Table 7. Through hardening steels: heat treatment and maximum hardness requirements in the softened condition

(heat treatment requirements also applicable to the steels specified in 2.2)

Steel		Heat treatment to be given to test bars and to material required in the finally heat treated condition			Requirements for hardenability test		Maximum HB when material supplied in a softened condition	
Category 1(1)	Category 2(1)	Hardening treatment		Tempering temperature	Preheat treatment temperature	Austenitizing temperature	Softened condition	Temper softened condition
		Temperature	Quenching medium(24)					
Carbon steels								
		°C		°C	°C	°C		
080M30		860–890	O or W	550–660	—	—		
080M36		840–870	O or W	550–660	—	—		
	080H36				*880–900*	*870*		
080M40		830–860	O	550–560			Not usually supplied in the softened condition	
	080H41		—		*880–900*	*860*		
080M46		820–850	O	550–660				
080H46					880–900	850		
080M50		810–840	O	550–660	—	—		
070M55		810–840	O	550–660	—	—		
Carbon manganese steels								
	120M19	*860–900*	*O or W*	*550–660*	No hardenability data specified		Not usually supplied in the softened condition	
120M36		840–870	O	550–660				
135M44		830–860	O	550–660				
150M19		860–900	O or W	550–660				
	150M28	*850–880*	*O*	*550–660*				
150M36		840–870	O	550–660				
	150M40	*830–860*	*O*	*550–660*				
Carbon manganese free cutting steels								
	216M28	*860–890*	*O or W*	*550–660*	No hardenability data specified		Not usually supplied in the softened condition	
212M36		840–870	O	550–660				
	225M36	*840–870*	*O*	*550–660*				
216M36		840–870	O	550–660				
216M44		830–860	O	550–660				
226M44		830–860	O	550–660				
Boron steels								
170H20		No mechanical properties specified			910–930	905		
170H36					870–890	840		
170H41					870–890	840		
185H40					870–890	840		
Alloy steels								
530M40		850–880	O	550–700	—	—	217	235
		830–860	W	550–700	—	—		
530H32					880–900	875		
530H36					880–900	875		
530H40					880–900	875		
605M36		840–870	O	550–680	—	—	217	235
	605H32				*880–900*	*855*		
	605H37				*880–900*	*855*		
606M36		840–870	O	550–680	—	—	217	235
708M40(25)		860–890	O	550–700	—	—	217	235
708H37					880–900	875		
708H42					880–900	875		
708H45					880–900	875		
709M40(25)		860–890	O	550–700	—	—	235	255
720M32 (25)		880–910	O	550–700	—	—	248	277
722M24 (25)		880–910	O	570–700	—	—	241	269

Figures in parenthesis indicate notes which appear at the end of the table.

Table 7. Through hardening steels:
heat treatment and maximum hardness requirements in the softened condition
(heat treatment requirements also applicable to the steels specified in **2.2**) *(concluded)*

Steel		Heat treatment to be given to test bars and to material required in the finally heat treated condition			Requirements for hardenability test		Maximum HB when material supplied in a softened condition	
Category 1 (1)	Category 2 (1)	Hardening treatment		Tempering temperature	Preheat treatment temperature	Austenitizing temperature	Softened condition	Temper softened condition
		Temperature	Quenching medium (24)					
Alloy steels *(concluded)*								
		°C		°C	°C	°C		
817M40		820–850	O	660 max. (27)			248	277
	826M31	*820–850*	*O*	*660 max.* (27)			*255*	277
826M40		820–850	O	660 max. (27)			255	277
835M30		810–840	O (26)	200–280	No hardenability data specified		255	277
	897M39 (25)	*920–970*	*O*	*550–700*				
905M39 (25)		880–920	O	550–700			235	255
	945M38	*840–870*	*O*	*550–680*			*217*	*235*

(1) See note to **1.4.1**.

(24) O = oil; w = water. Where oil hardening is specified, either a well-agitated conventional oil, or a proven synthetic quenchant may be used. Th synthetic quenchants may be employed at varying levels of dilution with water to achieve different predetermined cooling rates. However, synthe quenchants shall not be used for the heat treatment of test bars for material not supplied in the finally heat treated condition.

(25) Steels 708M40, 709M40, 720M32, 722M24, 897M39 and 905M39 are suitable for nitriding. Where parts are to be nitrided, the steel shall be hardened and tempered in accordance with the requirements of the above table but the tempering temperature shall be at least 30 °C above the temperature to be employed for nitriding.

(26) Where the ruling section does not exceed 63 mm air hardening may be employed.

