

INTERNATIONAL STANDARD



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Heat-treated steels, alloy steels and free-cutting steels — Part 10 : Wrought nitriding steels

*Aciers pour traitement thermique, aciers alliés et aciers pour décolletage —
Dixième partie : Aciers corroyés pour nitruration*

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

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.

Prior to 1972, the results of the work of the Technical Committees were published as ISO Recommendations; these documents are now in the process of being transformed into International Standards. As part of this process, Technical Committee ISO/TC 17 has reviewed ISO Recommendation R 683/X and found it technically suitable for transformation. International Standard ISO 683/X therefore replaces ISO Recommendation R 683/X-1970 to which it is technically identical.

ISO Recommendation R 683/X was approved by the Member Bodies of the following countries:

Australia	Hungary	South Africa, Rep. of
Austria	India	Spain
Belgium	Israel	Sweden
Canada	Italy	Switzerland
Colombia	Japan	Thailand
Czechoslovakia	Korea, Rep. of	Turkey
Denmark	Netherlands	United Kingdom
Egypt, Arab Rep. of	New Zealand	U.S.A.
Finland	Norway	U.S.S.R.
France	Poland	
Germany	Romania	

The Member Body of the following country expressed disapproval of the Recommendation on technical grounds:

Brazil

The Member Body of the following country disapproved the transformation of ISO/R 683/X into an International Standard:

U.S.S.R.

Heat-treated steels, alloy steels and free-cutting steels — Part 10 : Wrought nitriding steels

1 SCOPE AND FIELD OF APPLICATION

This International Standard gives specifications for the four grades of wrought chromium-molybdenum steels, chromium-molybdenum-vanadium steels and chromium-molybdenum-aluminium steels listed in table 2, usually intended for use in the quenched and tempered and subsequently nitrided conditions.

2 REFERENCES

ISO/R 79, *Brinell hardness test for steel*.

ISO/R 81, *Vickers hardness test for steel (Load 5 to 100 kgf)*.

ISO 82, *Steel — Tensile testing*.

ISO/R 83, *Charpy impact test (U-notch) for steel*.

ISO 86, *Steel — Tensile testing of sheet and strip less than 3 mm and not less than 0,5 mm thick*.

ISO 89, *Steel — Tensile testing of wire*.

ISO/R 377, *Selection and preparation of samples and test pieces for wrought steel*.

ISO/R 404, *General technical delivery requirements for steel*.

ISO/R 1024, *Rockwell superficial hardness test (N and T scales) for steel*.

3 REQUIREMENTS

3.1 Production processes

Unless otherwise agreed in the order, the processes used in making the steel and the product shall be left to the

discretion of the manufacturer, but the steel shall be killed. When he so requests, the user shall be informed what steelmaking process is being used.

3.2 Types of condition of delivery

The steels covered by this International Standard shall be ordered and delivered in accordance with table 1.

TABLE 1 — Types of condition of delivery

Requirements	Types of condition of delivery ¹⁾						
	1	1(c)	3	3(c)	4	4(c)	5
Chemical composition	X	X	X	X	X	X	X
Hardness in the annealed condition	—	X	—	X	—	X	—
Mechanical properties of — quenched and tempered test bars of 16 mm diameter	—	—	X	X	—	—	—
— quenched and tempered ruling sections	—	—	—	—	X	X	—
— quenched and tempered product in final dimensions	—	—	—	—	—	—	X

1) The numbers indicating the types of condition of delivery follow a co-ordinated series of numbers throughout all relevant ISO publications.

The type of condition of delivery according to table 1 shall be stated at the time of enquiry and order.

3.3 Chemical composition

3.3.1 The chemical composition expressed by the cast analysis shall be in accordance with table 2.

3.3.2 If ordered to type of condition of delivery 1 or 1(c) (see table 1), the permissible deviations given in table 3 between the values specified in table 2 and the product analysis of products up to 160 mm diameter shall apply. Above 160 mm diameter, the permissible deviations shall be stated at the time of enquiry and order.

3.3.3 If ordered to condition of delivery types 3, 3(c), 4, 4(c) and 5, the mechanical properties specified in table 4 shall be the governing criteria for acceptance. In such cases, the cast analysis may deviate slightly from the figures shown in table 2.

