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International Standard ISO 683/13

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Heat-treatable steels, alloy steels and free-cutting steels — Part 13: Wrought stainless steels

Aciers pour traitement thermique, aciers alliés et aciers pour décolletage — Partie 13: Aciers corroyés inoxydables

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 683/13 was prepared by Technical Committee ISO/TC 17, *Steel*.

This second edition cancels and replaces the first edition (ISO 683/13-1974), of which it constitutes a technical revision.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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INTERNATIONAL STANDARD ISO 683/13-1986 (E)

Heat-treatable steels, alloy steels and free-cutting steels — Part 13: Wrought stainless steels

1 Scope and field of application

1.1 This part of ISO 683 applies to the grades of wrought stainless steels listed in table 1 and usually intended for applications in which corrosion resistance is essential.

1.2 This part of ISO 683 is applicable to

- semi-finished products
- wrought bars
- flat products
- wire rods.

NOTE — Separate documents are existing or in preparation for

- precipitation hardening stainless steels (see ISO 683/16)
- heat-resisting steels (see ISO 4955)
- steels for use at elevated temperatures in engines (see ISO/TR 4956)
- stainless steels for use on and with pressure vessels and boilers [see ISO 2604/1 (forgings); ISO 2604/2 (wrought seamless tubes); ISO 2604/4 (plates), and ISO 2604/5 (longitudinally welded austenitic stainless steel tubes)]
- stainless steels for cold heading and cold extruding (see ISO 4954)
- wire and strip for stainless steel springs
- wire rods for the manufacture of welding electrodes.

1.3 In addition to this part of ISO 683, the general technical delivery requirements of ISO 404 are applicable.

2 References

ISO/R 80, *Rockwell hardness test (B and C scales) for steel.*

ISO 83, *Steel — Charpy impact test (U-notch).*

ISO 148, *Steel — Charpy impact test (V-notch).*

ISO 377, *Wrought steel — Selection and preparation of samples and test pieces.*

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

ISO 1035, *Hot rolled steel bars*

- *Part 1: Dimensions of round bars.*
- *Part 2: Dimensions of square bars.*
- *Part 3: Dimensions of flat bars.*
- *Part 4: Tolerances.*

ISO 3651, *Austenitic stainless steels — Determination of resistance to intergranular corrosion*

- *Part 1: Corrosion test in nitric acid medium by measurement of loss in mass (Huey test).*
- *Part 2: Corrosion test in a sulphuric acid/copper sulphate medium in the presence of copper turnings (Monypenny Strauss test).*

ISO 4200, *Plain end steel tubes, welded and seamless — General tables of dimensions and masses per unit length.*

ISO 4964, *Steel — Hardness conversions.*

ISO 6506, *Metallic materials — Hardness test — Brinell test.*

ISO 6507/1, *Metallic materials — Hardness test — Vickers test — Part 1: HV 5 to* HV 100.

ISO 6892, *Metallic materials — Tensile testing.*

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

3 Ordering

3.1 The purchaser shall state in his enquiry and order

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a) the steel type (see table 1);

b) the product form and the dimensions and tolerances of the product (see 4.7);

c) the treatment condition including surface condition (see 4.2, 4.6 and footnote 3 to table 3);

d) the quantity to be delivered;

e) the required type of document (see 5.6).

3.2 Certain options in ordering are permitted by this part of ISO 683 and the purchaser may also state in his enquiry and order the following related requirements:

f) whether a product analysis is required (see 5.2.1);

g) whether the mechanical properties are to be verified on reference test pieces (see 4.4);

h) whether a test on corrosion resistance is required (see 4.5);

j) whether [for steel types 3, 4 and 9 b] impact tests are required (see footnote 2 to table 5).

4 Requirements

4.1 Manufacture of the steel and of the product

Unless otherwise agreed in the order, the processes used in making the steel and the product are left to the discretion of the manufacturer. When he so requests, the purchaser shall be informed what steelmaking process is being used.

4.2 Heat treatment and surface condition at delivery

4.2.1 The heat-treatment condition at the time of delivery shall comply with the condition agreed in the order and should be one of the conditions indicated in tables 4 to 6. The manufacturer has to choose the heat treatment (see for guidance table 7) such that the properties are met.

4.2.2 The surface condition of the products should be one of those given in table 3.

4.3 Chemical composition

4.3.1 The chemical composition of the steels, as given by the cast analysis, shall be in accordance with the specifications in table 1.

4.3.2 The permissible deviations between the values specified in table 1 and the product analysis are given in table 2.

4.4 Mechanical properties

For the usual heat-treatment conditions, the mechanical properties are specified in table 4, 5 or 6. If the products are delivered in the non-heat-treated condition and if agreed at the time of enquiry and order, the mechanical properties specified in tables 4, 5 or 6 shall be achievable for suitably treated reference test pieces.

4.5 Corrosion resistance

For the resistance against intergranular corrosion, requirements may be agreed, for example on the basis of the intergranular corrosion tests given in ISO 3651/1 or ISO 3651/2.

4.6 Surface condition

The products may be ordered in the type of condition and surface condition indicated in table 3. Availability and the question of the types of condition most suited to a particular case should be discussed with the supplier. Except symbols F 10, F 11, and F 12, minor surface irregularities caused by manufacturing process are no cause for rejection.

4.7 Dimensions, tolerances on dimensions and masses

4.7.1 For hot-rolled bars, the dimensions specified in ISO 1035/1, ISO 1035/2 or ISO 1035/3 and the tolerances specified in ISO 1035/4 apply.