(27) Tempering between 280 °C and 500 °C should be avoided.

ble 8. Through hardening carbon steels: denability requirements

ory 1 (1)	Category 2 (1)	Chemical composition C	Mn	Cr	Mo	Ni	Others	HV 20 or 30 values at distance	1.25	2.00	2.75	3.50	4.25	5.00	5.75	6.50	7.25	9.00	10.5	12.0	15.0	20.0	25.0
		%	%	%	%	%	%		mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
	080H36	*0.33–0.40*	*0.60–1.00*					*max.*	*700*	*675*	*645*	*615*	*575*	*525*	*455*	*385*	*340*	*305*	*295*	*285*	*275*	*265*	*255*
								min.	*550*	*520*	*440*	*290*	*250*	*238*	*232*	*227*	*222*	*216*	*212*	*208*	*204*	*195*	*188*
	080H41	*0.38–0.45*	*0.60–1.00*					*max.*	*750*	*730*	*700*	*665*	*615*	*550*	*475*	*410*	*365*	*330*	*315*	*305*	*295*	*285*	*270*
								min.	*600*	*550*	*485*	*355*	*285*	*255*	*245*	*240*	*237*	*233*	*230*	*225*	*225*	*220*	*210*
16		0.43–0.50	0.60–1.00					max.	800	770	735	695	650	580	500	440	390	340	325	315	310	300	290
								min.	650	590	500	355	295	270	260	255	250	245	240	235	228	220	210

e note to 1.4.1.

e 9. Through hardening boron and alloy steels including steels capable of surface hardening by nitriding: enability requirements

) ry 1	Category 2 (1)	Chemical composition C	Mn	Cr	Mo	Ni	Others	HRC at distance	1.5	3	5	7	9	11	13	15	20	25	30	35	40	45	50
steels																							
		%	%	%	%	%	%		mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
0		0.17–0.23	0.80–1.10				B 0.0005–0.005	max.	48	48	47	46	43	39	32	26	20						
								min.	41	40	36	25											
6		0.32–0.39	0.80–1.10				B 0.0005–0.005	max.	58	58	57	56	54	52	47	41	30	25	24	–	23	–	22
								min.	51	49	47	43	35	26	20								
1		0.37–0.44	0.80–1.10				B 0.0005–0.005	max.	60	60	59	59	58	57	56	55	52	47	40	–	30		
								min.	53	53	52	51	50	47	42	35	28	20					
0		0.36–0.43	1.25–1.75	0.15–0.35	0.08–0.18		B 0.0005–0.005 S 0.03–0.06	max.	60	60	60	60	60	60	59	59	59	58	58	57	56	55	54
								min.	53	53	53	53	52	52	52	51	49	46	43	40	38	36	34
eels																							
2		0.29–0.35	0.50–0.90	0.80–1.25				max.	57	56	55	53	50	47	44	41	37	35	33	32	31	30	29
								min.	50	48	44	39	35	31	28	26	23	20					
5		0.33–0.40	0.50–0.90	0.80–1.25				max.	58	58	57	56	54	52	50	48	43	40	38	37	36	35	34
								min.	51	49	46	43	38	34	32	30	27	24	22	21			
0		0.37–0.44	0.50–0.90	0.80–1.25				max.	60	59	59	58	56	55	53	51	47	42	40	39	38	37	36
								min.	53	52	50	47	43	39	36	34	30	27	25	23	21	20	
	605H32	*0.29–0.35*	*1.25–1.75*		*0.22–0.32*			*max.*	*57*	*57*	*57*	*57*	*56*	*54*	*52*	*50*	*46*	*42*	*40*	*38*	*37*	*36*	*36*
								min.	*50*	*49*	*48*	*45*	*42*	*38*	*35*	*32*	*29*	*27*	*26*	*25*	*25*	*24*	*24*
	605H37	0.34–0.41	*1.25–1.75*		0.22–0.32			*max.*	*59*	*59*	*59*	*58*	*57*	*56*	*55*	*54*	*51*	*47*	*45*	*43*	*41*	*40*	*39*
								min.	*52*	*52*	*51*	*48*	*45*	*42*	*40*	*37*	*33*	*31*	*29*	*28*	*27*	*26*	*25*
7		0.34–0.41	0.65–1.05	0.80–1.25	0.15–0.25			max.	59	59	59	58	58	57	57	56	54	52	48	46	45	44	43
								min.	52	51	51	50	48	47	45	43	38	35	34	33	32	32	31
2		0.39–0.46	0.65–1.05	0.80–1.25	0.15–0.25			max.	62	62	62	61	61	60	60	59	58	56	55	53	52	51	50
								min.	55	55	54	53	52	51	50	48	43	39	36	35	34	33	33
5		0.42–0.49	0.65–1.05	0.80–1.25	0.15–0.25			max.	63	63	62	62	61	61	61	60	59	58	57	56	55	55	54
								min.	56	55	55	54	53	52	51	50	47	42	39	37	36	35	34

hote to 1.4.1.

