17

INTERNATIONAL STANDARD ISO 683/XV

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Heat-treated steels, alloy steels and free-cutting steels — Part 15 : Valve steels for internal combustion engines

Aciers pour traitement thermique, aciers alliés et aciers pour décolletage — Quinzième partie : Aciers pour soupapes de moteurs à combustion interne

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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.

International Standard ISO 683/XV was drawn up by Technical Committee ISO/TC 17, *Steel,* and circulated to the Member Bodies in November 1974.

It has been approved by the Member Bodies of the following countries :

Australia	Hungary	South Africa, Rep. of
Austria	India	Spain
Belgium	Iran	Sweden
Bulgaria	Ireland	Switzerland
Canada	Italy	Turkey
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Denmark	Mexico	U.S.S.R.
Finland	Netherlands	Yugoslavia
France	Poland	
Germany	Romania	

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

U.S.A.

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Heat-treated steels, alloy steels and free-cutting steels – Part 15 : Valve steels for internal combustion engines

1 SCOPE AND FIELD OF APPLICATION

1.1 This International Standard gives specifications for the grades of wrought alloyed steels listed in table 1 and usually intended for the manufacture of heads of high-stressed outlet valves of internal combustion engines. They may also be used for inlet valves.

This International Standard does not apply to hard facing alloys or to valve seat inserts.

1.2 This International Standard is applicable only to hot-formed bars of a diameter up to and including 40 mm.

2 REFERENCES

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

ISO 82, *Steel – Tensile testing.*

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

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

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 shall be informed what steelmaking process is being used.

3.2 Condition of delivery

The heat treatment condition of delivery is to be agreed upon between purchaser and manufacturer 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 1.

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

3.4 Mechanical properties

3.4.1 The following maximum Brinell hardness values are mandatory when material is ordered in the fully annealed condition :

Type of steel	Hardness (HB) max.
1	285
2	269
3	302
4	302

3.4.2 Typical tensile test values at room temperature for the finally heat-treated condition according to table 5 are given in table 3 for information.

3.4.3 Values of tensile strength at elevated temperatures for the finally heat-treated condition according to table 5 are given in table 4 for guidance.

3.4.4 The values in tables 3 and 4 apply to test pieces taken in the longitudinal direction.

3.5 Tolerances on dimensions and mass

The tolerances allowable on dimensions and masses shall be stated on the order as in accordance with the appropriate International Standard. However, in cases where one does not exist, the tolerances shall be stated on the order.

4 TESTING

4.1 Number of sample products

4.1.1 *Chemical composition*

The cast analysis shall be given by the manufacturer if requested by the purchaser. 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*

The number of sample products for testing the mechanical properties is to be agreed upon between purchaser and producer at the time of enquiry and order.

4.2 Samples and test pieces

4.2.1 *Chemical composition*

For product analysis, the selection of test samples shall be carried out in accordance with the requirements of ISO/R 377.

4.2.2 *Mechanical properties*

The test pieces for tensile test shall be taken in the longitudinal direction of the products. The axis of the test piece shall be in the longitudinal axis of the bar for rounds up to and including 25 mm, and at a distance of 12,5 mm from the surface of the bar for rounds over 25 up to and including 40 mm.

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

4.3.2 The Brinell hardness test shall be carried out in accordance with ISO/R 79.

4.3.3 The tensile test at room temperature shall be carried out in accordance with ISO 82.

4.3.4 The conditions for tensile test at elevated temperatures are to be agreed upon between purchaser and producer until an International Standard is available.

