INTERNATIONAL STANDARD ISO 683/XVI

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Heat-treated steels, alloy steels and free-cutting steels — Part 16 : Precipitation hardening stainless steels

Aciers pour traitement thermique, aciers alliés et aciers pour décolletage — Seizième partie : Aciers inoxydables, aptes au durcissement par précipitation

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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/XVI 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 :

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

No Member Body expressed disapproval of the document.

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Heat-treated steels, alloy steels and free-cutting steels — Part 16 : Precipitation hardening stainless steels

1 SCOPE AND FIELD OF APPLICATION

1.1 This International Standard gives specifications for the grades of wrought precipitation hardening stainless steels listed in table 1 and usually intended for use at room temperature.

1.2 This International Standard is applicable to solution treated or precipitation hardened products such as forgings, bars, plates, sheet, strip and wire.

2 REFERENCES

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

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

ISO 82, *Steel — Tensile testing.*

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.*

3 REQUIREMENTS

3.1 Production processes

3.1.1 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.

3.1.2 If special high impact properties are required, the steels shall be ordered as remelted by a consumable electrode process or a process recognized at least as equivalent by the purchaser.

3.2 Condition of heat treatment

The conditions of heat treatment for the different levels of mechanical properties are indicated in tables 7 to 10. When required in any other condition of heat treatment this shall be agreed between the purchaser and the manufacturer at the time of the enquiry and order.

3.3 Chemical composition

3.3.1 The chemical composition expressed by cast analysis shall be in accordance with table 1.

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

3.4 Mechanical properties

3.4.1 The purchaser shall state at the time of the enquiry and order the grade of mechanical properties required according to tables 3 to 6 inclusive.

NOTES

1 When impact properties are required the values for these and the methods for determining them should be agreed at the time of enquiry and order; see also 3.1.2.

2 Consideration must be given to the fact that these steels in the higher strength levels are more susceptible to stress corrosion.

3.4.2 For forms or sizes other than those given in tables 3 to 10 inclusive the mechanical properties and heat-treatment conditions shall be agreed between the purchaser and manufacturer at the time of enquiry and order.

3.5 Corrosion resistance

The performance of the stainless steels under various conditions of chemical attack cannot be characterized by test values in general terms. If desired a corrosion test may be agreed at the time of the enquiry and order.

3.6 Tolerances on dimensions and masses

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*

One sample product shall be tested for each cast and for each separate heat treatment batch.

4.2 Samples and test pieces

4.2.1 For product analyses the selection of samples shall be carried out in accordance with the requirements of ISO/R 377.

4.2.2 For each sample product taken for testing the mechanical properties when it is appropriate (see tables 3 to 6), one test piece for the tensile test and for the hardness test shall be provided. The test pieces shall be taken in the longitudinal direction of the products according to figure 1. For flat products, the manufacturer is permitted to use a transverse test piece (figure 2).

4.2.3 General conditions for selection and preparation of 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 tensile test shall be carried out in accordance with ISO 82, ISO 86 or ISO 89.

4.3.3 The Brinell hardness test shall be carried out in accordance with ISO/R 79. The Rockwell hardness test shall be carried out in accordance with ISO/R 80.

4.3.4 Details of a corrosion test, if specified, shall be agreed at the time of the enquiry and order.

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 the 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 and
- reclaiming.

TABLE 1 — **Type of steel, specified chemical composition (cast analysis) [1] and product form**

Type[2] of steel	C %	Si % max.	Mn %	P % max.	S % max.	N %	Al %	Cr %	Cu %	Mo %	Ni %	Ti %	(Nb + Ta) %	Commonly available product forms[3]			
1	0,07 max.	1,00	1,00 max.	0,040	0,030	—	—	15,5/17,5	3,00/5,00	—	3,00/5,00	—	0,15/0,45	B			
2	0,09 max.	1,00	1,00 max.	0,040	0,030	—	0,75/1,50	16,0/18,0	0,50 max.	—	6,50/7,75	—	—	B	W	S	P
3	0,09 max.	1,00	1,00 max.	0,040	0,030	—	0,75/1,50	14,0/16,0	—	2,00/3,00	6,50/7,75	—	—	B	W	S	P
4	0,07 max.	1,00	1,00 max.	0,040	0,030	—	—	14,0/15,5	2,50/4,50	—	3,50/5,50	—	5 × C %/0,45	B			
5	0,08/0,12	0,50	0,50/1,25	0,040	0,030	0,07/0,13	—	16,0/17,0	—	2,50/3,25	4,00/5,00	—	—		W	S	
6	0,10/0,15	0,50	0,50/1,25	0,040	0,030	0,07/0,13	—	15,0/16,0	—	2,50/3,25	4,00/5,00	—	—	B			P
7	0,08 max.	1,00	1,00 max.	0,040	0,030	—	0,40 max.	16,0/17,5	—	—	6,00/7,75	0,40/1,20	—	B			P
8	0,04/0,07	0,60	0,80/1,80	0,040	0,030	—	—	15,0/16,0	1,40/2,10	1,20/2,00	5,00/5,80	0,05/0,15	—			S	P
9	0,07 max.	0,60	1,00 max.	0,040	0,030	—	—	13,2/14,7	1,20/2,00	1,20/2,00	5,00/5,80	—	0,20/0,70	B			