Section four. Specific requirements for case hardening steels (for steels capable of surface hardening by nitriding, see section three)

This section brings together requirements for the case hardening steels whether they be carbon or alloy. Additionally, as with some other sections, the steels have been divided into two categories. Category 1 steels should be used for new designs and for established designs whenever this is possible.

In selecting a case hardening steel for components having larger section sizes, attention has to be given to the need to achieve the required surface hardness as well as the core properties. This applies particularly where core strength requirements are not high and a carbon or an alloy steel at the low end of the range would give the required core strength. If water hardening is not an option because of distortion, the use of an appropriate alloy steel may be necessary to achieve satisfactory case hardness.

Attention is drawn to the advantages of specifying hardenability requirements for alloy steels, see table 10.

Table 10. Case hardening boron and alloy steels: chemical composition and hardenability requirements

(for mechanical property requirements, see table 11; for steels capable of surface hardening by nitriding, see section three)

Steel		Chemical composition						HRC values at distance															
Category 1 (1)	Category 2 (1)	C	Mn	Cr	Mo	Ni	Others		1.5	3	5	7	9	11	13	15	20	25	30	35	40	45	50
Boron steels (HRC values)																							
		%	%	%	%	%	%		mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
170H15		0.12–0.18	0.80–1.10				P 0.060 max. S 0.03–0.06 B 0.0005–0.005	max. min.	45 38	45 38	44 36	43 31	42 25	39 21	36 19	33	27	25	24	–	24		
173H16		0.13–0.19	1.10–1.40				P 0.060 max. S 0.03–0.06 B 0.0005–0.005	max. min.	46 39	46 39	45 38	45 35	44 32	44 28	43 26	42 24	35	32	30	–	28		
174H20		0.17–0.23	1.20–1.50				P 0.060 max. S 0.03–0.06 B 0.0005–0.005	max. min.	48 41	48 41	48 41	48 40	47 39	47 37	47 35	46 32	44 26	42 23	39 21	–	36		
175H23		0.20–0.25	1.30–1.60				P 0.060 max. S 0.03–0.06 B 0.0005–0.005	max. min.	50 43	50 43	50 43	50 43	49 42	49 41	49 39	48 38	46 32	44 27	41 25	– –	39 23		
Alloy steels (HV values)																							
									HV 20 or 30 values at distance														
									1.25	2.00	2.75	3.50	4.25	5.00	5.75	6.50	7.25	9.00	10.5	12.0	15.0	20.0	25.0
523H15		0.12–0.18	0.30–0.60	0.30–0.60				max. min.	510 380	490 340	445 280	385 240	340 200	315 180	295	280	260	235	220	215	210	205	200
527H17		0.14–0.20	0.70–1.00	0.60–0.90				max. min.	460 380	450 365	440 345	415 320	385 295	355 270	330 255	310 250	300 240	285 230	275 220	270 210	270 210	255 190	240

(1) See note to **1.4.1.**

Table 10. Case hardening boron and alloy steels:
chemical composition and hardenability requirements *(continued)*

Steel		Chemical composition						HRC values at distance																
Category 1 (1)	Category 2 (1)	C	Mn	Cr	Mo	Ni	Others		1.5	3	5	7	9	11	13	15	20	25	30	35	40	45	50
Alloy steels (HRC values)																								
		%	%	%	%	%	%		mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
590H17		0.14–0.20	1.00–1.30	0.80–1.10				max.	47	46	44	42	39	37	34	33	31	30	29	28	27		
								min.	39	36	32	29	26	24	22	20							
	635H15	*0.12–0.18*	*0.60–0.90*	*0.40–0.80*		*0.70–1.10*		*max.*	*45*	*43*	*40*	*36*	*33*	*30*	*28*	*26*	*24*	*23*	*22*	*20*			
								min.	*38*	*32*	*26*	*23*	*21*										
	637H17	*0.14–0.20*	*0.60–0.90*	*0.60–1.00*		*0.85–1.25*		*max.*	*45*	*45*	*44*	*42*	*40*	*37*	*35*	*33*	*31*	*30*	*29*	*28*	*28*	*27*	*26*
								min.	*39*	*37*	*34*	*29*	*27*	*24*	*23*	*21*	*20*						
	655H13	*0.10–0.16*	*0.35–0.60*	*0.70–1.00*		*3.00–3.75*		*max.*	*44*	*44*	*44*	*43*	*42*	*41*	*40*	*39*	*37*	*35*	*34*	*33*	*32*	*32*	*31*
								min.	*37*	*36*	*34*	*32*	*30*	*28*	*27*	*25*	*23*	*22*	*21*				
	665H17	*0.14–0.20*	*0.35–0.75*		*0.20–0.30*	*1.50–2.00*		*max.*	*46*	*44*	*41*	*36*	*31*	*28*	*25*	*24*	*22*	*21*	*20*				
								min.	*39*	*33*	*24*	*21*											
	665H20	*0.17–0.23*	*0.35–0.75*		*0.20–0.30*	*1.50–2.00*		*max.*	*48*	*45*	*41*	*37*	*32*	*29*	*27*	*25*	*23*	*21*	*20*				
								min.	*41*	*35*	*26*	*22*	*20*										
	665H23	*0.20–0.26*	*0.35–0.75*		*0.20–0.30*	*1.50–2.00*		*max.*	*51*	*49*	*46*	*43*	*39*	*34*	*31*	*29*	*27*	*25*	*24*	*23*	*22*	*22*	
								min.	*44*	*40*	*33*	*28*	*26*	*23*	*22*	*21*	*20*						
708H20		0.17–0.23	0.60–0.90	0.85–1.15	0.15–0.25			max.	47	47	46	44	41	39	36	35	33	31	30	29	28	28	
								min.	39	38	35	32	29	26	22	22	20						
	805H17	*0.14–0.20*	*0.60–0.95*	*0.35–0.65*	*0.15–0.25*	*0.35–0.75*		*max.*	*46*	*44*	*40*	*36*	*32*	*28*	*27*	*25*	*23*	*21*	*20*				
								min.	*39*	*33*	*26*	*22*	*20*										
805H20		0.17–0.23	0.60–0.95	0.35–0.65	0.15–0.25	0.35–0.75		max.	48	47	44	40	35	32	30	28	25	24	23	23	23	22	
								min.	41	37	31	25	22	20									

