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INTERNATIONAL STANDARD

ISO 9327-1

First edition
1999-04-15

Steel forgings and rolled or forged bars for pressure purposes — Technical delivery conditions —

Part 1:
General requirements

Pièces forgées et barres laminées ou forgées en acier pour appareils à pression — Conditions techniques de livraison —

Partie1: Exigences générales

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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 3.

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.

International Standard ISO 9327-1 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 10, *Steel for pressure purposes*.

This first edition, together with parts 2 to 5 of ISO 9327, cancels and replaces ISO 2604-1:1975.

ISO 9327 consists of the following parts, under the general title *Steel forgings and rolled or forged bars for pressure purposes — Technical delivery conditions*:

— *Part 1: General requirements*

— *Part 2: Non-alloy and alloy (Mo, Cr and CrMo) 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: Stainless steels*

Annexes A, B and C form an integral part of this part of ISO 9327.

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Steel forgings and rolled or forged bars for pressure purposes — Technical delivery conditions —

Part 1:
General requirements

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1 Scope

1.1 This part of ISO 9327 covers the technical delivery conditions for forgings (see note 1) and for rolled or forged bars for pressure purposes manufactured from the following internationally used steels (see note 2):

a) non-alloy and alloy ferritic or martensitic steels with specified room temperature properties and supplementary requirements for elevated temperature properties covered in ISO 9327-2;

b) nickel steels with specified low temperature properties covered in ISO 9327-3;

c) weldable fine grain steels with high proof strength (room temperature, elevated temperature and low temperature grades) covered in ISO 9327-4;

d) austenitic and austenitic-ferritic steels (room temperature and elevated temperature grades) covered in ISO 9327-5.

NOTE 1 In accordance with ISO 6929 the term forgings covers here open die forgings including ring rolled products as well as closed die forgings.

NOTE 2 Additional to the internationally used steels for pressure purposes covered in parts 2 to 5 of ISO 9327, there are other steels used regionally or nationally for the same application. These other steels shall not be precluded by this International Standard provided that they comply with the relevant International or National Standards for vessel constructions.

NOTE 3 The following International Standards also apply for steel products for pressure purposes: ISO 9328 parts 1 to 5, ISO 9329 parts1 to 4, ISO 9330 parts 1 to 6, ISO 4978.

1.2 In special cases variations of the requirements of this International Standard or additions to them may form the subject of an agreement at the time of enquiry and order (see annex C).

1.3 In addition to the requirements of this International Standard the general technical delivery requirements in ISO 404 apply, unless otherwise indicated in the following.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 9327. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 9327 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

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

ISO 683-13:1986, *Heat-treatable steels, alloy steels and free-cutting steels — Part 13: Wrought stainless steels.*

ISO 3651-1:1998, *Determination of resistance to intergranular corrosion of stainless steels— Part 1: Austenitic and ferritic-austenitic (duplex) stainless steels — Corrosion test in nitric acid medium by measurement of loss in mass (Huey test).*

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

ISO 4948-2:1982, *Steels — Classification — Part 2: Classification of unalloyed and alloy steels according to main quality classes and main property or application characteristics.*

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

ISO 9327-2, *Steel forgings and rolled or forged bars for pressure purposes — Technical delivery conditions — Part 2: Non-alloy and alloy (Mo, Cr and CrMo) steels with specified elevated temperature properties.*

ISO 9327-3, *Steel forgings and rolled or forged bars for pressure purposes — Technical delivery conditions — Part 3: Nickel steels with specified low temperature properties.*

ISO 9327-4, *Steel forgings and rolled or forged bars for pressure purposes — Technical delivery conditions — Part 4: Weldable fine grain steels with high proof strength.*

ISO 9327-5, *Steel forgings and rolled or forged bars for pressure purposes — Technical delivery conditions — Part 5: Stainless steels.*

ISO/TR 9769:1991, *Steel and iron — Review of available methods of analysis.*

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

ISO/TR 15461:1997, *Steel forgings — Testing frequency, sampling conditions and test methods for mechanical tests.*

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3 Terms and definitions

For the purposes of this part of ISO 9327 the following terms and definitions apply.