4.4 Retests

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

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

4.5 Certification of tests

For certification of the tests, ISO/R 404 is valid, acceptable documents being as follows :

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

5 DEFECTS AND DIMENSIONAL TOLERANCES

The conditions given in ISO/R 404 are valid for

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

TABLE 1 – **Types of steel and specified chemical composition (applicable to cast analysis)**

Type of steel	C %	Si %	Mn %	P % max.	S %	Cr %	N %	Ni %	Other elements % [1]
1	0,40/0,50	2,75/3,75	≤ 0,80	0,040	0,030 max.	7,5/ 9,5		≤ 0,50	
2	0,35/0,45	1,8 /3,0	≤ 0,80	0,040	0,030 max.	9,5/11,5			0,70/ 1,3 Mo
3	0,80/0,90	≤ 1,0	≤ 1,5	0,040	0,030 max.	16,5/18,5			2,0 / 2,5 Mo 0,30/ 0,60 V
4	0,75/0,85	1,75/2,50	≤ 0,80	0,040	0,030 max.	19,0/21,0		1,0 / 1,7	
5	0,35/0,50	≤ 2,0	≤ 1,0	0,045	0,030 max.	12,0/15,0		12,0 /15,0	2,0 / 3,0 W[2]
6	0,40/0,50	2,0 /3,0	0,80/ 1,5	0,045	0,030 max.	17,0/20,0		8,0 /10,0	0,80/ 1,20 W
7	0,15/0,25	0,70/1,0	1,0 / 1,5	0,045	0,030 max.	20,0/22,0	0,15/0,20	10,5 /12,5	
8	0,48/0,58	≤ 0,25	8,0 /10,0	0,050	0,035 max.	20,0/23,0	0,38/0,55	3,25/ 4,5	
9	0,48/0,58	≤ 0,25	8,0 /10,0	0,050	0,035/0,090	20,0/23,0	0,38/0,55	3,25/ 4,5	
10	0,65/0,75	0,45/0,85	5,5 / 7,0	0,050	0,025/0,065	20,0/22,0	0,18/0,28	1,4 / 1,9	
11	≤ 0,10	≤ 1,0	≤ 1,0	0,045	0,030 max.	18,0/21,0		Rest	1,0 / 1,8 Al ≤ 2,0 Co ≤ 3,0 Fe
12	0,08/0,16	≤ 1,0	1,0 / 2,0	0,045	0,030 max.	20,0/22,5	0,10/0,20	19,0/21,0	1,8 / 2,7 Ti 18,5 /21,5 Co 2,5 / 3,5 Mo 0,75/ 1,25 Nb 2,0 / 3,0 W

1) Elements not quoted in the table 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 of such elements from scrap or other materials used in the manufacture, but residual elements may be present provided the hardenability, mechanical values and applicability are not affected.

2) The tungsten content may be lowered to 1,5 % if there is a molybdenum content of 0,20/0,50 %.

TABLE 2 — **Permissible deviations between the limiting values specified in table 1 and product analysis**

Type of steel	Permissible deviations[1]								
	C %	Si %	Mn %	P %	S %	Cr %	N %	Ni %	other elements %
1	± 0,02	± 0,15	+ 0,03	+ 0,005	+ 0,005	± 0,10	–	+ 0,03	–
2	± 0,02	± 0,15	+ 0,03	+ 0,005	+ 0,005	± 0,15	–	–	± 0,05 Mo
3	± 0,03	+ 0,10	+ 0,04	+ 0,005	+ 0,005	± 0,20	–	–	± 0,10 Mo, ± 0,03 V
4	± 0,03	± 0,10	+ 0,03	+ 0,005	+ 0,005	± 0,25	–	± 0,07	–
5	± 0,02	+ 0,10	+ 0,04	+ 0,005	+ 0,005	± 0,20	–	± 0,15	± 0,10 W
6	± 0,02	± 0,15	± 0,04	+ 0,005	+ 0,005	± 0,25	–	± 0,15	± 0,05 W
7	± 0,02	± 0,10	± 0,04	+ 0,005	+ 0,005	± 0,25	± 0,01	± 0,15	–
8	± 0,02	+ 0,05	± 0,06	+ 0,005	+ 0,005	± 0,25	± 0,03	± 0,07	–
9	± 0,02	+ 0,05	± 0,06	+ 0,005	± 0,010	± 0,25	± 0,03	± 0,07	–
10	± 0,03	± 0,05	± 0,06	+ 0,005	± 0,005	± 0,25	± 0,02	± 0,07	–
11	+ 0,01	+ 0,10	+ 0,04	+ 0,005	+ 0,005	± 0,25	–	–	± 0,05 Al, + 0,10 Co ± 0,10 Ti
12	± 0,01	+ 0,10	+ 0,04	+ 0,005	+ 0,005	± 0,25	± 0,01	± 0,20	± 0,20 Co, ± 0,10 Mo ± 0,10 Nb, ± 0,10 W