(1) See note to **1.4.1**.

Table 10. Case hardening boron and alloy steels:
chemical composition and hardenability requirements *(concluded)*

Steel		Chemical composition						HRC values at distance															
Category 1 (1)	Category 2 (1)	C	Mn	Cr	Mo	Ni	Others		1.5	3	5	7	9	11	13	15	20	25	30	35	40	45	50
Alloy steels (HRC values) *(concluded)*																							
		%	%	%	%	%	%		mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
305H22		0.19–0.25	0.60–0.95	0.35–0.65	0.15–0.25	0.35–0.75		max.	50	49	46	43	38	34	32	30	27	25	25	24	24	24	
								min.	43	39	33	28	25	22	20								
308H17		0.14–0.20	0.70–1.05	0.35–0.65	0.30–0.40	0.35–0.75		max.	46	45	44	41	38	34	32	30	28	27	26	26	25	25	
								min.	39	38	33	27	24	23	21	21	19	18					
315H17		0.14–0.20	0.60–0.90	0.80–1.20	0.10–0.20	1.20–1.70		max.	46	46	45	45	44	43	42	41	38	35	34	34	33	33	
								min.	39	37	35	33	32	30	29	27	25	22	20				
320H17		0.14–0.20	0.60–0.90	0.80–1.20	0.10–0.20	1.50–2.00		max.	46	46	46	46	45	45	44	44	42	40	38	38	37	37	
								min.	39	39	38	37	35	33	32	30	28	26	25	25	24	24	
322H17		0.14–0.20	0.40–0.70	1.30–1.70	0.15–0.25	1.75–2.25		max.	46	46	46	46	45	45	45	45	45	44	43	43	42	42	
								min.	39	39	39	38	38	37	37	36	35	33	32	31	30	29	
	832H13	*0.10–0.16*	*0.35–0.60*	*0.70–1.00*	*0.10–0.25*	*3.00–3.75*		*max.*	*44*	*44*	*44*	*44*	*44*	*44*	*44*	*43*	*42*	*40*	*38*	*36*	*35*	*34*	
								min.	*37*	*37*	*37*	*36*	*34*	*32*	*30*	*28*	*26*	*23*	*22*	*21*	*21*	*21*	
335H15		0.12–0.18	0.25–0.50	1.00–1.40	0.15–0.30	3.90–4.30		max.	45	45	45	45	45	45	45	45	45	45	44	44	44	43	
								min.	38	38	38	38	38	38	38	38	37	36	35	34	33	32	

1) See note to **1.4.1**.

Table 11. Case hardening steels: chemical composition and mechanical property requirements