1) Elements not quoted in this 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, from scrap or other materials 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 alteration when the relevant International Standards have been established.

3) B = bars and forging (see tables 3 and 7). S = sheet and strip 0,5 to < 3 mm thick (see tables 5 and 9).
W = wire (see tables 4 and 8). P = plate ⩾ 3 ⩽ 25 mm thick (see tables 6 and 10).

TABLE 2 — **Permissible deviations between specified analysis and product analysis**

Type of steel	Permissible deviations[1]												
	C %	Si %	Mn %	P %	S %	N %	Al %	Cr %	Cu %	Mo %	Ni %	Ti %	(Nb+Ta) %
1	+ 0,01	+ 0,05	+ 0,03	+ 0,005	+ 0,005	—	—	± 0,20	± 0,15	—	± 0,07	—	± 0,05
2	+ 0,01	+ 0,05	+ 0,03	+ 0,005	+ 0,005	—	± 0,10	± 0,20	+ 0,10	—	± 0,10	—	—
3	+ 0,01	+ 0,05	+ 0,03	+ 0,005	+ 0,005	—	± 0,10	± 0,20	—	± 0,10	± 0,10	—	—
4	+ 0,01	+ 0,05	+ 0,03	+ 0,005	+ 0,005	—	—	± 0,20	+ 0,15	—	± 0,10	—	± 0,05
5	± 0,01	+ 0,05	± 0,04	+ 0,005	+ 0,005	+ 0,02 − 0,01	—	± 0,20	—	± 0,10	± 0,07	—	—
6	± 0,01	+ 0,05	± 0,04	+ 0,005	+ 0,005	+ 0,02 − 0,01	—	± 0,20	—	± 0,10	± 0,07	—	—
7	+ 0,01	+ 0,05	+ 0,03	+ 0,005	+ 0,005	—	+ 0,05	± 0,20	—	—	± 0,10	± 0,07	—
8	± 0,01	+ 0,05	± 0,04	+ 0,005	+ 0,005	—	—	± 0,20	± 0,10	± 0,10	± 0,10	+ 0,03 − 0,02	—
9	+ 0,01	+ 0,05	+ 0,03	+ 0,005	+ 0,005	—	—	± 0,15	± 0,10	± 0,10	± 0,10	—	± 0,05

1) ± 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.

TABLE 3 — **Mechanical properties[1] for bars, forgings and wire rods**

Type of steel	Heat treatment[2]	Hardness			$R_{p0,2}$ min.	R_m	A min. for d or e[5] > 5 ⩽ 160 mm
		HB max.[3]	HRC max.[3]	HRC min.[4]	N/mm²	N/mm²	%
1 and 4	ST	363	39				
	R 131			40	1 170	1 310 to 1 620	10
	R 117			38	1 070	1 170 to 1 490	10
	R 107			35	1 000	1 070 to 1 420	11
	R 096			30	790	960 to 1 350	12
	R 093			28	720	930 to 1 320	14
	R 080			24	510	800 to 1 210	16
2[6]	ST	229	21[7]				
	R 127			41	1 030	1 270 to 1 510	6
	R 117			38	960	1 170 to 1 300	6
3[6]	ST	255	23				
	R 138			43	1 090	1 380 to 1 650	6
	R 124			40	1 030	1 240 to 1 450	6
6	ST	363	39				
	R 117			37	1 070	1 170 to 1 490	11
	R 137			43	1 130	1 370 to 1 670	8
7	ST	302	32				
	R 131			39	1 180	1 310 to 1 610	10[8]
	R 124			37	1 100	1 240 to 1 540	10[8]
	R 118			35	1 030	1 180 to 1 470	10[8]
9	ST-1	341	36				
	R 113			38	1 030	1 130 to 1 320	12
	R 093			29	780	930 to 1 080	15
	ST-2	363	39				
	R 127			40	1 030	1 270 to 1 470	10