4.7.2 For not continuously hot-rolled flat products, the specifications of ISO 7452 apply.

4.7.3 In the cases of continuously rolled flat products, forged bars and wire rods, the dimensions and the tolerances allowable on dimensions and masses shall be stated in the order as long as there are no International Standards to cover them.

5 Testing

5.1 Agreement of tests and documents

5.1.1 For each delivery, the issue of any document according to ISO 404 may be agreed at the time of enquiry and order.

5.1.2 If, in accordance with such an agreement, specific inspection is to be carried out, the specifications given in 5.2 to 5.5 shall be observed.

5.2 Number of tests

5.2.1 Chemical composition

The cast analysis is given by the manufacturer. If a product analysis is required by the purchaser, one sample product shall be taken from each cast.

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5.2.2 Mechanical properties

The test unit consists of products of the same cast, the same size (see the note) and the same heat-treatment batch.

For the tensile test at room temperature, one test piece has to be taken per test unit.

If an impact test at room temperature is required by the purchaser, the number of test pieces per test unit shall be agreed.

NOTE — Products with deviations of 25 % from the largest size may be collated.

5.2.3 Corrosion resistance

For the composition of the test unit, see 5.2.2. If a test for the resistance against intergranular corrosion is required, the number of test pieces per test unit is to be agreed.

5.3 Selection and preparation

5.3.1 General

The general conditions given in ISO 377 for the selection and the preparation of samples and test pieces shall apply.

5.3.2 Product analysis

For product analysis, the selection and preparation of samples shall be carried out in conformity with the requirements of ISO 377.

5.3.3 Tensile and impact tests

5.3.3.1 For the tensile test the requirement of in 5.3.3.2 and 5.3.3.3 apply; for the impact test the requirement of in 5.3.3.2 are applicable.

If products are delivered in the untreated condition, the sample shall be converted into the usual heat-treatment condition according to table 4, 5 or 6 and table 7.

5.3.3.2 In the case of bars and wire rods, the test pieces shall be taken according to figure 1 in the longitudinal direction of the products. In cases of dispute, the tensile test pieces shall have a gauge length of

$$L_o = 5{,}65\sqrt{S_o}$$

where S_o is the original cross-section.

Where impact test pieces are required, these should lie next to one another in the sample. They shall have the dimensions specified in the relevant International Standard for impact test.

5.3.3.3 For flat products, the test pieces are to be taken in accordance with figure 2. In cases of dispute products of thickness $\geqslant 3$ mm shall have a gauge length of

$$L_o = 5{,}65\sqrt{S_o}$$

For products of thickness <3 mm, test pieces either of 20 mm width and 80 mm gauge length or of 12,5 mm width and 50 mm gauge length according to ISO 6892 may be used.

5.3.4 Hardness test and test on corrosion resistance

Details for the selection and preparation of samples and test pieces for hardness tests and tests on corrosion resistance may be agreed at the time of enquiry and order.

5.4 Methods of test

5.4.1 Chemical analysis

In cases of dispute, the methods used for the chemical analysis shall be those established by the relevant International Standards. If no International Standards exist, the methods shall be agreed upon at the time of enquiry and order.

5.4.2 Tensile test

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

5.4.3 Impact test

The impact test shall be carried out in accordance with the International Standard agreed between the interested parties.

Unless otherwise specified at the time of enquiry and order, the impact value shall be determined by taking the arithmetic mean of three test results.

5.4.4 Hardness test

The Brinell hardness test shall be carried out in accordance with ISO 6506.

The Rockwell hardness test shall be carried out in accordance with ISO/R 80.

The Vickers hardness test shall be carried out in accordance with ISO 6507/1.

5.4.5 Corrosion test

Unless otherwise agreed, tests on corrosion resistance shall be carried out in accordance with ISO 3651/1 or 3651/2.

5.5 Retests

For retests ISO 404 shall apply.

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5.6 Certification of the tests

ISO 404 is valid, an acceptable document being one of the following

- statement of compliance with the order
- test report
- inspection certificate
- inspection report.

6 Marking

The products are to be marked with the manufacturer's symbol, the steel grade, and, if so agreed when ordering, with the cast number. When specific inspection is carried out, the products are to be provided additionally with an identification number which enables the test pieces to be related to the cast and product from which they stem.

7 Complaints

The conditions for dealing with complaints laid down in ISO 404 shall apply.

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Table 1 — Types of steel and specified chemical composition (cast analysis)[1]