Steel		Chemical composition						Test bar diameter	R_m min.	A min. on $5.65\sqrt{S_o}$	Impact	
Category 1(1)	Category 2(1)	C	Mn	Cr	Mo	Ni	Others				Izod min.	KCV min.
Carbon steels												
		%	%	%	%	%	%	mm	N/mm²(2)		ft·lb	J
045M10		0.07–0.13	0.30–0.60					13	430	18	35	42
								19(28)	430	18	35	42
	045A10	*0.08–0.13*	*0.30–0.60*									
080M15		0.12–0.18	0.60–1.00					13	490	16	30	35
								19(28)	460	16	30	35
								29	430	18	30	35
	080A15	*0.13–0.18*	*0.70–0.90*									
Carbon manganese steels												
130M15		0.12–0.18	1.10–1.50					13	740	13	25	28
								19(28)	650	14	30	35
								29	590	15	35	42
	125A15	*0.13–0.18*	*1.10–1.40*									
210M15		0.12–0.18	0.90–1.30				S 0.10–0.18	13	490	16	30	35
								19(28)	460	16	30	35
								29	430	18	30	35
	210A15	*0.13–0.18*	*0.90–1.20*				*S 0.10–0.18*					
214M15		0.12–0.18	1.20–1.60				S 0.10–0.18	13	740	12	25	28
								19(28)	650	12	30	35
								29	590	13	35	42
	214A15	*0.13–0.18*	*1.20–1.50*				*S 0.10–0.18*					
Alloy steel												
523M15		0.12–0.18	0.30–0.60	0.30–0.60				19	620	13	25	28
527M17		0.14–0.20	0.70–1.00	0.60–0.90				19	770	12	15(29)	16(29)
	527A17	*0.14–0.19*	*0.70–0.90*	*0.70–0.90*								
590M17		0.14–0.20	1.00–1.30	0.80–1.10				19	930	10	15(29)	16(29)
	590A15	*0.13–0.18*	*0.90–1.20*	*0.90–1.20*								
	635M15	*0.12–0.18*	*0.60–0.90*	*0.40–0.80*		*0.70–1.10*		*19*	*770*	*12*	*20*	*22*
	635A14	*0.12–0.17*	*0.70–0.90*	*0.50–0.75*	*0.10 max.*	*0.70–1.00*						
	637M17	*0.14–0.20*	*0.60–0.90*	*0.60–1.00*		*0.85–1.25*		*19*	*930*	*10*	*15*	*16*
	637A16	*0.14–0.19*	*0.70–0.90*	*0.70–1.00*	*0.10 max.*	*0.90–1.20*						
	655M13	*0.10–0.16*	*0.35–0.60*	*0.70–1.00*		*3.00–3.75*		*19*	*1000*	*9*	*30*	*35*
	665M17	*0.14–0.20*	*0.35–0.75*		*0.20–0.30*	*1.50–2.00*		*19*	*770*	*12*	*30*	*35*
	665M20	*0.17–0.23*	*0.35–0.75*		*0.20–0.30*	*1.50–2.00*		*19*	*850*	*11*	*20*	*22*
	665M23	*0.20–0.26*	*0.35–0.75*		*0.20–0.30*	*1.50–2.00*		*19*	*930*	*10*	*12*	*13*

Figures in parentheses indicate notes which appear at the end of the table.

Table 11. Case hardening steels:
chemical composition and mechanical property requirements *(concluded)*

Steel		Chemical composition						Test bar diameter	R_m min.	A min. on $5.65\sqrt{S_o}$	Impact	
Category 1(1)	Category 2(1)	C	Mn	Cr	Mo	Ni	Others				Izod min.	KCV min.
Alloy steels *(concluded)*												
		%	%	%	%	%	%	mm	N/mm²(2)		ft lb	J
708M20		0.17–0.23	0.60–0.90	0.85–1.15	0.15–0.25			19	930	10	15(29)	16 (29)
	805M17	*0.14–0.20*	*0.60–0.95*	*0.35–0.65*	*0.15–0.25*	*0.35–0.75*	P 0.035 max. S 0.035 max.	*19*	*770*	*12*	*20*	*22*
	805A17	*0.15–0.20*	*0.70–0.90*	*0.40–0.60*	*0.15–0.25*	*0.40–0.70*						
805M20		0.17–0.23	0.60–0.95	0.35–0.65	0.15–0.25	0.35–0.75		19	850	11	15	16
805A20		0.18–0.23	0.70–0.90	0.40–0.60	0.15–0.25	0.40–0.70						
805M22		0.19–0.25	0.60–0.95	0.35–0.65	0.15–0.25	0.35–0.75		19	930	10	10	11
805A22		0.20–0.25	0.70–0.90	0.40–0.60	0.15–0.25	0.40–0.70						
808M17		0.14–0.20	0.70–1.05	0.35–0.65	0.30–0.40	0.35–0.75		19	930	10	20	22
815M17		0.14–0.20	0.60–0.90	0.80–1.20	0.10–0.20	1.20–1.70		19	1080	8	20	22
820M17		0.14–0.20	0.60–0.90	0.80–1.20	0.10–0.20	1.50–2.00		19	1160	8	20	22
822M17		0.14–0.20	0.40–0.70	1.30–1.70	0.15–0.25	1.75–2.25		19	1310	8	20	22
	832M13	*0.10–0.16*	*0.35–0.60*	*0.70–1.00*	*0.10–0.25*	*3.00–3.75*		*19*	*1080*	*8*	*25*	*28*
835M15		0.12–0.18	0.25–0.50	1.00–1.40	0.15–0.30	3.90–4.30		19	1310	8	25	28

(1) See note to **1.4.1.**

(2) 1 N/mm² = 1 MPa.