1) HB = Brinell hardness; HRC = Rockwell-C hardness; $R_{p0,2}$ = 0,2 % proof stress; R_m = tensile strength; A = percentage elongation after fracture for a gauge length of $L_o = 5{,}65\sqrt{S_o}$ (S_o = original cross-sectional area of gauge length).

1 N/mm² = 1 MPa

2) See table 7.

3) If not otherwise agreed at the time of enquiry and order, in cases of dispute the HB max. values are valid for diameters or thicknesses ⩾ 10 mm, the HRC values for diameters or thicknesses ⩾ 5 to < 10 mm.

4) For information. In cases of dispute the specifications for the tensile properties only apply.

5) d = diameter or e = thickness in millimetres.

6) Steels 2 and 3 — mechanical properties are applicable for sizes ⩽ 75 mm.

7) This value corresponds approximately to 98 HRB.

8) For diameters or thicknesses of > 5 ⩽ 12,5 mm : A min. ⩾ 7 %.

TABLE 4 — **Mechanical properties [1] of wire of diameter ⩾ 0,5 and ⩽ 5 mm**

Type of steel	Heat treatment [2]	HRC min. [3]	$R_{p0,2}$ min.	R_m
			N/mm²	N/mm²
2	ST			1 030 max.
	R 172	46	[4]	1 720 to 1 930
	R 127	41	1 030	1 270 to 1 510
	R 117	38	960	1 170 to 1 380
3	ST			1 100 max.
	R 172	46	[4]	1 720 to 1 930
	R 138	43	1 090	1 380 to 1 650
	R 124	40	1 030	1 240 to 1 450
5	ST			1 270 max.
	R 114	37	1 030	1 140 to 1 430

1) HRC = Rockwell-C hardness; $R_{p0,2}$ = 0,2 % proof stress; R_m = tensile strength.
1 N/mm² = 1 MPa

2) See table 8.

3) For information. In cases of dispute the specifications for the tensile properties only apply.

4) Minimum $R_{p0,2}$ not specified for spring temper wire.

TABLE 5 — **Mechanical properties [1] for sheet and strip with thicknesses ⩾ 0,5 mm and < 3 mm**

Type of steel	Heat treatment [2]	HRC max. [3]	HRC min. [3]	$R_{p0,2}$ min.	$R_{p0,2}$ max.	R_m	A min.
				N/mm²	N/mm²	N/mm²	%
2	ST	21 [4]			380	1 030 max.	20
	R 165		46	1 580		1 650 to 1 930	1
	R 145		44	1 310		1 450 to 1 720	3
	R 124		38	1 030		1 240 to 1 450	5
3	ST	23			450	1 100 max.	22
	R 165		46	1 580		1 650 to 1 930	1
	R 155		46	1 380		1 550 to 1 890	3
	R 131		40	1 170		1 310 to 1 550	4
5	ST	25			550	1 270 max.	19
	R 114		37	1 030		1 140 to 1 430	9
8	ST	22			440	1 030 max.	20
	R 118		40	980		1 180 to 1 370	6
	R 098		31	800		980 to 1 180	8

1) HRC = Rockwell-C hardness; $R_{p0,2}$ = 0,2 % proof stress; R_m = tensile strength; A = percentage elongation after fracture for both test pieces specified in ISO 86 (see figure 2, footnote 1 in the present International Standard).

1 N/mm² = 1 MPa

2) See table 9.

3) For information. In cases of dispute the specifications for the tensile properties only apply.

4) 21 HRC corresponds approximately to 98 HRB.