3.4 Mechanical properties

3.4.1 If specified, the mechanical properties shall be those shown in table 4.

3.4.1.1 The values apply to test pieces taken on rounds in the direction of the metal fibre, the axis of the test piece corresponding to figure 1.

3.4.1.2 For rectangular sections, the ranges for equivalent diameters are given in figure 2.

3.4.1.3 For other sections, the equivalent diameter shall be agreed at the time of enquiry and order.

3.4.2 The mechanical properties in the quenched and tempered condition as given in table 4 are those which can be obtained for one of the conditions given below :

- a) For a reference test bar of 16 mm diameter, taken from the product to be delivered either by machining from a location according to figure 1 or by forging, and then quenched and tempered according to the temperatures and times listed in table 6 (types of condition of delivery 3 and 3(c) of table 1).

TABLE 2 — Types of steel and specified chemical composition
(applicable to cast analysis)¹⁾

Type of steel	C %	Si %	Mn %	P % max.	S % ²⁾ max.	Al %	Cr %	Mo %	Ni % max.	V %
1	0,28 to 0,35	0,15 to 0,40	0,40 to 0,70	0,030	0,035	—	2,80 to 3,30	0,30 to 0,50	0,30	—
2	0,35 to 0,42	0,15 to 0,40	0,40 to 0,70	0,030	0,035	—	3,00 to 3,50	0,80 to 1,10	—	0,15 to 0,25
3	0,30 to 0,37	0,20 to 0,50	0,50 to 0,80	0,030	0,035	0,80 to 1,20	1,00 to 1,30	0,15 to 0,25	—	—
4	0,38 to 0,45	0,20 to 0,50	0,50 to 0,80	0,030	0,035	0,80 to 1,20	1,50 to 1,80	0,25 to 0,40	—	—

1) Elements not quoted in table 2 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 materials used in manufacture, of such elements which affect the mechanical properties and applicability.

2) By agreement between the purchaser and manufacturer, the steel may be ordered with an upper limit of sulphur less than 0,035 %.

TABLE 3 — Permissible deviations between specified analysis and product analysis

Type of steel	Permissible deviation ¹⁾									
	C %	Si %	Mn %	P %	S %	Al %	Cr %	Mo %	Ni %	V %
1	± 0,01	± 0,03	± 0,04	+ 0,005	+ 0,005	—	± 0,10	± 0,03	+ 0,03	—
2	± 0,02	± 0,03	± 0,04	+ 0,005	+ 0,005	—	± 0,10	± 0,03	—	± 0,02
3	± 0,02	± 0,03	± 0,04	+ 0,005	+ 0,005	± 0,10	± 0,05	± 0,02	—	—
4	± 0,02	± 0,03	± 0,04	+ 0,005	+ 0,005	± 0,10	± 0,05	± 0,02	—	—

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

b) For a ruling section¹⁾ to be specified at the time of enquiry and order, which is quenched and tempered according to the temperatures listed in table 6 (types of condition of delivery 4 and 4(c) of table 1).

For location of the test bar, see 4.2.1.

c) For the product in the quenched and tempered condition of delivery (type of condition of delivery 5 of table 1).

For location of the test bar, see 4.2.1.

3.4.3 If the products are delivered in the annealed condition, a maximum hardness in accordance with table 5, measured after preparation of the surface in the conventional manner, may be agreed in addition to the other requirements (types of condition of delivery 1(c), 3(c) and 4(c) of table 1).

3.5 Tolerances on dimensions and mass

The tolerances allowable on dimensions and mass shall be stated in the order, as long as there are no ISO publications to cover them.

4 TESTING

4.1 Number of sample products

4.1.1 Chemical composition

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

4.1.2 Mechanical properties

4.1.2.1 For material not supplied in the finally heat-treated condition (types of condition of delivery 3, 3(c), 4 and 4(c) of table 1), one sample product shall be taken from each cast for testing in accordance with the requirements of tables 4 or 5.

4.1.2.2 For material supplied in the finally heat-treated condition (type of condition of delivery 5 of table 1), one sample product shall be taken from each size grouping from each heat-treatment batch for testing in accordance with table 4. If the product is continuously heat-treated, one sample product for each 15 t or part thereof, but a least one sample product for each cast, shall be taken.