(28) Preferred size.

(29) These are new steels which may have been conservatively rated due to limited data.

Table 12. Case hardening steels : heat treatment and maximum hardness requirements

Steel			Requirements for hardenability test		Maximum hardness HB (when specified on the order) in the condition of delivery			
Category 1 (1)	Category 2 (1)	Hardening temperature	Preheat treatment temperature	Austenitizing temperature	Bars and billets for forging	Forgings and bars for machining		
						Normalized	Sub-critically annealed	Normalized and tempered
Carbon, carbon manganese steels								
		°C	°C	°C				
045M10		900–930						
080M15		900–930						
130M15		900–930						
210M15		900–930						
214M15		900–930						
Boron steels								
170H15		–	930–950	925				
173H16		–	930–950	925				
174H20		–	930–950	925				
175H23		–	930–950	925				
Alloy steels								
523H15		–	930–950	925	207	207		
523M15		820–840	–	–	207	207		
527H17		–	930–950	925	–	217		
527M17		820–840	–	–	–	217		
590H17		–	930–950	870	–	217		
590M17		820–840	–	–	–	217		
	635H15	–	*930–950*	*925*	*207*	*207*		
	635M15	*820–840*	–	–	*207*	*207*		
	637H17	–	*930–950*	*925*	*217*	*217*		
	637M17	*820–840*	–	–	*217*	*217*		
	655H13	–	*880–900*	*830*	*255*	–	*255*	*223*
	655M13	*800–820*	–	–	*255*	–	*255*	*223*
	665H17	–	*930–950*	*925*	*207*	*207*		
	665H20	–	*930–950*	*925*	*207*	*207*		
	665H23	–	*930–950*	*925*	*229*	*229*		
	665M17	*820–840*	–	–	*207*	*207*		
	665M20	*820–840*	–	–	*207*	*207*		
	665M23	*820–840*	–	–	*229*	*229*		
708H20		–	930–950	925				
708M20		830–840	–	–	–	–	–	217
	805H17	–	*930–950*	*925*	*207*	*207*		
805H20		–	930–950	925	207	207		
805H22		–	930–950	925	217	217		
	805M17	*820–840*	–	–	*207*	*207*		
805M20		820–840	–	–	207	207		
805M22		820–840	–	–	217	217		
808H17		–	930–950	925	–	–		
808M17		820–840	–	–	–	–		
815H17		–	930–950	925	255	–	255	241
815M17		820–840	–	–	255	–	255	241
820H17		–	880–900	830	277	–	269	248
820M17		820–840	–	–	277	–	269	248
822H17		–	880–900	830	277	–	269	255
822M17		820–840	–	–	277	–	269	255
	832H13	–	*880–900*	*830*	*255*	–	*255*	*248*
	832M13	*800–820*	–	–	*255*	–	*255*	*248*
835H15		–	880–900	830	277	–	277	269
835M15		800–820 (30)	–	–	277	–	277	269

(1) See note to **1.4.1.**

(30) Shall also be stress relieved at a temperature not exceeding 200 °C.

Section five. Specific requirements for stainless and heat resisting steels including those supplied as bright bar

This section specifies requirements for ferritic, martensitic and austenitic stainless and heat resisting steels.

Especially in the case of austenitic steels, changes have been made to take into account agreements that have been reached in international harmonization discussions and mainly concern the chemical composition ranges. The changes include the introduction of 2.0 % to 2.5 % and 2.5 % to 3.0 % molybdenum ranges in place of the single range 2.25 % to 3.0 % molybdenum, the removal of the previous minimum silicon and manganese limits and for certain unstabilized steels, the chromium range has been widened allowing chromium down to 17.0 %.

Table 12. Case hardening steels : heat treatment and maximum hardness requirements