TABLE 6 — **Mechanical properties[1] for plates with thicknesses ⩾ 3 mm and ⩽ 25 mm**

Type of steel	Heat treatment[2]	HB max.	HRC min.[3]	$R_{p0,2}$ min.	R_m	A min.
				N/mm²	N/mm²	%
2	ST	229				
	R 145		44	1 310	1 450 to 1 720	5
	R 124		38	1 030	1 240 to 1 450	6
3	ST	255				
	R 155		46	1 380	1 550 to 1 890	4
	R 131		40	1 170	1 310 to 1 550	5
6	ST	363				
	R 117		37	1 070	1 170 to 1 490	11
7	ST	302				
	R 131		39	1 180	1 310 to 1 610	7
	R 124		37	1 100	1 240 to 1 540	7
	R 118		35	1 030	1 180 to 1 470	9
8	ST	235				
	R 118		40	980	1 180 to 1 370	8
	R 098		31	800	980 to 1 180	10

1) HB = Brinell hardness; HRC = Rockwell-C hardness; $R_{p0,2}$ = 0,2 % proof stress; R_m = tensile strength; A = percentage elongation after fracture for a gauge length of $L_o = 5{,}65\sqrt{S_o}$ (S_o = original cross-sectional area of gauge length).
1 N/mm² = 1 MPa

2) See table 10.

3) For information. In cases of dispute the specifications for the tensile properties only apply.

TABLE 7 — **Heat treatment for bars, forgings and wire rods**

Type of steel	Heat treatment symbol	Solution treatment temperature	Solution treatment cooling[1]	Condition before hardening	Hardening treatment
1 and 4	ST	1 040 ± 15 °C	A, O		
	R 131			ST	480 ± 10 °C, for 1 h, cool in air or water
	R 117			ST	495 ± 10 °C, for 4 h, cool in air or water
	R 107			ST	550 ± 10 °C, for 4 h, cool in air or water
	R 096			ST	590 ± 10 °C, for 4 h, cool in air or water
	R 093			ST	620 ± 10 °C, for 4 h, cool in air or water
	R 080			ST	760 ± 10 °C, for 2 h, cool in air or water plus 620 ± 10 °C, for 4 h, cool in air or water
2	ST	1 065 ± 15 °C	A, O		
	R 127			ST	955 ± 10 °C, 10 min, cool rapidly to ⩽ 20 °C, cool within 1 h to ⩽ − 70 °C, hold not less than 8 h, warm in air to room temperature. Heat to 510 ± 10 °C, hold 1 h, cool in air
	R 117			ST	760 ± 10 °C, 90 min, cool to ⩽ 20 °C within 1 h, hold not less than 30 min. Heat to 565 ± 10 °C, hold 90 min, cool in air
3	ST	1 065 ± 15 °C	A, O		
	R 138			ST	955 ± 10 °C, 10 min, cool rapidly to ⩽ 20 °C, cool within 1 h to ⩽ − 70 °C, hold not less than 8 h, warm in air to room temperature. Heat to 510 ± 10 °C, hold 1 h, cool in air
	R 124			ST	760 ± 10 °C, 90 min, cool to ⩽ 20 °C within 1 h, hold not less than 30 min. Heat to 565 ± 10 °C, hold 90 min, cool in air
6	ST	1 040 ± 15 °C, 3 h max., cool to ⩽ 20 °C. Heat to 775 ± 10 °C, hold 3 h, cool to room temperature. Heat to 580 ± 10 °C, hold 3 h, cool in air or water			
	R 117			ST	955 ± 10 °C, 1 h per 25 mm − 1 h max., rapid cool to ⩽ 20 °C, cool to ⩽ − 75 °C, hold 3 h, warm to room temperature. Heat to 540 ± 10 °C, hold 3 h, cool in air or water
	R 137			ST	955 ± 10 °C, 1 h per 25 mm − 1 h max., rapid cool to ⩽ 20 °C, cool to ⩽ − 75 °C, hold 3 h, warm to room temperature. Heat to 400 ± 10 °C, hold 3 h, cool in air or water
7	ST	1 040 ± 15 °C	A		
	R 131			ST	510 ± 10 °C, for 30 min, cool in air
	R 124			ST	540 ± 10 °C, for 30 min, cool in air
	R 118			ST	565 ± 10 °C, for 30 min, cool in air
9	ST-1	1 050 ± 15 °C	A		
	R 113			ST-1	850 ± 10 °C for 2 h, cool in air, plus 450 ± 10 °C for 2 h, cool in air
	R 093			ST-1	750 ± 10 °C for 2 h, cool in air, plus 540 ± 10 °C for 2 h, cool in air
	ST-2	950 ± 15 °C	A		
	R 127			ST-2	450 ± 10 °C for 2 h, cool in air

1) A = air, O = oil.