Type[2] of steel	Chemical composition [% (*m/m*)]													
	C	Si max.	Mn	P max.	S	N	Al	Cr	Mo	Nb[3]	Ni	Se min.	Ti	Cu
Ferritic steels														
1 Ti	0,08 max.	1,0	1,0 max.	0,040	0,030 max.	—	—	10,5 to 12,5	—	—	1,0 max.	—	6×%C<1,0	—
1	0,08 max.	1,0	1,0 max.	0,040	0,030 max.	—	—	12,0 to 14,0	—	—	1,0 max.	—	—	—
2	0,08 max.	1,0	1,0 max.	0,040	0,030 max.	—	0,10 to 0,30	12,0 to 14,0	—	—	1,0 max.	—	—	—
8	0,08 max.	1,0	1,0 max.	0,040	0,030 max.	—	—	16,0 to 18,0	—	—	1,0 max.	—	—	—
8a	0,08 max.	1,0	1,5 max.	0,060	0,15 to 0,35	—	—	16,0 to 18,0	0,60 max.[4]	—	1,0 max.	—	—	—
8b	0,07 max.	1,0	1,0 max.	0,040	0,030 max.	—	—	16,0 to 18,0	—	—	1,0 max.	—	7×%C<1,10	—
9c	0,08 max.	1,0	1,0 max.	0,040	0,030 max.	—	—	16,0 to 18,0	0,90 to 1,30	—	1,0 max.	—	—	—
F1	0,025 max.[5]	1,0	1,0 max.	0,040	0,030 max	0,025 max.[5]	—	17,0 to 19,0	1,75 to 2,50	—[6]	0,60 max.	—	—[6]	—
Martensitic steels														
3	0,09 to 0,15	1,0	1,0 max.	0,040	0,030 max.	—	—	11,5 to 13,5	—	—	1,0 max.	—	—	—
7	0,08 to 0,15	1,0	1,5 max.	0,060	0,15 to 0,35	—	—	12,0 to 14,0	0,60 max.[4]	—	1,0 max.	—	—	—
4	0,16 to 0,25	1,0	1,0 max.	0,040	0,030 max.	—	—	12,0 to 14,0	—	—	1,0 max.	—	—	—
9a	0,10 to 0,17	1,0	1,5 max.	0,060	0,15 to 0,35	—	—	15,5 to 17,5	0,60 max.[4]	—	1,0 max.	—	—	—
9b	0,14 to 0,23	1,0	1,0 max.	0,040	0,030 max.	—	—	15,0 to 17,5	—	—	1,5 to 2,5	—	—	—
5	0,26 to 0,35	1,0	1,0 max.	0,040	0,030 max.	—	—	12,0 to 14,0	—	—	1,0 max.	—	—	—
Austenitic steels														
10	0,030 max.	1,0	2,0 max.	0,045	0,030 max.	—	—	17,0 to 19,0	—	—	9,0 to 12,0	—	—	—
11	0,07 max.	1,0	2,0 max.	0,045	0,030 max.	—	—	17,0 to 19,0	—	—	8,0 to 11,0	—	—	—
15	0,08 max.	1,0	2,0 max.	0,045	0,030 max.	—	—	17,0 to 19,0	—	—	9,0 to 12,0	—	5×%C<0,80	—
16	0,08 max.	1,0	2,0 max.	0,045	0,030 max.	—	—	17,0 to 19,0	—	10×%C<1,0	9,0 to 12,0	—	—	—
12	0,12 max.	1,0	2,0 max.	0,045	0,030 max.	—	—	17,0 to 19,0	—	—	8,0 to 10,0	—	—	—
17	0,12 max.	1,0	2,0 max.	0,060	0,15 to 0,35	—	—	17,0 to 19,0	—[7]	—	8,0 to 10,0[8]	—	—	—
17a	0,12 max.	1,0	2,0 max.	0,20	0,060 max.	—	—	17,0 to 19,0	—[7]	—	8,0 to 10,0	0,15	—	—
13	0,10 max.	1,0	2,0 max.	0,045	0,030 max.	—	—	17,0 to 19,0	—	—	11,0 to 13,0	—	—	—
14	0,15 max.	1,0	2,0 max.	0,045	0,030 max.	—	—	16,0 to 18,0	—	—	6,0 to 8,0	—	—	—
19	0,030 max.	1,0	2,0 max.	0,045	0,030 max.	—	—	16,5 to 18,5	2,0 to 2,5	—	11,0 to 14,0	—	—	—
20	0,07 max.	1,0	2,0 max.	0,045	0,030 max.	—	—	16,5 to 18,5	2,0 to 2,5	—	10,5 to 13,5	—	—	—
21	0,08 max.	1,0	2,0 max.	0,045	0,030 max.	—	—	16,5 to 18,5	2,0 to 2,5	—	11,0 to 14,0	—	5×%C<0,80	—
23	0,08 max.	1,0	2,0 max.	0,045	0,030 max.	—	—	16,5 to 18,5	2,0 to 2,5	10×%C<1,0	11,0 to 14,0	—	—	—
19a	0,030 max.	1,0	2,0 max.	0,045	0,030 max.	—	—	16,5 to 18,5	2,5 to 3,0	—	11,5 to 14,5	—	—	—
20a	0,07 max.	1,0	2,0 max.	0,045	0,030 max.	—	—	16,5 to 18,5	2,5 to 3,0	—	11,0 to 14,0	—	—	—
24	0,030 max.	1,0	2,0 max.	0,045	0,030 max.	—	—	17,5 to 19,5	3,0 to 4,0	—	14,0 to 17,0	—	—	—
10 N	0,030 max.	1,0	2,0 max.	0,045	0,030 max.	0,12 to 0,22	—	17,0 to 19,0	—	—	8,5 to 11,5	—	—	—
19 N	0,030 max.	1,0	2,0 max.	0,045	0,030 max.	0,12 to 0,22	—	16,5 to 18,5	2,0 to 2,5	—	10,5 to 13,5	—	—	—
19a N	0,030 max.	1,0	2,0 max.	0,045	0,030 max.	0,12 to 0,22	—	16,5 to 18,5	2,5 to 3,0	—	11,5 to 14,5	—	—	—
A-2	0,15 max.	1,0	5,5 to 7,5	0,060	0,030 max.	0,05 to 0,25	—	16,0 to 18,0	—	—	3,5 to 5,5	—	—	—
A-3	0,15 max.	1,0	7,5 to 10,5	0,060	0,030 max.	0,05 to 0,25	—	17,0 to 19,0	—	—	4,0 to 6,0	—	—	—
A-4	0,025 max.[9]	1,0	2,0 max.	0,035	0,025 max.	—[10]	—	19,0 to 22,0	4,0 to 5,0	—	24,0 to 27,0	—	—	1,0 to 2,0

1) Elements not quoted shall not be intentionally added to the steel without the agreement of the purchaser, other than for the purpose of finishing the heat. All reasonable precautions shall be taken to prevent the addition, from scrap or other material used in manufacture, of such elements which affect the hardenability, mechanical properties and applicability.