Steel			Requirements for hardenability test		Maximum hardness HB (when specified on the order) in the condition of delivery			
Category 1 (1)	Category 2 (1)	Hardening temperature	Preheat treatment temperature	Austenitizing temperature	Bars and billets for forging	Forgings and bars for machining		
						Normalized	Sub-critically annealed	Normaliz tempere
Carbon, carbon manganese steels								
		°C	°C	°C				
045M10		900–930						
080M15		900–930						
130M15		900–930						
210M15		900–930						
214M15		900–930						
Boron steels								
170H15		–	930–950	925				
173H16		–	930–950	925				
174H20		–	930–950	925				
175H23		–	930–950	925				
Alloy steels								
523H15		–	930–950	925	207	207		
523M15		820–840	–	–	207	207		
527H17		–	930–950	925	–	217		
527M17		820–840	–	–	–	217		
590H17		–	930–950	870	–	217		
590M17		820–840	–	–	–	217		
	635H15	–	*930–950*	*925*	*207*	*207*		
	635M15	*820–840*	–	–	*207*	*207*		
	637H17	–	*930–950*	*925*	*217*	*217*		
	637M17	*820–840*	–	–	*217*	*217*		
	655H13	–	*880–900*	*830*	*255*	–	*255*	*223*
	655M13	*800–820*	–	–	*255*	–	*255*	*223*
	665H17	–	*930–950*	*925*	*207*	*207*		
	665H20	–	*930–950*	*925*	*207*	*207*		
	665H23	–	*930–950*	*925*	*229*	*229*		
	665M17	*820–840*	–	–	*207*	*207*		
	665M20	*820–840*	–	–	*207*	*207*		
	665M23	*820–840*	–	–	*229*	*229*		
708H20		–	930–950	925	–	–	–	217
708M20		830–840	–	–	–	–	–	–
	805H17	–	*930–950*	*925*	*207*	*207*		
805H20		–	930–950	925	207	207		
805H22		–	930–950	925	217	217		
	805M17	*820–840*	–	–	*207*	*207*		
805M20		820–840	–	–	207	207		
805M22		820–840	–	–	217	217		
808H17		–	930–950	925	–	–		
808M17		820–840	–	–	–	–		
815H17		–	930–950	925	255	–	255	241
815M17		820–840	–	–	255	–	255	241
820H17		–	880–900	830	277	–	269	248
820M17		820–840	–	–	277	–	269	248
822H17		–	880–900	830	277	–	269	255
822M17		820–840	–	–	277	–	269	255
	832H13	–	*880–900*	*830*	*255*	–	*255*	*248*
	832M13	*800–820*	–	–	*255*	–	*255*	*248*
835H15		–	880–900	830	277	–	277	269
835M15		800–820 (30)	–	–	277	–	277	269

(1) See note to **1.4.1.**

(30) Shall also be stress relieved at a temperature not exceeding 200 °C.

ble 13. Ferritic and martensitic stainless and heat resisting steels :
emical composition, heat treatment and mechanical property requirements

el (7)	Chemical composition (maximum unless range stated)									Softened condition HB max.	Heat treatment condition	LRS	Heat treatment	R_m	R_e min.	A min. on $5.65\sqrt{S_o}$	Impact		$R_{p0.2}$ (10) min.	HB
	C	Si	Mn	P	S	Cr	Mo	Ni	Se								Izod min.	KCV min.		
ritic steels																				
	%	%	%	%	%	%	%	%	%			mm	°C	N/mm² (2)	N/mm² (2)		ft·lb	J	N/mm² (2)	
3S17	0.08	1.0	1.0	0.040	0.030	12.0–14.0	–	0.50	–	170	–	150	700–780 (31)	420 min.	280	20	–	–	245	170 max.
0S17	0.08	1.0	1.0	0.040	0.030	16.0–18.0	–	0.50	–	170	–	63	750–820 (32)	430 min.	280	20	–	–	245	170 max.
rtensitic steels																				
0S21	0.09–0.15	1.0	1.0	0.040	0.030	11.5–13.5	–	1.00	–	207	P	150	950–1020 (33) 650–750 (34)	550–700	370	20	⩽ 63 mm 40 > 63 mm 25	–	340	152–207
											R	63	600–700 (34)	700–850	525	15	25	–	495	201–255
6S21	0.09–0.15	1.0	1.5	0.060	0.15–0.35	11.5–13.5	0.60	1.00	–	207	P	150	950–1020 (33) 650–750 (34)	550–700	370	15	25	–	340	152–207
											R	63	600–700 (34)	700–850	525	11	20	–	495	201–255
6S29	0.14–0.20	1.0	1.5	0.060	0.15–0.35	11.5–13.5	0.60	1.00	–	217	R	150	950–1020 (33) 650–750 (34)	700–850	525	11	20	–	495	201–255
											S	29	600–700 (34)	775–925	585	10	10	–	555	223–277
6S37	0.20–0.28	1.0	1.5	0.060	0.15–0.35	12.0–14.0	0.60	1.00	–	229	R	150	950–1020 (33) 650–750 (34)	700–850	525	11	20	–	495	201–255
											S	150	600–700 (34)	775–925	585	10	10	–	555	223–277
6S41	0.09–0.15	1.0	1.5	0.060	0.060	11.5–13.5	0.60	1.00	0.15–0.35	179	P	150	950–1020 (33) 650–750 (34)	550–700	370	15	25	–	340	152–207
											R	63	600–700 (34)	700–850	525	11	20	–	495	201–255
0S29	0.14–0.20	1.0	1.0	0.040	0.030	11.5–13.5	–	1.00	–	217	R	150	950–1020 (33) 650–750 (34)	700–850	525	15	⩽ 63 mm 25 > 63 mm 20	–	495	201–255
											S	29	600–700 (34)	775–925	585	13	20	–	555	223–277
0S37	0.20–0.28	1.0	1.0	0.040	0.030	12.0–14.0	–	1.00	–	229	R	150	950–1020 (33) 650–750 (34)	700–850	525	15	⩽ 63 mm 25 > 63 mm 20	–	495	201–255
											S	150	600–700 (34)	775–925	585	13	⩽ 63 mm 20 > 63 mm 10	–	555	223–277
1S29	0.12–0.20	1.0	1.0	0.040	0.030	15.0–18.0	–	2.0–3.0	–	277	T	150	950–1020 (33) 550–650 (34) (35)	850–1000	680	11	⩽ 63 mm 25 > 63 mm 15	–	635	248–302

2) 1 N/mm² = 1 MPa.

