

ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION R 683/IX

HEAT-TREATED STEELS, ALLOY STEELS
AND FREE-CUTTING STEELS

PART 9
WROUGHT FREE-CUTTING STEELS

1st EDITION

October 1970

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Printed in Switzerland

Also issued in French and Russian. Copies to be obtained through the national standards organizations.

BRIEF HISTORY

The ISO Recommendation R 683/IX, *Heat-treated steels, alloy steels and free-cutting steels – Part 9 : Wrought free-cutting steels*, was drawn up by Technical Committee ISO/TC 17, *Steel*, the Secretariat of which is held by the British Standards Institution (BSI).

Work on this question led to the adoption of Draft ISO Recommendation No. 1364, which was circulated to all the ISO Member Bodies for enquiry in December 1967. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

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

The following Member Bodies opposed the approval of the Draft :

Brazil
United Kingdom

This Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided to accept it as an ISO RECOMMENDATION.

HEAT-TREATED STEELS, ALLOY STEELS AND FREE-CUTTING STEELS

PART 9 WROUGHT FREE-CUTTING STEELS

1. SCOPE

- 1.1 This ISO Recommendation covers three groups of wrought free-cutting steels for mechanical purposes as listed in Table 3, namely,
- (a) not intended for heat treatment,
 - (b) suitable for case hardening,
 - (c) suitable for quenching and tempering.
- 1.2 This ISO Recommendation applies to semi-finished products, bars, wire rods, and bright steel.

2. DEFINITION

Free-cutting steels are characterized by good machinability, i.e. high metal removal rate, essentially obtained by higher than normal contents of sulphur, or sulphur and lead.

3. REQUIREMENTS

3.1 Production processes

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 user should be informed what steelmaking process is being used.

3.2 Chemical composition and mechanical properties

- 3.2.1 The steels covered by this ISO Recommendation should be ordered and delivered in accordance with Table 1.

TABLE 1 – Types of condition of delivery

Requirements	Types of condition of delivery*									
	1	1(b)	1(n)	1(q)	3	3(b)	4	4(b)	5	6
Chemical composition	X	X	X	X	X	X	X	X	X	X
Hardness (maximum value)										
– in the "as rolled" or "as peeled" condition	–	X	–	–	–	X	–	X	–	–
– in the normalized condition	–	–	X	–	–	–	–	–	–	–
Mechanical properties										
– in the normalized condition	–	–	X	–	–	–	–	–	–	–
– in the cold-drawn condition	–	–	–	X	–	–	–	–	–	–
– in the quenched and tempered condition										
– for a 16 mm diameter test bar	–	–	–	–	X	X	–	–	–	–
– for a ruling section	–	–	–	–	–	–	X	X	–	–
– for a product in final dimensions**	–	–	–	–	–	–	–	–	X	–
– in the quenched and tempered and subsequently cold-drawn condition	–	–	–	–	–	–	–	–	–	X
– in the simulated case-hardened condition***	–	–	–	–	–	–	–	–	X	–

* The numbers indicating the types of condition of delivery follow a co-ordinated series of numbers throughout all relevant ISO Recommendations.

** For the quenched and tempered steels 7, 8, 9 and 10.

*** For the case-hardening steels 4, 4Pb, 5 and 6.

3.2.2 For the steels covered by this ISO Recommendation, the relevant types of condition of delivery, detailed in Table 1, are appropriate for the types of steel as given in Table 2.

TABLE 2 – Types of steel and related conditions of delivery

Type of steel	Type of condition of delivery
1, 2, 2Pb, 3, 3Pb	1, 1(b), 1(n), 1(q)
4, 4Pb, 5, 6	1, 1(q), 5
7, 8, 9, 10	1, 1(b), 3, 3(b), 4, 4(b), 5, 6

The type of condition of delivery according to Tables 1 and 2 should be stated at the time of enquiry and order.