2) The type numbers are tentative and will be subject to alternation when the relevant International Standards have been established.

3) Tantalum determined as niobium.

4) After agreement at the time of enquiry and order the steel may be supplied with a Mo content of 0,20 to 0,60 % (*m/m*).

5) (C + N) max. 0,040 % (*m/m*).

6) 8 × (C + N) < (Nb + Ti) < 0,80 % (*m/m*).

7) The manufacturer has the option of adding molybdenum up to 0,70 % (*m/m*).

8) The maximum nickel content of semi-finished products for fabrication into seamless tubes may be increased by 0,5 % (*m/m*).

9) For certain applications, particularly where the steel is applied in chloride solutions, the carbon content may be specified to max. 0,020 % (*m/m*).

10) After agreement, nitrogen may be added to this steel up to a limit of max. 0,15 % (*m/m*).

Table 2 — Product analysis — Permissible deviations from the specified cast analysis
(see table 1)[1)]

Element	Cast analysis (specified limits) [% (*m/m*)]		Permissible deviation[2)] from the specified composition
C		≤ 0,030	+ 0,005
	> 0,030	< 0,20	± 0,01
	≥ 0,20	≤ 0,35	± 0,02
Si		≤ 1,0	+ 0,05
Mn		≤ 1,0	+ 0,03
	> 1,0	≤ 2,0	± 0,04
	≥ 5,5	≤ 10,5	± 0,10
P		≤ 0,040	+ 0,005
	> 0,040	≤ 0,20	+ 0,010
S		≤ 0,030	+ 0,005
	> 0,030	≤ 0,060	+ 0,010
	≥ 0,15	≤ 0,35	± 0,02
N		< 0,05	+ 0,005
	≥ 0,05	≤ 0,25	+ 0,02 − 0,01
Al		≤ 0,30	± 0,05
Cr	≥ 10,5	< 15,0	± 0,15
	≥ 15,0	≤ 20,0	± 0,20
	> 20,0	≤ 22,0	± 0,25
Mo		≤ 0,60	+ 0,03
	> 0,60	< 1,75	± 0,05
	≥ 1,75	≤ 5,0	± 0,10
Nb		≤ 1,0	± 0,05
Ni		≤ 1,0	+ 0,03
	> 1,0	≤ 5,0	± 0,07
	> 5,0	≤ 10,0	± 0,10
	> 10,0	≤ 20,0	± 0,15
	> 20,0	≤ 27,0	± 0,20
Se	≥ 0,15		− 0,02
Ti		≤ 1,00	± 0,05
	> 1,00	≤ 1,20	± 0,07
Cu	≥ 1,0	≤ 2,0	± 0,10

1) Valid for diameters ≤ 160 mm or for cross-sections with the same area.

2) ± means that in one cast and in more than one product analysis the deviation may occur over the upper value or under the lower value of the specified range in table 1 but not both at the same time.

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Table 3 — Type of condition and surface condition of stainless steel products[1)]

Symbol[2)]	Type of condition	Surface condition	Form of product				Remarks
			Bars	Flat products	Wire rods	Semi-finished products	
F 1	Hot formed, not heat treated, not descaled	Covered with rolling skin, except for conditioned portions	×	×	×	×	Suitable only for such parts which will be descaled or machined after production, preferably for products which will be hot worked
F 2	Hot formed, not heat treated, overall ground to be suitable for reworking	Metallic, that means in this case not metallic bright, but a metallic condition which improves the possibility of inspection	—	—	—	×	—
F 3	Hot formed, heat treated, not descaled	Covered with rolling skin	×	×	×	×	Suitable only for such parts, which will be descaled all over or machined after production
F 4	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
F 5	Hot formed, heat treated, pickled		×	—	—	—	
F 6	Hot formed, heat treated, prepared by machining	Metallic bright	×	—	—	—	—
F 7	Mechanically or chemically descaled, cold formed, heat treated, pickled	Smoother than for conditions F 4 or F 5	×	×	—	—	—
F 8	Mechanically or chemically descaled, cold rolled, bright annealed or bright annealed and slightly rerolled	Bright and smoother than for condition F 7	—	×	—	—	Especially suitable for grinding polishing and brushing
F 9	Mechanically or chemically descaled, cold formed, heat treated, pickled, slightly rerolled or bright drawn	Matt and smoother than for condition F 7	×	×	—	—	Products in this condition, apart from exceptions among sheets and strips, are somewhat harder than according to surface condition F 7 or F 8; they are especially suitable for grinding, brushing and polishing
F 10	Ground	Where necessary, details should be agreed at the time of enquiry and order	×	×	—	—	As starting condition commonly the conditions F 7, F 8 or F 9 are used[3)]
F 11	Polished		×	×	—	—	
F 12	Brushed	Matt silk	—	×	—	—	The best starting conditions are surface conditions F 8 and F 9[3)]

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

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

3) For flat products, the order shall indicate in each case whether grinding or polishing or brushing is to be performed on both sides or on one side.