— For the terms “steel”, “non-alloy steel”, “alloy steel”, “quality steel” and “special steel” the definitions given in ISO 4948-1 and ISO 4948-2 apply.

— For the terms “bar” and “forging” the definitions given in ISO 6929 apply.

— For the terms “ruling section” and “equivalent diameter” or “equivalent thickness” see annex A.

NOTE The classification of the steels listed in ISO 9327-2 and ISO 9327-4, in accordance with ISO 4948, is indicated in Table 1, footnote a, of ISO 9327-2:1999 and ISO 9327-4:1999. All steels listed in ISO 9327-3 and ISO 9327-5 are alloy, special steels.

4 Ordering

4.1 The purchaser shall state on his enquiry and order the indications and requirements given below:

a) the quantity of products required;

b) an indication of the product form (e.g. "forging");

c) the number(s) of the standard(s) or drawing(s) containing the dimensions, tolerances and surface finishes, the requirements for surface quality and, where appropriate, the mass with which the products shall comply in the condition at delivery (see 5.6 to 5.8);

d) the designation "steel" and the number of the applicable part of ISO 9327;

e) the designation of the steel type required (see Table 1 of ISO 9327-2:1999, ISO 9327-3:1999, ISO 9327-4:1999 and ISO 9327-5:1999);

f) where necessary, the heat treatment condition;

g) in the case of forgings with differing cross sections over their length the ruling section or, where two samples of different parts of a product with different thicknesses are to be taken, the different ruling sections;

h) the type of inspection document required (see 6.1) and, if an inspection certificate of type 3.1.A or 3.1.C or an inspection report is required, the address of the inspection representative or the inspection body;

i) details of marking [see 7.1 c) and 7.2];

j) where one or more of the supplementary requirements (options) of annex C apply, the appropriate clause number of annex C (e. g. clause C.6) and possibly other necessary details.

NOTE 1 The agreed requirements for surface finish shall be compatible with the requirements for non-destructive inspection.

NOTE 2 As long as ISO/TR 4949 is not transformed into an International Standard, steel type designations referred to in 4.1 a) are tentative. Steel type designations used until now in International Standard ISO 2604-1 (cancelled and replaced by ISO 9327) are given in Table 1 of ISO 9327-2:1999, ISO 9327-3:1999, ISO 9327-4:1999 and ISO 9327-5:1999 for comparison.

EXAMPLE: To be delivered are three forgings according to drawing number 24789 of company XYZ with an as heat-treated individual mass of more than 2 400 kg (i.e. according to Table 1 individual testing), manufactured in accordance with ISO 9327-2, of steel type 13CrMo9-10 (see Table 1 of ISO 9327-2:1999), with an inspection certificate of type 3.1.B according to ISO 10474.

The minimum elevated temperature proof strength values specified in Table 3 of ISO 9327-2:1999 shall apply (see option clause C.4).

For the softest of the three forgings an additional room temperature tensile test and an additional tensile test at 500 °C on test pieces from samples subjected to an additional heat treatment of 15 h at 670 °C shall be carried out (see option clause C.7).

Ordering information:

— three forgings acc. to XYZ drawing No. 24789;

— steel ISO 9327-2 – 13CrMo9-10;

— document ISO 10474 – 3.1.B;

— applicable supplementary requirements of ISO 9327-1:1999:

  — clause C.4 – applicability of the minimum elevated temperature proof strength values,

  — clause C.7 – mechanical tests on samples with additional heat treatment;

— the test pieces shall be taken from the softest of the three forgings;

— heat treatment: 15 h at 670 °C;

— tests: one tensile test at room temperature, one at 500 °C;

— requirements: as specified in the delivery conditions.

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4.2 The manufacturer shall state in his offer and confirmation of the order the indications given below:

a) in the case of fine grain steels covered in ISO 9327-4 the chemical composition of the type of alloy supplied (see 5.2.2.1);

b) in the case of steels for which, in Table 1 of ISO 9327-2:1999 or ISO 9327-4:1999, the heat treatment Q + T is given as an alternative, whether he wishes to reserve the possibility of using this alternative and, if so, the lowest tempering temperature which might apply;

c) in cases, where for different thicknesses different mechanical properties are specified, the greatest equivalent thickness which the ruling section will presumably exhibit in the as heat-treated surface condition (see Table 1, footnote d in ISO 9327-2:1999 and ISO 9327-4:1999);

d) in accordance with clause 5, Table 5 and annex C of ISO/TR 15461:1997, the three main directions X, Y and Z of strain.