3.2.3 The chemical composition expressed by the cast analysis should be in accordance with Table 3.

TABLE 3 – Types of steel and chemical composition guaranteed
(applicable to cast analysis)*

Type of steel	C %	Si %	Mn %	P % max.	S %	Pb %
Non-heat-treatable steels						
1	0.13 max.	0.05 max.	0.60 to 1.20**	0.11	0.18 to 0.25	–
2	0.14 max.	0.05 max.	0.90 to 1.30	0.11	0.24 to 0.32	–
2Pb	0.14 max.	0.05 max.	0.90 to 1.30	0.11	0.24 to 0.32	0.15 to 0.35
3	0.15 max.	0.05 max.	1.0 to 1.50	0.11	0.30 to 0.40	–
3Pb	0.15 max.	0.05 max.	1.0 to 1.50	0.11	0.30 to 0.40	0.15 to 0.35
Case-hardening steels						
4	0.07 to 0.13	0.15 to 0.40	0.50 to 0.90	0.06	0.15 to 0.25	–
4Pb	0.07 to 0.13	0.15 to 0.40	0.50 to 0.90	0.06	0.15 to 0.25	0.15 to 0.35
5	0.09 to 0.15	0.15 to 0.40	0.90 to 1.20	0.06	0.15 to 0.25	–
6	0.14 to 0.20	0.15 to 0.40	0.50 to 0.90	0.06	0.15 to 0.25	–
Quenched and tempered steels						
7	0.32 to 0.39	0.15 to 0.40	0.50 to 0.90	0.06	0.15 to 0.25	–
8	0.32 to 0.39	0.15 to 0.40	0.90 to 1.20	0.06	0.15 to 0.25	–
9	0.32 to 0.39	0.15 to 0.40	1.30 to 1.65	0.06	0.15 to 0.25	–
10	0.42 to 0.50	0.15 to 0.40	0.50 to 0.90	0.06	0.15 to 0.25	–

* Elements not quoted in Table 3 should 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 should be taken to prevent the addition, from scrap or other materials used in manufacture, of such elements which affect the mechanical properties and applicability.

** A manganese content of 0.50 % min. can be agreed between purchaser and supplier.

- 3.2.3.1 If ordered to types of condition of delivery 1 or 1(b) (see Table 1), the following permissible deviations between the values specified in Table 3 and the product analysis of products up to 160 mm (6.3 in) diameter should apply. Above 160 mm (6.3 in) diameter, the permissible deviations should be stated at the time of enquiry and order.

TABLE 4 — Permissible deviations between specified analysis and product analysis

Type of steel	Permissible deviations*					
	C %	Si %	Mn %	P %	S %	Pb %
1	+ 0.02	0	± 0.06	+ 0.02	± 0.03**	—
2	+ 0.02	0	± 0.06	+ 0.02	± 0.03	—
2Pb	+ 0.02	0	± 0.06	+ 0.02	± 0.03	0
3	+ 0.02	0	± 0.06	+ 0.02	± 0.04	—
3Pb	+ 0.02	0	± 0.06	+ 0.02	± 0.04	0
4	± 0.02	± 0.03	± 0.04	+ 0.008	± 0.03	—
4Pb	± 0.02	± 0.03	± 0.04	+ 0.008	± 0.03	0
5	± 0.02	± 0.03	± 0.06	+ 0.008	± 0.03	—
6	± 0.02	± 0.03	± 0.04	+ 0.008	± 0.03	—
7	± 0.03	± 0.03	± 0.04	+ 0.008	± 0.03	—
8	± 0.03	± 0.03	± 0.06	+ 0.008	± 0.03	—
9	± 0.03	± 0.03	± 0.06	+ 0.008	± 0.03	—
10	± 0.03	± 0.03	± 0.04	+ 0.008	± 0.03	—

* ± means that in one cast the deviation may occur over the upper value or under the lower value of the specified range in Table 3 but not both at the same time.

** A permissible deviation of $\begin{matrix} + 0.05 \\ - 0.03 \end{matrix}$ % S for type of steel 1 may be agreed between the purchaser and the supplier.

- 3.2.3.2 If ordered to types of condition of delivery 1(n), 1(q), 3, 3(b), 4, 4(b), 5 and 6, the mechanical properties specified in Tables 5, 6 and 7 should be the governing criteria for acceptance. In such cases, the cast analysis may deviate slightly from the values shown in Table 3.

3.3 Hardness

- 3.3.1 If the products are delivered in the types of condition of delivery 1(b) or 1(n) of Table 1, the maximum hardness as shown in Tables 5 and 7 should apply.
- 3.3.2 If the products suitable for quenching and tempering are delivered in a condition other than quenched and tempered, with or without subsequent cold reduction, a maximum hardness measured after preparation of the surface in the conventional manner, in accordance with Table 7, can be agreed in addition to the other requirements (types of condition of delivery 3(b) and 4(b) of Table 1).