TABLE 8 — **Heat treatment for wire**

Type of steel	Heat treatment symbol	Solution treatment		Condition before hardening	Hardening treatment
		temperature	cooling [1]		
2	CW	No treatment, as cold worked			
	ST	1 040 ± 15 °C	A, O		
	R 172			CW	480 ± 10 °C, for 1 h, cool in air
	R 127			ST	955 ± 10 °C, 10 min, cool rapidly to ⩽ 20 °C, cool within 1 h to ⩽ − 70 °C, hold not less than 8 h, warm in air to room temperature. Heat to 510 ± 10 °C, hold 1 h, cool in air
	R 117			ST	760 ± 10 °C, 90 min, cool to ⩽ 20 °C within 1 h, hold not less than 30 min. Heat to 565 ± 10 °C, hold 90 min, cool in air
3	CW	No treatment, as cold worked			
	ST	1 040 ± 15 °C	A, O		
	R 172			CW	480 ± 10 °C, for 1 h, cool in air
	R 138			ST	955 ± 10 °C, 10 min, cool rapidly to ⩽ 20 °C, cool within 1 h to ⩽ − 70 °C, hold not less than 8 h, warm in air to room temperature. Heat to 510 ± 10 °C, hold 1 h, cool in air
	R 124			ST	760 ± 10 °C, 90 min, cool to ⩽ 20 °C within 1 h, hold not less than 30 min. Heat to 565 ± 10 °C, hold 90 min, cool in air
5	ST	1 055 ± 15 °C	A, W		
	R 114			ST	930 ± 10 °C, 45 min per 25 mm minimum. Rapid cool to ⩽ 20 °C, cool to ⩽ − 75 °C, hold 3 h, warm to room temperature. Heat to 540 ± 10 °C, hold 3 h, cool in air

1) A = air, O = oil, W = water.

TABLE 9 — **Heat treatment for sheet and strip**

Type of steel	Heat treatment symbol	Solution treatment		Condition before hardening	Hardening treatment
		temperature	cooling[1]		
2	CW	No treatment, as cold worked			
	ST	1 040 ± 15 °C	A, O		
	R 165			CW	480 ± 10 °C, for 1 h, cool in air
	R 145			ST	955 ± 10 °C, 10 min, cool rapidly to ⩽ 20 °C, cool within 1 h to ⩽ − 70 °C, hold not less than 8 h, warm in air to room temperature. Heat to 510 ± 10 °C, hold 1 h, cool in air
	R 124			ST	760 ± 10 °C, 90 min, cool to ⩽ 20 °C within 1 h, hold not less than 30 min. Heat to 565 ± 10 °C, hold 90 min, cool in air
3	CW	No treatment, as cold worked			
	ST	1 040 ± 15 °C	A, O		
	R 165			CW	480 ± 10 °C, for 1 h, cool in air
	R 155			ST	955 ± 10 °C, 10 min, cool rapidly to ⩽ 20 °C, cool within 1 h to ⩽ − 70 °C, hold not less than 8 h, warm in air to room temperature. Heat to 510 ± 10 °C, hold 1 h, cool in air
	R 131			ST	760 ± 10 °C, 90 min, cool to ⩽ 20 °C within 1 h, hold not less than 30 min. Heat to 565 ± 10 °C, hold 90 min, cool in air
5	ST	1 055 ± 15 °C	A, W		
	R 114			ST	930 ± 10 °C, 45 min per 25 mm minimum, rapid cool to ⩽ 20 °C, cool to ⩽ − 75 °C, hold 3 h, warm to room temperature. Heat to 540 ± 10 °C, hold 3 h, cool in air
8	ST	1 050 ± 15 °C	A		
	R 118			ST	750 ± 10 °C, for 2 h, cool in air to 0 ± 5 °C. Reheat 450 ± 10 °C for 2 h, cool in air
	R 098			ST	750 ± 10 °C, for 2 h, cool in air to 0 ± 5 °C. Reheat 540 ± 10 °C for 2 h, cool in air

1) A = air, O = oil, W = water.