1) ± means that in one cast analysis 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.

TABLE 3 — **Typical mechanical properties[1] at room temperature in the finally heat-treated condition**
(for information purposes only) (see table 5)

Type of steel	Condition of heat treatment[2]	Mechanical properties			
		$R_{p0,2}$	R_m	A	Z
		N/mm²	N/mm²	%	%
1	Q + T	685	930	16	40
2	Q + T	735	930	15	35
3	Q + T	835	1 080	12	15
4	Q + T	735	930	10	15
5	ST	345	785	35	40
6	ST	440	885	30	40
7	ST + (P)	440	835	25	25
8	ST + P	640	1 030	8	10
9	ST + P	640	1 030	8	10
10	ST + P	540	1 030	20	30
11	ST + P	590	1 080	30	35
12	ST + P	390	885	25	30

1) $R_{p0,2}$ = 0,2 % proof stress (yield stress).
R_m = tensile strength.
A = percentage elongation after fracture ($L_o = 5\,d_o$).
Z = percentage reduction of area.
1 N/mm² = 1 MPa

2) Q = quenched, T = tempered, ST = solution treated,
P = precipitation hardened.

TABLE 4 – **Typical values for tensile strength at elevated temperatures in the finally heat-treated condition**
(for information purposes only) (see table 5)

Type of steel	Condition of heat treatment 1)	Tensile strength R_m in N/mm² at							
		500 °C	550 °C	600 °C	650 °C	700 °C	750 °C	800 °C	850 °C
1	Q + T	490	365	245	155	110	70		
2	Q + T	540	410	295	185	125	80		
3	Q + T	540	410	295	235	175	135	100	
4	Q + T	590	460	345	245	145	110	70	
5	ST	540	510	490	390	315	255	195	
6	ST	590	540	490	410	345	265	195	
7	ST + (P)	590	550	510	450	390	345	295	
8	ST + P	640	600	560	500	440	365	325	245
9	ST + P	640	600	560	500	440	365	325	245
10	ST + P	640	590	540	490	440	365	295	
11	ST + P	735	705	685	640	590	490	390	
12	ST + P	550	530	510	480	450	390	345	245

1) Q = quenched, T = tempered, ST = solution treated, P = precipitation hardened.

TABLE 5 – **Conditions for heat treatment**
(given for guidance only)

Type of steel	Quenching or solution heat treatment °C	Quenching agent	Tempering or ageing treatment °C
1	1 020 to 1 070	Oil or air	720 to 820
2	1 020 to 1 080	Oil or air	720 to 820
3	1 050 to 1 080	Oil	700 to 750
4	1 050 to 1 080	Oil or air	700 to 800
5	980 to 1 080	Water or oil	–
6	980 to 1 080	Water	–
7	1 100 to 1 200	Oil or water	700 to 800 1)
8	1 100 to 1 180	Water	730 to 800 2)
9	1 100 to 1 180	Water	730 to 800 2)
10	1 100 to 1 200	Water	730 to 780
11	1 020 to 1 100	Air or water	700 to 750 2)
12	1 150 to 1 200	Air or water	780 to 830

1) The ageing treatment may be omitted for certain applications.

2) Depending on the ageing temperature employed the time at temperature will vary up to a maximum of 12 h.