4.2 Samples and test pieces

4.2.1 The test pieces for tensile test and impact test shall be taken in the longitudinal direction of the products according to figure 1.

4.2.2 For product analyses, the selection of samples shall be carried out in conformity with the requirements of ISO/R 377.

4.2.3 General conditions for selection and preparation of test samples and test pieces for steel shall be in accordance with ISO/R 377.

4.3 Test methods

4.3.1 The tensile test shall be made in accordance with ISO 82, ISO 86 or ISO 89.

4.3.2 The impact test shall be made in accordance with ISO/R 83. Unless otherwise specified at the time of enquiry and order, the impact value shall be determined by the arithmetic average of the results obtained by the breaking of three test pieces next to one another in the test sample or test bar.

4.3.3 The Brinell hardness test shall be made in accordance with ISO/R 79. The Vickers hardness test shall be made in accordance with ISO/R 81. The Rockwell superficial (N scale) hardness test shall be made in accordance with ISO/R 1024.

4.3.4 In cases of dispute, the methods for the chemical analysis shall be those established by the relevant ISO publications. If no ISO publications are available, the methods may be agreed upon between the interested parties and specified at the time of enquiry and order.

4.4 Retests

4.4.1 For retests for mechanical properties ISO/R 404 is valid.

4.4.2 For retests for the product analysis, ISO/R 404 is valid.

4.5 Certification of the tests

For certification of the tests, ISO/R 404 is valid, acceptable documents being namely

- statement of compliance with the order, or
- report based on quality control, or
- works certificate, or
- test certificate, or
- certificate of acceptance.

1) In the selection of a steel, one of the most important considerations is whether the mechanical properties required can be obtained from the steel in the size and shape at the time of heat treatment. That portion, which is most important from the point of view of the mechanical properties obtained by heat treatment, is referred to as the ruling section, and the ruling section should always be expressed in terms of the diameter of an equivalent round bar (see figure 1).

5 DEFECTS AND DIMENSIONAL TOLERANCES

The conditions given in ISO/R 404 are valid for

- surface defects,
- rectification,
- internal defects,
- dimensional tolerances and
- reclaiming.

TABLE 4 — Mechanical properties for the quenched and tempered condition¹⁾

Type of steel	Diameter	R_e min.	R_m	A min.	KU min.	Hardness of nitrided surface, max.	
	mm	N/mm ²	N/mm ²	%	J	HV	HR 15N
1	≤ 16	880	1 080 to 1 280	10	24	800	92
	> 16 ≤ 40	830	1 030 to 1 230	10	30	800	92
	> 40 ≤ 100	780	980 to 1 180	11	30	800	92
	> 100 ≤ 160	740	930 to 1 130	12	30	800	92
	> 160 ≤ 250	690	880 to 1 080	12	30	800	92
2	≤ 70	1 080	1 270 to 1 470	8	15	800	92
3	≤ 70	590	780 to 930	14	25	950	93,5
4	≤ 100	740	930 to 1 130	12	20	950	93,5
	> 100 ≤ 160	640	830 to 980	14	25	950	93,5

1) R_e = yield stress (0,2 % proof stress)

R_m = tensile strength

A = percentage elongation after fracture ($L_0 = 5 d_0$)

KU = impact strength with U-notch

HV = Vickers hardness number

HR 15N = Rockwell superficial (N scale) hardness with 15 kgf load.

TABLE 5 — Hardness in the annealed condition

Type of steel	Hardness HB max.
1	248
2	262
3	248
4	262

TABLE 6 — Conditions for heat treatment

Type of steel	Quenching ¹⁾ °C	Quenching agent	Tempering ²⁾ °C	Nitriding ³⁾ °C
1	870 to 910	Oil	570 to 650	490 to 510
2	920 to 960	Air or oil	570 to 650	490 to 510
3	900 to 940	Oil or water	570 to 650	500 to 520
4	880 to 920	Oil	570 to 650	500 to 520

1) Time for austenitizing as a guide : 0,5 h minimum.

2) Time for tempering as a guide : 1 h minimum.

3) Time for nitriding depends on the desired depth of the nitrided case.