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Table 4 — Mechanical properties of the ferritic steels in the annealed condition

Type of steel	HB[1), 2)] max.	R_e[3)] min. N/mm²	R_m[4)] N/mm²	A min.[5)] (%)			
	for bars $5 < d < 25$ mm, flat products $0,5 < a < 12$ mm, wire rods $5 < d < 20$ mm			for bars $5 < d < 25$ mm and wire rods $5 < d < 20$ mm	for flat products[6)] with thickness (mm)		
					$0,5 < a < 3$	$3 < a < 12$	
					longitudinal and transverse	longitudinal	transverse
1 Ti	184	210[7)]	390 to 590	25	18	25	23
1	197	230	400 to 630	20	18	20	18
2	197	230	400 to 630	20	18	20	18
8	197	250	430 to 630	20	18	20	18
8a	197	250	430 to 630	15	—	—	—
8b	193	230	420 to 620	20	18	20	18
9c	205	280	460 to 660	18	17	18	17
F1	217	275[8)]	420 to 620	20	18	20	18

1) For thin materials the HRB or HV hardness test may be used by agreement between purchaser and producer, where it is not practicable to use the HB test.

2) Not deciding for acceptance.

3) R_e: yield stress which may be taken as 0,2 % proof stress.

4) R_m: tensile strength.

5) A: percentage elongation after fracture.

The values for bars are valid for a gauge length of $L_o = 5,65\sqrt{S_o}$. The values for flat products $0,5 < a < 3$ mm in thickness are valid for both test pieces specified in ISO 6892. (ISO 6892 recommends test pieces either of 20 mm width and 80 mm gauge length or of 12,5 mm width and 50 mm gauge length).

6) For flat products less than 300 mm in width only longitudinal, for flat products 300 mm and over in width only transverse test pieces are to be taken.

7) If used for construction purposes a minimum of 260 N/mm² may be agreed at the time of enquiry and order.

8) Where appropriate, higher values may be agreed at the time of enquiry and order.

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Table 5 — Mechanical properties of the martensitic steels in the annealed and quenched and tempered conditions

Type of steel	Heat-treatment condition	HB[1] max.	$R_{p0,2}$ min. N/mm²	R_m N/mm²	A_5 min.[2] (%)			Impact energy, min. (J)
		for bars $5 < d < 100$ mm, flat products < 20 mm, wire rods $5 < d < 20$ mm			bars $5 < d < 100$ mm and wire rods $5 < d < 20$ mm	flat products $3 < a < 20$ mm		
					longitudinal	longitudinal	transverse	
3	Aa	200	—	—	—	—	—	—
	Ab	200	250	470 to 670	20	—	—	—
	Q + T	—	400	600 to 800	16	16	12	— [3]
7	A	207[4], [5]	—	700 max.	—	—	—	—
	Q + T	—	440	620 to 820	12	—	—	—
4	A	220[5]	—	740 max.	—	—	—	—
	Q + T 1	—	450	650 to 850	15	15	11	— [3]
	Q + T 2	—	550	750 to 950	13	13	10	— [3]
9a	A	217[5]	—	730 max.	—	—	—	—
	Q + T	—	450	640 to 840	11	—	—	—
9b	A	285[5]	—	950 max.	—	—	—	—
	Q + T	—	680	880 to 1 080	11	—	—	— [3]
5	A	235[5]	—	780 max.	—	—	—	—
	Q + T[6]	—	600	800 to 1 000	11	—	—	—

1) In cases where other hardness tests are applied to test thin flat products, the test results are to be converted in accordance with the tables for conversion of hardness values given in ISO 4964.

2) The values are valid for a gauge length of $L_o = 5{,}65\sqrt{S_o}$.

3) If impact values are required, the impact values and the kind of impact test piece to be applied are to be agreed.

4) For certain conditions of machining, especially where the surface finish is of importance, the steel may after agreement at the time of enquiry and order also be delivered with a hardness of 207 to 262 HB.

5) In cases of dispute, the tensile strength value is the deciding factor.

6) For minimum hardness in the quenched and tempered condition, see steel No. 28 in ISO 4957, *Tool steels*.

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Table 6 — Mechanical properties of the austenitic steels in the solution-treated condition

Type of steel	HB[1] max.	$R_{p0,2\ min.}$[2] N/mm²	$R_{p1,0\ min.}$[2] N/mm²	R_m N/mm²	$A_{min.}$ (%)[3]		
	for bars, flat products max. 75 mm, wire rods max. 20 mm				bars[4] $5 < d < 160$	flat products in thickness (mm)	
						$0,5 < a < 3$	3 to 75
10	192	180	215	480 to 680	40	37	40
11	192	195	230	500 to 700	40	37	40
15	192	200	235	510[5] to 710	35	33	35
16	192	205	240	510 to 710	30	28	30
12	192	195	230	500 to 700	40	37	40
17	192	195	230	500 to 700	35	—	—
17a	192	195	230	500 to 700	35	—	—
13	192	180	220	490 to 690	40	37	40
14	212	220	—	590 to 780	—	37	40
19	192	190	225	490 to 690	40	37	40
20	192	205	240	510 to 710	40	37	40
21	192	210	245	510[5] to 710	35	33	35
23	192	215	250	510 to 710	30	28	30
19a	192	190	225	490 to 690	40	37	40
20a	192	205	240	510 to 710	40	37	40
24	192	195	230	490 to 690	35	33	35
10 N	212	270	305	550 to 750	35	33	35
19 N	212	280	315	580 to 780	35	33	35
19a N	212	280	315	580 to 780	35	33	35
A — 2	217	300	340	640 to 830	40	37	40
A — 3	217	300	340	640 to 830	40	37	40
A — 4	220	220[6]	255[6]	520 to 720[6]	35	33	35

1) For thin materials the HRB or HV hardness test may be used by agreement between user and producer where it is not practicable to use the HB test.