TABLE 10 – **Heat treatment for plate**

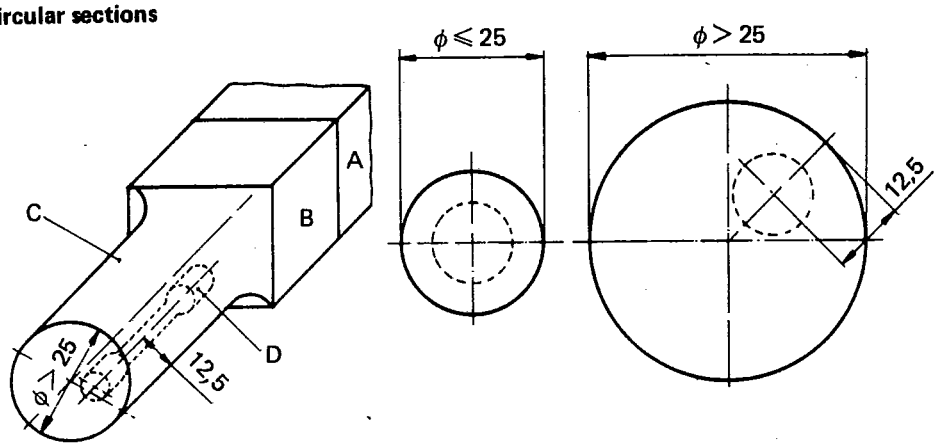
Type of steel	Heat treatment symbol	Solution treatment		Condition before hardening	Hardening treatment
		temperature	cooling[1]		
2	ST	1 040 ± 15 °C	A, O		
	R 145			ST	955 ± 10 °C, 10 min, cool rapidly to ⩽ 20 °C, cool within 1 h to ⩽ – 70 °C, hold not less than 8 h, warm in air to room temperature. Heat to 510 ± 10 °C, hold 1 h, cool in air
	R 124			ST	760 ± 10 °C, 90 min, cool to ⩽ 20 °C within 1 h, hold not less than 30 min. Heat to 565 ± 10 °C, hold 90 min, cool in air
3	ST	1 040 ± 15 °C	A, O		
	R 155			ST	955 ± 10 °C, 10 min, cool rapidly to ⩽ 20 °C, cool within 1 h to ⩽ – 70 °C, hold not less than 8 h, warm in air to room temperature. Heat to 510 ± 10 °C, hold 1 h, cool in air
	R 131			ST	760 ± 10 °C, 90 min, cool to ⩽ 20 °C within 1 h, hold not less than 30 min. Heat to 565 ± 10 °C, hold 90 min, cool in air
6	ST	1 040 ± 15 °C, hold 3 h max., cool to ⩽ 20 °C. Heat to 775 ± 10 °C, hold 3 h, cool to room temperature. Heat to 580 ± 10 °C, hold 3 h, cool in air or water			
	R 117			ST	955 ± 10 °C, hold 1 h per 25 mm – 1 h max. – rapid cool to ⩽ 20 °C, cool to ⩽ – 75 °C, hold 3 h, warm to room temperature. Heat to 540 ± 10 °C, hold 3 h, cool in air or water
7	ST	1 040 ± 15 °C	A		
	R 131			ST	510 ± 10 °C for 30 min, cool in air
	R 124			ST	540 ± 10 °C for 30 min, cool in air
	R 118			ST	565 ± 10 °C for 30 min, cool in air
8	ST	1 050 ± 15 °C	A		
	R 118			ST	750 ± 10 °C for 2 h, cool in air to 0 ± 5 °C. Reheat 450 ± 10 °C for 2 h, cool in air
	R 098			ST	750 ± 10 °C for 2 h, cool in air to 0 ± 5 °C. Reheat 540 ± 10 °C for 2 h, cool in air

1) A = air, O = oil.

Dimensions in millimetres

Circular tensile test piece

Circular sections



A = Sample product
B = Test sample
C = Test bar (the piece after reduction to the size in which it is to be heat-treated)
D = Test piece