NOTE Where the steels are further fabricated by welding it may be appropriate to check whether the intended welding conditions are compatible with the heat treatment conditions intended by the manufacturer.

5 Requirements

5.1 Manufacturing process

5.1.1 Steelmaking

The steel shall be produced by one of the basic oxygen processes or by the electric or open-hearth process or by a combination of these.

Other processes may be used by agreement between the interested parties (see option clause C.1).

5.1.2 Deoxidation

Other steels than stainless steels shall be fully killed.

5.1.3 Hot working

The choice of the hot working process (e. g. hammering, drop forging, pressing, extruding, ring rolling or, in the case of bars, rolling) is left to the discretion of the manufacturer (see option clause C.2).

5.1.4 Heat treatment condition

The products shall be supplied in the heat treatment condition indicated in Table 1 of ISO 9327-2:1999, ISO 9327-3:1999, ISO 9327-4:1999 and ISO 9327-5:1999 for the particular steel type ordered.

Where different heat treatment conditions with the same properties are specified the choice between these conditions is left to the manufacturer [see 4.2 b)].

5.1.5 Surface finish

The surface finish shall comply with the agreements in the order [see 4.1c)]. Usual surface treatments are:

— for the steels covered in ISO 9327-2, ISO 9327-3 and ISO 9327-4: as-forged, rough machined or finish machined and, for smaller forgings, shot-blasted;

— for the stainless steels of ISO 9327-5: the treatments F3 to F6 are given in Table B.1.

5.1.6 Cast separation

The products shall be delivered separated by casts.

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5.2 Chemical composition

5.2.1 For the steels covered in ISO 9327-2, ISO 9327-3 and ISO 9327-5, the following applies:

5.2.1.1 The chemical composition determined by the cast analysis shall be within the limits given in Table 1 of ISO 9327-2:1999, ISO 9327-3:1999 and ISO 9327-5:1999 (see option clause C.3).

Elements not quoted in these tables shall not be intentionally added without the agreement of the purchaser, other than for the purpose of finishing the cast.

5.2.1.2 When a product analysis is carried out on samples taken and prepared in accordance with clause C.5 its results shall not deviate from the specified limits for the cast analysis by more than the values given in the Table 2 of ISO 9327-2:1999, ISO 9327-3:1999 and ISO 9327-5:1999.

5.2.2 For the fine grain steels covered in ISO 9327-4 the following applies:

5.2.2.1 The chemical composition of the individual fine grain steel may – depending on the type of alloy additions selected by the manufacturer and on the thickness of the product – be different. It shall, however, in each case comply with the requirements for the results of the cast analysis given for the relevant steel type in Table 1 of ISO 9327-4:1999 and with the requirements of the second paragraph of 5.2.1.1.

As the chemical composition influences the welding characteristics, the manufacturer shall describe in his offer the type of alloy which he will supply. For this purpose he shall indicate for the carbon content and for the contents of the alloying elements the limiting values applicable for this type of alloy (see option clause C.3).

5.2.2.2 The results of a product analysis on samples taken and prepared in accordance with option clause C.5 shall not deviate from the limiting values indicated by the manufacturer for the cast analysis of this type of alloy by more than the values given in Table 2 of ISO 9327-4:1999.

5.3 Mechanical properties

5.3.1 The products when being supplied in the heat-treated condition indicated in Table 1 of ISO 9327-2:1999, ISO 9327-3:1999, ISO 9327-4:1999 and ISO 9327-5:1999 and being tested in accordance with 6.2.2 or C.8 shall comply with

— the room temperature tensile properties specified in Table 1 of ISO 9327-2:1999, ISO 9327-3:1999, ISO 9327-4:1999 and ISO 9327-5:1999;

— the impact properties specified in Table 1 of ISO 9327-2:1999 and ISO 9327-5:1999 and in Table 3 of ISO 9327-3:1999 and ISO 9327-4:1999.