2) The $R_{p0,2}$ min. value shall be determined unless it has been agreed between the purchaser and the supplier that the $R_{p1,0}$ min. value is required instead of the $R_{p0,2}$ min. value.

3) The values for bars and flat products having a thickness of 3 to 75 mm are valid for a gauge length of $L_o = 5,65\sqrt{S_o}$. For flat products $0,5 < a < 3$ mm in thickness the values are valid for both test pieces specified in ISO 6892.

4) For bars greater than 160 mm in thickness, the elongation values are to be agreed.

5) For bars above 100 mm diameter or thickness lower values are to be agreed.

6) If the addition of nitrogen up to a limit of max. 0,15 % (m/m) was agreed, also higher tensile values may be agreed.

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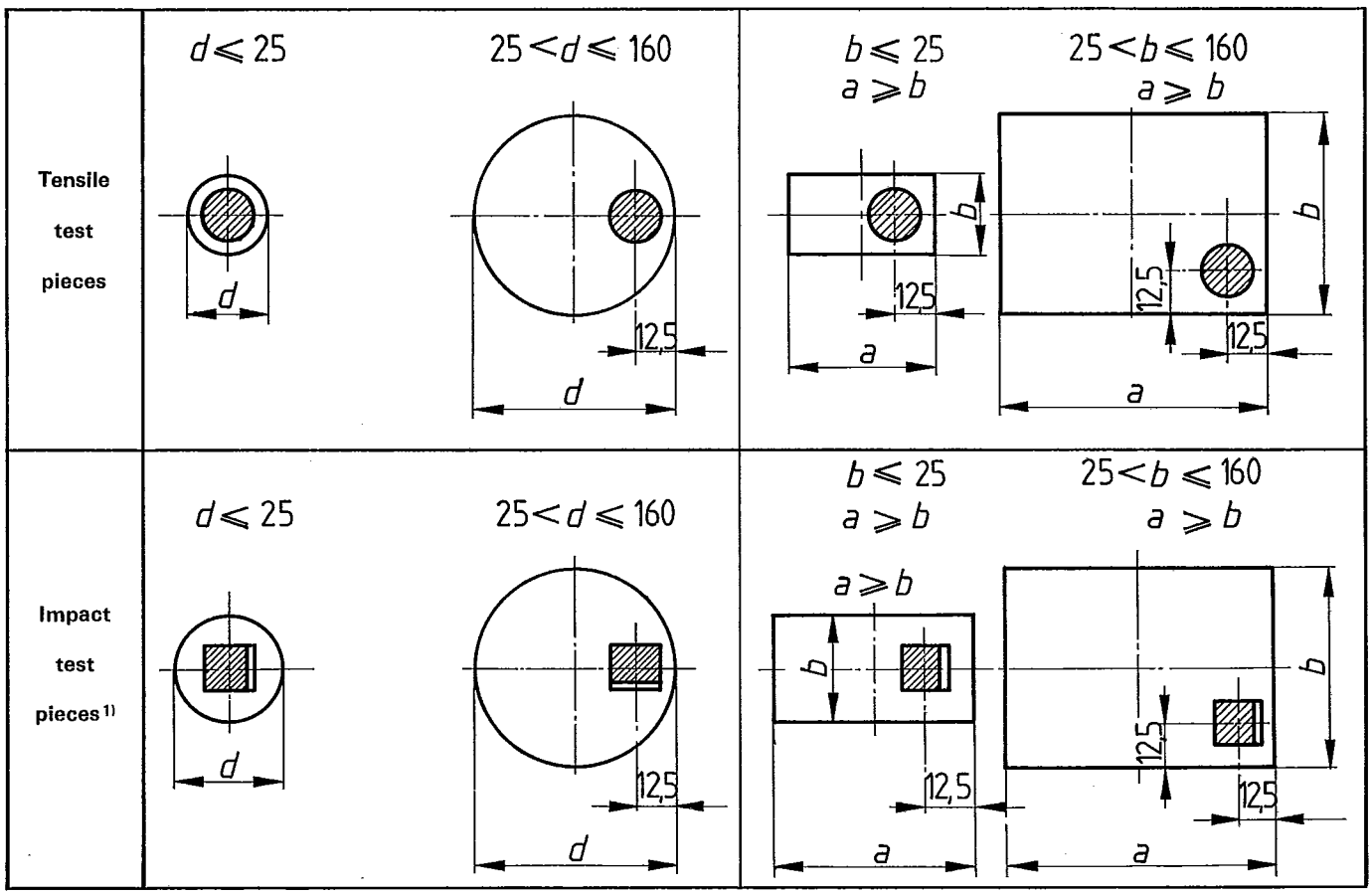

1) In the case of rounds, the longitudinal axis of the notch shall be approximately in the shortest distance to the rolling surface; in the case of rectangles it shall be perpendicular to the wider rolling surface.