Rectangular sections

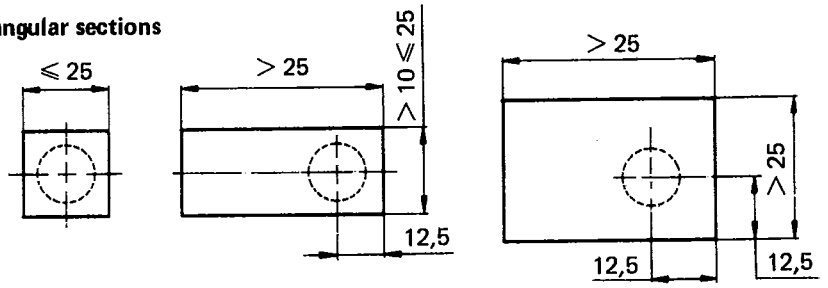
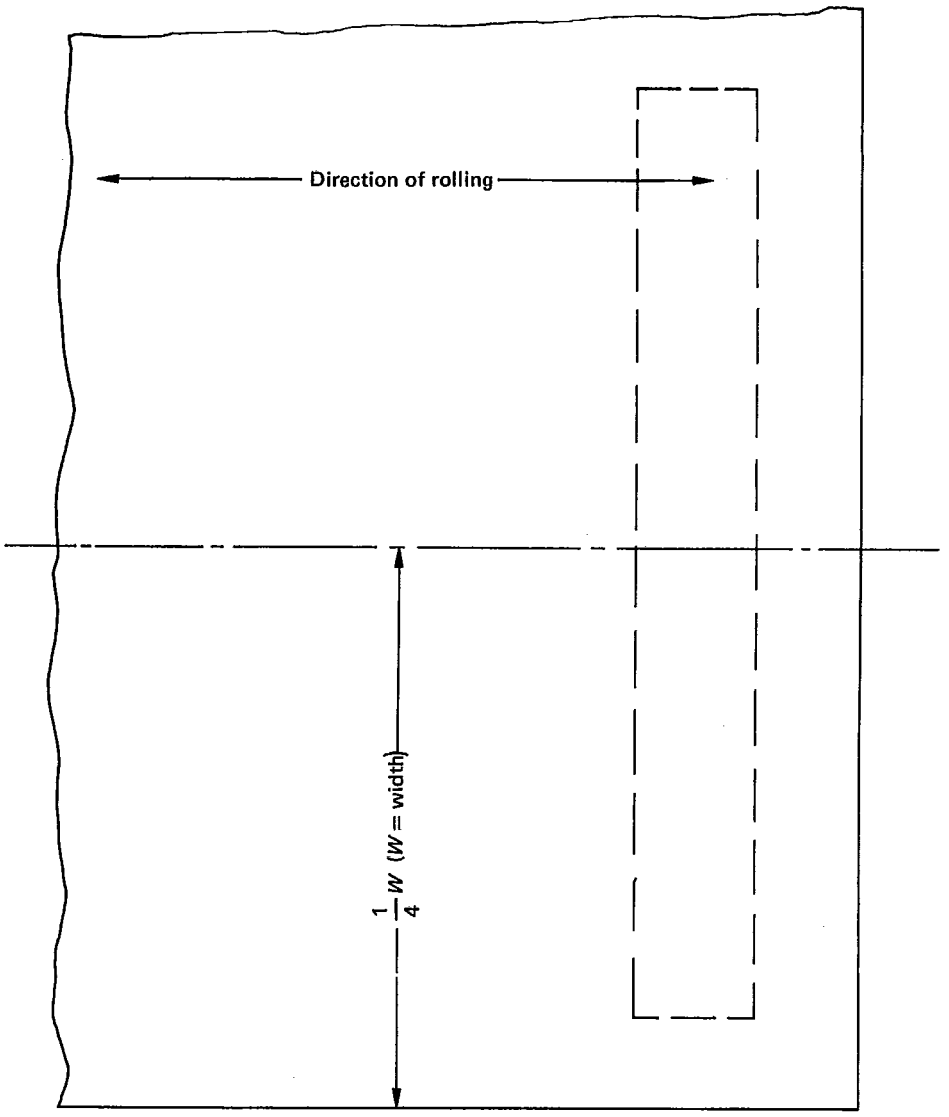


FIGURE 1 — **Location of the test pieces in bars and wire**



Thickness	Samples for test pieces according to ISO 86 [1]
< 3 mm	Rectangular test piece [2] — 25 mm
⩾ 3 mm ⩽ 10 mm	25 mm
> 10 mm ⩽ 25 mm	Round test piece [2] — 25 mm

1) ISO 86 specifies test pieces of either 20 mm width and 80 mm gauge length or of 12,5 mm width and 50 mm gauge length, the latter being applicable only for thicknesses of ⩾ 0,5 mm and ⩽ 2 mm.

2) Gauge length in cases of dispute : $L_o = 5{,}65\sqrt{S_o}$.

FIGURE 2 — **Location of the test pieces in sheet, strip or plate**