5.3.2 For the elevated temperature proof strength see clause C.4.

5.3.3 Estimates of the average stress rupture and 1 % creep strain properties are given in Tables 4 and 5 of ISO 9327-2:1999 and ISO 9327-5:1999.

5.4 Weldability

The steels covered by the relevant parts of ISO 9327 are generally regarded as being weldable. However, the general weldability of the steels cannot be guaranteed as the behaviour of the steel during and after welding is dependant not only on the steel, but also on the welding conditions and the final use for which the steel is employed. Therefore, where appropriate, the welding procedure shall be agreed between the interested parties at the time of enquiry and order (see option clause C.7).

5.5 Internal soundness

The products shall be free from internal imperfections likely to have an adverse effect on mechanical and other properties.

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NOTE Until International Standards for non-destructive testing of the products covered by the relevant parts of ISO 9327 are available, more exact requirements for the internal soundness of the products may be agreed on the basis of option clause C.12.

5.6 Surface finish and quality

5.6.1 The forgings shall have a workmanlike finish.

5.6.2 The maximum size of surface discontinuities shall be as agreed at the time of enquiry and order.

NOTE For hot rolled round bars such agreements should be based, where appropriate, on the surface quality classes specified in ISO 9443 (see also option clauses C.13 and C.14).

5.6.3 Surface discontinuities may be dressed by chipping and/or grinding providing the dimensions in the dressed area are not less than the specified minimum dimensions.

Following agreement with the purchaser, repairs of discontinuities exceeding the agreed maximum size are permitted. In such cases the details of any proposed repair procedure shall be supplied by the manufacturer to the purchaser for written approval. All repair welding operations shall be carried out by qualified operators. The position of such repairs shall be marked on the forging drawing or on the forgings themselves and referred to on the test certificate.

5.7 Dimensions, shape and tolerances

The dimensions and shape of the products shall comply within the agreed tolerances with the requirements of the order.

5.8 Calculation of nominal mass

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

— steel 16CrMo20-5 7,8 kg/dm³

— steel X23CrMoV12-1 7,7 kg/dm³

— other non-alloy and alloy steels of ISO 9327-2, ISO 9327-3 and ISO 9327-4 7,85 kg/dm³

— stainless CrNi-steels of ISO 9327-5 7,9 kg/dm³

— stainless CrNiMo-steels of ISO 9327-5 8,0 kg/dm³

6 Inspection, testing and conformity of products

6.1 Inspection and testing procedures and types of inspection documents

6.1.1 For deliveries in accordance with the relevant parts of ISO 9327, depending on the agreements in the order, either an inspection certificate 3.1.A, 3.1.B or 3.1.C or inspection report 3.2 (see ISO 10474) shall be issued on the basis of the specific inspections and tests covered under 6.2 and of any ordered supplementary inspections and tests.

6.1.2 The document shall contain the following.

a) The number of the relevant parts of ISO 9327 and the steel designation which shall be regarded as a claim by the manufacturer that the product has been manufactured in accordance with the appropriate requirements of the standard. The accuracy of this claim is solely the manufacturer's responsibility.

b) All symbols, letters or numbers which in addition to the information under a) are necessary to relate the order, the document, the test pieces, test results and products to each other and, if necessary, to the various sampling and testing conditions and deliveries.

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c) The steelmaking method.

d) The results of the cast analysis for all elements specified for the steel type supplied. In the case of the fine grain steels of ISO 9327-4 the elements niobium, titanium and vanadium are only to be regarded as specified elements when these are added to the steel and when the manufacturer has consequently, in accordance with 5.2.2, paragraph 2, indicated limiting values for these elements in the relevant type of alloy.

e) The heat treatment with – in the case of tempered or quenched and tempered products or reference test pieces – the heat treatment temperatures and cooling conditions applied.

f) The results of all the tests and inspections specified in 6.2 or ordered by supplementary requirements (see options clauses C.5 to C.15) and, where this should be necessary, the sampling and testing conditions (e.g. special heat treatment, test piece orientation, testing temperatures etc.).

g) The statement that the material complies with the requirements of the order.

h) Whether any repairs have been performed (see 5.6.3). The location of such repairs shall be marked clearly on the drawings or on the products themselves.

i) The identification of the inspector and/or, where appropriate, the inspection authority.