Figure 1 — Location of the test pieces in bars and wire rod

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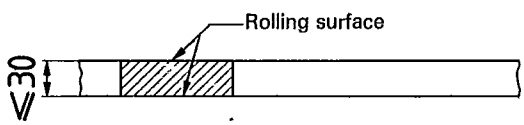
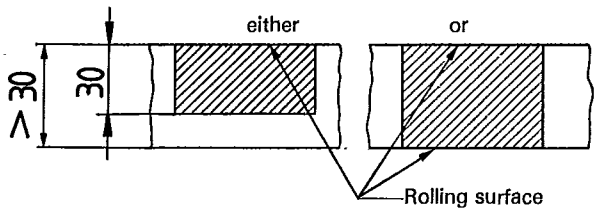
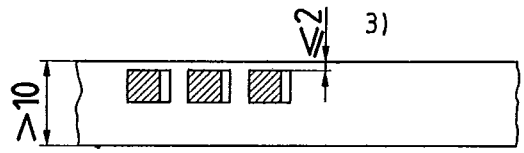
Type of test	Thickness product	Position of longitudinal test piece axis for a product width, w		Distance of test piece from rolling surface
	mm	w < 300 mm	w > 300 mm	mm
Tensile test[1]	≤ 30	longitudinal	transverse	
	> 30			
Impact test[2]	> 10[3]	transverse	transverse	

1) The test piece shall correspond to ISO 6892. Except in case of dispute, for thicknesses equal to or greater than 20 mm, round test pieces may be used. For thicknesses >30 mm the round test piece is to be taken in 1/4 of the product thickness.

2) The longitudinal axis of the notch shall be perpendicular to the rolling surface of the product.

3) For product thicknesses >30 mm, impact test pieces are to be taken in 1/4 of product thickness.

Figure 2 — Location of test pieces in sheet, strip or plate

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Annex A

Additional technical information

(This annex does not form an integral part of the Standard.)

A.1 Heat treatment

Information on heat treatment of stainless steels is given in table 7.

A.2 Physical properties

Information on some physical properties of stainless steels is given in table 8.

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Table 7 — Heat treatment

Type of steel	Annealing or solution treatment			Quenching and tempering			
	Symbol[1]	Temperature[2] °C	Cooling[3]	Symbol[1]	Temperature[2] °C	Cooling[3]	Temperature °C
Ferritic steels							
1 Ti	A	750 to 850	a, f				
1	A	750 to 800	a, f				
2	A	750 to 800	a, f				
8	A	750 to 850	a, w, f				
8a	A	750 to 850	a, w, f				
8b	A	750 to 850	a, w, f				
9c	A	750 to 850	a, w, f				
F1	A	800 to 1 000	w, a[4]				
Martensitic steels							
3	A[5]	700 to 780 or	a	Q + T 1	950 to 1 000	o, a	700 to 750
		700 to 870	f				
7	A	700 to 780 or	a	Q + T	950 to 1 000	o, a	700 to 750
		700 to 870	f				
4	A	700 to 780 or	a	Q + T 1	950 to 1 000	o, a	700 to 750[4]
		700 to 870	f	Q + T 2	950 to 1 000	o, a	650 to 700[4]
9a	A	800 to 850	a, f	Q + T	980 to 1 030	o, a	550 to 650
9b	A	650 to 750[6]	a	Q + T	980 to 1 030	o, a	600 to 700
5	A	700 to 780 or	a	Q + T	950 to 1 050	o, a	630 to 680
		700 to 870	f				
Austenitic steels[7]							
10 + 10 N	Q	1 000 to 1 100	w, a[8]				
11	Q	1 000 to 1 100	w, a[8]				
15	Q	1 020 to 1 120	w, a[8]				
16	Q	1 020 to 1 120	w, a[8]				
12	Q	1 000 to 1 100	w, a[8]				
17 + 17a	Q	1 000 to 1 100	w, a[8]				
13	Q	1 000 to 1 100	w, a[8]				
14	Q	1 020 to 1 120	w, a[8]				
19 + 19 N	Q	1 020 to 1 120	w, a[8]				
20	Q	1 020 to 1 120	w, a[8]				
21	Q	1 020 to 1 120	w, a[8]				
23	Q	1 020 to 1 120	w, a[8]				
19a + 19a N	Q	1 020 to 1 120	w, a[8]				
20a	Q	1 020 to 1 120	w, a[8]				
24	Q	1 020 to 1 120	w, a[8]				
A-2	Q	1 000 to 1 100	w, a[8]				
A-3	Q	1 000 to 1 100	w, a[8]				
A-4	Q	1 050 to 1 150	w, a[8]				

1) A: annealing; Q: quenching; T: tempering.

2) In the case where the heat treatment is performed in a continuous furnace, the upper part of the given temperature range, or even in excess of it, is normally preferred.

3) f: furnace; a: air; o: oil; w: water.

4) Accelerated cooling.

5) Covers heat treatment conditions Aa and Ab according to table 5.

6) Prior transformation to martensite may be necessary.

7) In the case of heat treatment in the course of processing after delivery, the lower part of the given solution temperature range is to be striven for. If, in the course of heat treatment, the temperature was not below the specified lower limit of the solution temperature, the following temperatures are sufficient for repeat heat treatments: 980 °C in the case of molybdenum-free steels, 1 000 °C in the case of steels with <3 % (m/m) Mo, 1 020 °C in the case of steels with >3 % (m/m) Mo.

8) Cooling sufficiently rapid.

