specified in ISO 7778, the samples to be taken as specified in 8.2.1.2 may also be taken from there except in cases of arbitration.

▲ **8.2.1.3** If, following agreement at the time of enquiry and order, the products are not to be delivered in the usual delivery condition, the samples shall be treated to the usual delivery condition prior to the test.

8.2.2 Preparation of test pieces

8.2.2.1 General

The test pieces shall be prepared in accordance with Table 3 (products in accordance with ISO 9328-2 to ISO 9328-6) or Table 4 (products in accordance with ISO 9328-7).

8.2.2.2 Test pieces for the tensile test

8.2.2.2.1 One test piece shall be prepared in accordance with ISO 6892 for the tensile test from each test unit and this shall be a rectangular test piece, unless a circular test piece may be used (see 8.2.2.2.3).

8.2.2.2.2 At least one rolled surface shall be retained on rectangular test pieces. However, both rolled surfaces shall generally be retained on the test piece in the case of product thicknesses $\leqslant$ 25 mm for products in accordance with ISO 9328-2 to ISO 9328-6 or $\leqslant$ 10 mm in the case of products in accordance with ISO 9328-7. Additionally, rectangular test pieces for products in accordance with ISO 9328-5 and ISO 9328-6, shall represent either the full product thickness or half of the product thickness retaining one rolled surface.

8.2.2.2.3 Circular test pieces are permissible, but shall only be provided for product thicknesses $>$ 25 mm for products in accordance with ISO 9328-2 to ISO 9328-6 or $>$ 10 mm for products in accordance with ISO 9328-7. Test piece diameters shall be at least 10 mm for products in accordance with ISO 9328-2 to ISO 9328-6 and at least 5 mm for products in accordance with ISO 9328-7.

8.2.2.3 Test pieces for the impact test

Standard V-notched test pieces shall be prepared from the samples for the impact test, in accordance with ISO 148.

In the case of nominal product thicknesses, t, of 6 mm $\leqslant t \leqslant$ 10 mm subsidiary size test pieces of widths of 7,5 mm or 5 mm shall be machined. Test pieces shall not be machined for product thicknesses $<$ 6 mm. The notch shall be perpendicular to the surface of the product.

9 Test methods

9.1 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 upon, if possible, with reference to the corresponding International Standards.

9.2 Tensile test at room temperature

9.2.1 For the steels of ISO 9328-2 to ISO 9328-6 the tensile test at room temperature shall be carried out in accordance with ISO 6892, generally using a proportional test piece of gauge length L_0 = 5,65 $\sqrt{S_0}$ where S_0 is the original cross-sectional area of the test piece. Test pieces with a constant gauge length may be used; in which case, the elongation value shall be converted in accordance with ISO 2566-1 for the steels of ISO 9328-2 to ISO 9328-6.

The yield strength to be determined shall be the upper yield strength, R_{eH}, or, wherever this is not pronounced, the 0,2 % proof strength, $R_{p0,2}$.

9.2.2 For the steels of ISO 9328-7 the tensile test at room temperature shall be carried out in accordance with ISO 6892 taking into account the additional or deviating conditions specified in Table 4. For proportional test pieces, the gauge lengths specified in 9.2.1 shall be used. For non-proportional test pieces, the elongation values shall be converted in accordance with ISO 2566-2. The tensile strength and elongation after fracture shall be determined and additionally, for ferritic, martensitic and austenitic-ferritic steels, the 0,2 % proof strength and for austenitic steels the 0,2 % and 1,0 % proof strength.

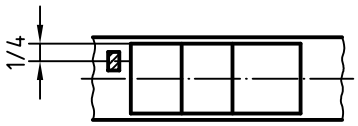
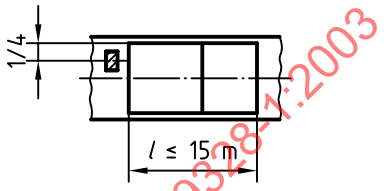
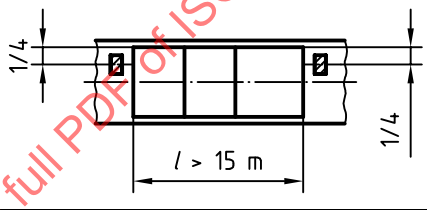
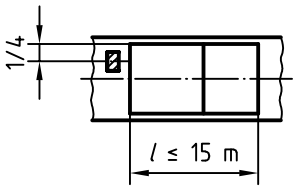
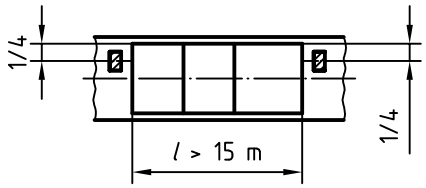
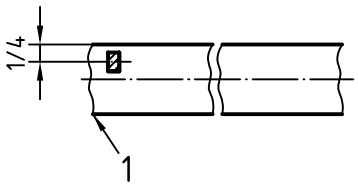
In cases of dispute, and where permitted (see 8.2.2.2.3), the tensile test shall be carried out on circular test pieces.

9.3 Tensile test at elevated temperature

The 0,2 % proof strength, the 1,0 % proof strength and the tensile strength at elevated temperature shall be determined in accordance with ISO 783. Verification, if required, shall be obtained at one of the temperatures given in the relevant table of the individual parts of ISO 9328.

▲ This temperature shall be agreed upon at the time of enquiry and order.

Table 2 — Positions from which the samples are taken

Products	Steel grade	Sheet/plate thickness mm	Product length supplied per rolled plate m	Position of samples (plan view)
Plate/ sheet	Non-alloy steels	⩽ 50	No limitation	
		> 50	⩽ 15	
			> 15	a 
	Alloy steels	No limitation	⩽ 15	
			> 15	a 
Strip	No distinction	No limitation	—	b  **Key** 1 outside end

a The samples may also be taken from the other side of the product. Only one sample is necessary if the product has been continuously cast and if this is mentioned in the inspection document.

b For the plate/sheet cut from strip, the strip remains the test unit as long as the plate/sheet is not quenched and tempered.