6.2 Specific inspection and testing

6.2.1 Requirements to be verified

In accordance with 6.1.2 the results of the cast analysis shall be given by the manufacturer (see option clauses C.5 and C.6).

The following requirements are to be verified by specific inspection and testing:

a) the tensile properties at room temperature (see 6.2.2);

b) the ISO V-notch impact strength of the steels of ISO 9327-2 , ISO 9327-3 and ISO 9237-4 (see 6.2.2) and ISO 9237-5 (see option clause C.8);

c) the surface quality (see 6.2.3);

d) the dimensional requirements (see 6.2.3).

6.2.2 Mechanical testing

The sampling conditions and test methods shall be as specified in ISO/TR 15461. In the cases where ISO/TR 15461 offers various options those specified in Tables 1 and 2 shall be applied (see option clause C.9).

6.2.3 Visual and dimensional inspection

Each product shall be inspected visually and appropriate checks shall be made for compliance with the dimensional tolerances (see option clauses C.13 and C.14).

6.2.4 Re-tests

ISO 404 shall apply.

7 Marking

7.1 The products shall legibly be marked to show

a) the designation for the type of steel, as given in the tables;

b) the mark of the manufacturer of the products;

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c) symbols, letters or numbers which relate to each other the reason for traceability, the test certificates, test pieces and products.

7.2 Unless the provisions of 7.3 are valid, the identification marks shall be stamped on each piece in such a location and in such a manner as may be indicated by the purchaser such that it will not be detrimental to the end use of the forging.

7.3 On forgings which are boxed, the information in 7.1 may be marked on the box or on a tag securely attached to the box in which the products are shipped.

Table 1 — Testing frequency

1	2	3	4	5	6	7	8	9
Product Characteristics				**Testing frequency for room temperature tensile tests and for impact tests**				
Steel	**Treatment condition**	**As heat-treated individual mass in kg of**		**Test units and number of sample products to be taken per test unit** [a, b]	**Conditions for taking 2 samples per sample product** [a]	**Number of test pieces to be taken per sample**		**Testing frequency for elevated temperature tensile tests**
		forgings other than bars	**rolled or forged bars**			**tensile**	**impact**	
Austenitic steels or normalized non-alloy steels with $R_{m,min}$ [c] ⩽ 500 N/mm²	Finally heat-treated	⩽ 60	—	CH5 or CHD10 or CFHD15	—	1	3	d
		> 60 ⩽ 2 000		CH10 or CHD15 or CFHD20				
		—	⩽ 3 000	CH15 or CHD20 or CFHD25				
		> 2 000	> 3 000	IND	L5 or W4			
Other steels		⩽ 40	—	CHD2,5 or CFHD5	—			
		> 40 ⩽ 1 000		CHD5 or CFHD10				
		—	⩽ 2 000	CHD10 or CFHD15				
		> 1 000	> 2 000	IND	L5 or W4			

a The symbols used in columns 5 and 6 belong to the system of symbols for sampling conditions explained in ISO/TR 15461.

b Where for the same conditions several test units are indicated, the choice between these test units is, unless otherwise agreed at the time of enquiry and order, left to the discretion of the manufacturer.

c Where, depending on the thickness, several minimum tensile strength ($R_{m,min}$) values are specified for the steel, the highest minimum value shall be deciding.

d Where the test units according to column 5 are not to be subjected to uniformity checks by hardness tests (= test units without "U" in its symbol) from each third sample product taken, in addition to the test pieces to be taken according to columns 7 and 8, one tensile test piece shall be taken for testing the elevated temperature proof strength. Where, according to column 5, the test units are to be subjected to uniformity checks by hardness tests (= test units with a "U" in its symbol), from the sample product with the lowest hardness, in addition to the test pieces to be taken according to columns 7 and 8, one tensile test piece shall be taken for testing the elevated temperature proof strength.