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Table 8 — Physical properties

Type of steel	Density	Modulus of elasticity at						Coefficient of thermal expansion between 20 °C and					Thermal conductivity at 20 °C	Specific heat capacity at 20 °C	Electrical resistivity at 20 °C
		20 °C	100 °C	200 °C	300 °C	400 °C	500 °C	100 °C	200 °C	300 °C	400 °C	500 °C			
	kg/dm³	kN/mm²						$10^{-6} \cdot K^{-1}$					W/(m·K)	J/(kg·K)	Ω·mm²/m
Ferritic steels															
1 Ti	7,7[1]	220	215	210	205	200		10,5	11,0	11,5	12,0		25	460	0,60
1 2		216	213	207	200	192		10,5	11,0	11,5	12,0	12,0	30		
8a 8b		220	218	212	205	197		10,0	10,0	10,5	10,5	11,0	25		
9c		216	213	207	200	192		10,0	10,5	10,5	10,5	11,0	25		0,70
F1		225	220	210	203	195		10,0	11,0	11,5	12,0	23,5			0,60
Martensitic steels															
3 7 4	7,7[1]	216	213	207	200	192		10,5	11,0	11,5	12,0	12,0	30	460	0,60
9a								10,0	10,5	10,5	10,5	11,0	25		0,70
9b								10,0	10,5	11,0	11,0	11,0			
5		220	218	212	205	197		10,5	11,0	11,5	12,0	12,0	30		0,55
Austenitic steels															
10 11 15 16 12 17 17a 13 14	7,9[1]	200	194	186	179	172	165	16,0	17,0	17,0	18,0	18,0	15	500	0,73
19 20	8,0[1]							16,5	17,5	17,5	18,5	18,5	15		0,75
21								16,5	17,5	18,5	18,5	19,0			
23								16,5	17,5	18,0	18,5	19,0			
24								16,5	17,5	17,5	18,5	18,5	14		0,85
10 N	7,9[1]							16,0	17,0	17,0	18,0	18,0	15		0,73
19 N 19a N	8,0[1]							16,5	17,5	17,5	18,5	18,5			0,75
A-2 A-3	7,9[1]							16,5	17,5	18					0,7
A-4	8,0[1]	200	195	185	175	170	165	15,2	16,1	16,8	17,0	17,2	14	480	0,85

1) If as for the unalloyed and low alloyed steels a three digit density value is preferred the following values are recommended:

for ferritic and martensitic steels, 7,70 kg/dm³,
for the above Cr-Ni austenitic steels, 7,92 kg/dm³,
for the above CrNiMo austenitic steels, 7,98 kg/dm³.

It should however, be observed that these values do not apply for steels to which aluminium or silicon have been added. An addition of 1 % (*m/m*) Al leads, for example in the case of steels with 13 % (*m/m*) Cr, to a decrease of the density from ~ 7,72 to ~ 7,58 kg/dm³. Austenitic steels with about 2 % (*m/m*) Si of the type CrNi 25-20 or 20-12 have a density of about 7,78 compared with 7,92 kg/dm³ of the normal CrNi types with ~ 0,4 % (*m/m*) Si.

This shows that the values agreed for a group of steels is also dependent on the types covered in the group.

Because of such influences of the chemical composition on the density values, the above recommendation for the three digit density values of various not exactly defined steel groups are in any case somewhat uncertain. In view of this, it is not intended to amend the slightly different values used until now for the calculation of the nominal mass of tubes in ISO 4200.

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Annex B

Combinations of heat-treatment conditions, types of condition and mechanical properties required for product forms covered by this part of ISO 683

(This annex does not form an integral part of the Standard.)

Product form	Heat treatment	Type of condition Symbol according to table 3)	Mechanical properties required[1]		
			Ferritic steels	Martensitic steels	Austenitic steels
Semi-finished products	Hot formed (not heat treated)	F 1, F 2	—	—	—
	Annealed or solution treated	F 3, F 4, F 5	—	—	—
	Quenched and tempered	—	—	—	—
	Dimension range (mm)		—	—	—
Bars	Hot formed (not heat treated)	F 1	—	—	—
	Annealed or solution treated	F 3, F 4, F 5, F 6, F 7, F 9, F 10, F 11	H, R_p, R_m, A (table 4)	H, R_p, R_m, A (table 5)	H, R_p, R_m, A (table 6)
	Quenched and tempered	F 3, F 4, F 5, F 6, F 7, F 9, F 10, F 11	—	R_p, R_m, A, K (table 5)	—
	Dimension range (mm)		$5 < d < 25$	$5 < d < 100$	$5 < d < 160$
Flat products	Hot formed (not heat treated)	F 1	—	—	—
	Annealed or solution treated	F 3, F 4, F 5, F 7, F 8, F 9, F 10, F 11, F 12	H, R_p, R_m, A (table 4)	H, R_p, R_m, A (table 5)	H, R_p, R_m, A (table 6)
	Quenched and tempered	F 3, F 4, F 5, F 7, F 8, F 9, F 10, F 11, F 12	—	R_p, R_m, A, K (table 5)	—
	Dimension range (mm)		$0{,}5 < d < 12$	20 max.	75 max.
Wire rods	Hot formed (not heat treated)	F 1	—	—	—
	Annealed or solution treated	F 3, F 4, F 5	H, R_p, R_m, A (table 4)	H, R_p, R_m, A (table 5)	H, R_p, R_m (table 6)
	Quenched and tempered	F 3, F 4, F 5	—	R_p, R_m, A, K (table 5)	—
	Dimension range (mm)		$5 < d < 20$	$5 < d < 20$	20 max.

1) H: hardness; R_p: yield stress; R_m: tensile strength; A: elongation; D: impact.

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