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Table 2 — Sampling conditions

1	2	3	4	
Type of sample product	**Distance of the test pieces from the surface**	**Applicable to**	**Direction of test pieces**	
			tensile	impact
The type of sample product with, where necessary, indications on the way of mounting surplus material and on the location of the test pieces shall be agreed when ordering, where possible, by reference to the relevant symbols in Table 3 of ISO/TR 15461:1997.	$t/4 \times t/2$	bars and shafts in thicknesses $\leqslant$ 160 mm	X	X-Y
		others	Y	Y-X
NOTE The symbols in column 4 belong to the system of symbols for sampling conditions explained in ISO/TR 15461.				

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Annex A
(normative)

Ruling section and equivalent diameters or thicknesses

A.1 Scope

Until a relevant International Standard is available this annex covers definitions for the terms “ruling section” and “equivalent diameter” (d_{eq}) or “equivalent thicknesses” (t_{eq}) and ways for the determination of d_{eq} and t_{eq}.

A.2 Definitions

A.2.1
Ruling section
that section for which the specified mechanical properties shall apply

A.2.2
Equivalent diameter (d_{eq}) or **equivalent thickness (t_{eq})**
equivalent diameter or equivalent thickness is that diameter or thickness of a ruling section (t_R) of a shape X for which, when the same heat treatment, sampling and testing conditions are applied, the same properties as for the thickness of a ruling section with the reference shape R may be expected.

A.3 Reference shape of the ruling section

In ISO 9327-2, ISO 9327-3, ISO 9327-4 and ISO 9327-5 the specified mechanical properties refer to products with a ruling section whose shape complies with the following characteristics:

— form of the cross-section: rectangular;

— width to thickness ratio: $\geqslant 2$;

— length to width ratio: $\geqslant 4$

A.4 Determination of the equivalent diameters or equivalent thicknesses

A.4.1 For ruling sections with other characteristics than those described in clause A.3 the diameters or thicknesses equivalent to the thicknesses given in the tables for the mechanical properties of ISO 9327-2:1999, ISO 9327-3:1999, ISO 9327-4:1999 and ISO 9327-5:1999 shall, unless otherwise agreed at the time of enquiry and order, where possible be read off from Table A.1.

A.4.2 If, for the shape of the ruling section of the ordered product, no equivalent thicknesses are given in Table A.1, the thickness range of Table 1 of ISO 9327-2:1999, ISO 9327-3:1999, ISO 9327-4:1999 and ISO 9327-5:1999 which shall be regarded as applicable for the relevant ruling section, shall be agreed at the time of enquiry and order.

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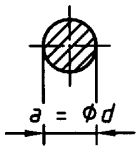
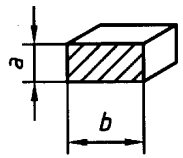
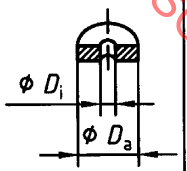
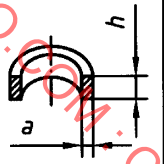
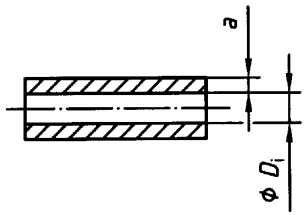
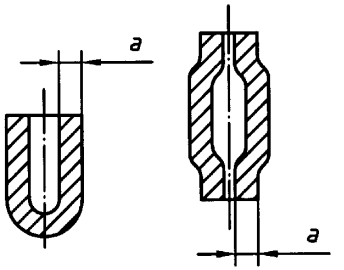
Table A.1

Thickness of the reference ruling section t_R[a]	Equivalent thickness a in millimetres for ruling sections with another shape than the reference ruling section								
	Bars with cross section		Discs	Rings	Cylindrical hollow sections, both ends open			Cylindrical hollow sections	Other ruling sections
	round	rectangular						one end closed / both ends closed	
									
	$a = d$	$1 \leqslant \frac{b}{a} \leqslant 2$ $a \approx 0{,}8\ d$	$D_a - D_i \geqslant 2a$ $D_i \leqslant 200$ mm	$h > a$ $D_i > 200$ mm	$D_i < 80$ mm	80 mm $\leqslant D_i \leqslant$ 200 mm	$D_i > 200$ mm		
mm	mm		$a \approx d/1{,}5$	$a \approx d/1{,}5$	$a \approx d/2$	$a \approx d/1{,}75$	$a \approx d/1{,}5$	$a \approx d/2{,}5$	
16	24	19	16	16	12	14	16	10	By agreement (see A.4.2)
30	45	36	30	30	22	26	30	18	
35	52	42	35	35	26	30	35	21	
40	60	48	40	40	30	34	40	24	
50	75	60	50	50	37	43	50	30	
60	90	72	60	60	45	51	60	36	
70	105	84	70	70	53	60	70	42	
100	150	120	100	100	75	86	100	60	
150	225	180	150	150	113	129	150	90	
250	375	300	250	250	188	214	250	150	
300	500	400	333	333	250	286	333	200	

[a] Indicated are the thickness values given in the tables for mechanical properties in ISO 9327 parts 2 to 4. These are applicable for ruling sections with rectangular cross-section, a width to thickness ratio of ⩾ 2 and a length to thickness ratio of ⩾ 4.

Table A.1 — Equivalent thickness for ruling sections of different shape

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Annex B
(normative)

Usual surface conditions for stainless steels

From the various surface conditions specified in ISO 683-13 for various products of stainless steels, those given in Table B.1 are considered as usual surface conditions for the products covered by the relevant parts of ISO 9327.

Table B.1 — Type of condition and surface condition of stainless steel products [a]

Symbol [b]	Type of condition	Surface condition	Remarks
F3	Hot-formed, heat-treated, not descaled	Covered with scale from hot forming	Suitable only for such parts, which will be descaled all over or machined after production
F4	Hot-formed, heat-treated, mechanically descaled	Mechanically clean	The type of mechanical descaling, for example rough grinding, blasting or rough peeling, depends on the product form and is, unless otherwise agreed, left to the discretion of the manufacturer.
F5	Hot-formed, heat-treated, pickled		
F6	Hot-formed, heat-treated, prepared by machining	Metallic bright	—

a Combinations of the different conditions may be agreed at the time of enquiry and order.

b The symbols are preliminary. It is intended to establish a system of symbols for the different types of condition and surface condition.

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Annex C
(normative)

Supplementary or special requirements (options)

NOTE As indicated in 1.2 and 4.1 j) the individual supplementary or special requirements given in the following only apply, as far as this has been agreed, together with the necessary details at the time of enquiry and order.

C.1 Special refining processes (to 5.1.1)

The steel shall be subjected to a special refining process. The type of process (vacuum treatment, remelting process) shall be agreed at the time of enquiry and order.

C.2 Hot working (to 5.1.3)

The process and, if so agreed, the degree of hot working shall be in compliance with special agreements made at the time of enquiry and order.

C.3 Residual elements (to 5.2.1.1 and 5.2.2.1)

If, in special cases, the purchaser considers that the level of residual elements is important in relation to the mechanical and technological properties of the steel in the intended application, the cast (ladle) analysis limits for such elements shall be agreed at the time of the enquiry or order and the agreed elements shall then be analysed and the values reported.

C.4 Minimum elevated temperature proof strength values (to 5.3.2)

For test pieces taken, prepared and tested in accordance with 6.2.2 the minimum elevated temperature proof strength values given for the relevant steel in ISO 9327-2, ISO 9327-4 or ISO 9327-5 shall apply as a mandatory requirement (see also clause C.10).

C.5 Product analysis (to 5.2.1.2 and 5.2.2.2)

One product analysis shall be carried out per cast for the determination of all elements for which values are specified for the steel type concerned either in Table 1 of ISO 9327-2:1999, ISO 9327-3:1999, ISO 9327-4:1999 and ISO 9327-5:1999 or by ordering option clause C.3. In the case of the fine grain steels of ISO 9327-4:1999 the restrictions of 6.1.2, d) of that standard are also applicable.

The samples for analysis may be taken from a test piece used for the verification of the mechanical properties. In cases of dispute, however, as far as possible chips shall be taken from locations uniformly distributed over the whole cross-section of the product and the method of analysis shall be selected from the list of internationally standardized methods given in ISO/TR 9769.

C.6 Check on mixing up of steels (to 6.2.1)

NOTE This supplementary requirement is normally only applied for alloy steels

All products shall be checked to prevent materials becoming mixed up. The method used for such checks and the sampling conditions are, unless otherwise agreed at the time of enquiry and order, left to the discretion of the manufacturer.

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