7) All the steels are category 1, see also foreword.

0) When specifically ordered.

31) Air cooled or furnace cooled.

(35) When 0.2 % proof stress is specified, it is recommended that a double tempering treatment be used:
(a) 640 °C to 680 °C followed by
(b) 590 °C to 610 °C.

Table 14. Austenitic stainless and heat resisting steels: chemical composition, softening treatment and mechanical property requirements

(for mechanical property requirements for austenitic steels in the cold drawn condition, see table 15)

Steel(7)	Chemical composition (maximum unless range stated)									Softening temperature	Maximum section	R_m min.	A min. on $5.65\sqrt{S_o}$	$R_{p0.2}$ (10)	$R_{p1.0}$ (10)	Sensitization period (see 1.15.6)	HB max. (36)
	C	Si	Mn	P	S	Cr	Mo	Ni	Others								
Austenitic steels																	
	%	%	%	%	%	%	%	%	%	°C	mm	N/mm²(2)		N/mm²(2)	N/mm²(2)	min	
302S31	0.12	1.0	2.0	0.045	0.030	17.0–19.0	–	8.0–10.0	–	1000–1100	160	510	40	190	225	–	183
304S11	0.030	1.0	2.0	0.045	0.030	17.0–19.0	–	9.0–12.0	–	1000–1100	160	480	40	180	215	30	183
304S15	0.06	1.0	2.0	0.045	0.030	17.5–19.0	–	8.0–11.0	–	1000–1100	160	480	40	195	230	15	183
304S31	0.07	1.0	2.0	0.045	0.030	17.0–19.0	–	8.0–11.0	–	1000–1100	160	490	40	195	230	15	183
321S31	0.08	1.0	2.0	0.045	0.030	17.0–19.0	–	9.0–12.0	Ti 5C–0.80	1000–1100	160	510	35	200	235	30	183
347S31	0.08	1.0	2.0	0.045	0.030	17.0–19.0	–	9.0–12.0	Nb 10C–1.00	1000–1100	160	510	30	205	240	30	183
316S11	0.030	1.0	2.0	0.045	0.030	16.5–18.5	2.00–2.50	11.0–14.0	–	1000–1100	160	490	40	190	225	30	183
316S13	0.030	1.0	2.0	0.045	0.030	16.5–18.5	2.50–3.00	11.5–14.5	–	1000–1100	160	490	40	190	225	30	183
316S31	0.07	1.0	2.0	0.045	0.030	16.5–18.5	2.00–2.50	10.5–13.5	–	1000–1100	160	510	40	205	240	15	183
316S33	0.07	1.0	2.0	0.045	0.030	16.5–18.5	2.50–3.00	11.0–14.0	–	1000–1100	160	510	40	205	240	15	183
320S31	0.08	1.0	2.0	0.045	0.030	16.5–18.5	2.00–2.50	11.0–14.0	Ti 5C–0.80	1000–1100	160	510	35	210	245	30	183
310S31	0.15	1.5	2.0	0.045	0.030	24.0–26.0	–	19.0–22.0	–	1000–1100	160	510	40	205	240	–	207
303S31	0.12	1.0	2.0	0.060	0.15–0.35	17.0–19.0	1.00(37)	8.0–10.0	–	1000–1100	160	510	40	190	225	–	183
303S42	0.12	1.0	2.0	0.060	0.060	17.0–19.0	1.00(37)	8.0–10.0	Se 0.15–0.35	1000–1100	160	510	40	190	225	–	183
325S31	0.12	1.0	2.0	0.045	0.15–0.35	17.0–19.0	–	8.0–11.0	Ti 5C–0.90	1000–1100	160	510	35	200	235	30	183

(2) 1 N/mm² = 1MPa.
(7) All the steels are category 1, see also foreword.
(10) When specifically ordered.
(36) Straightening by reeling or cold rectification of austenitic steels can increase the surface hardness above the specified maximum.
(37) Optional addition.

Table 15. Austenitic stainless steels in the cold drawn condition: mechanical property requirements (see 1.13.4.1 (c))

Selection	R_m min.	A min. on $5.65\sqrt{S_o}$	$R_{p0.2}$ min.
mm	N/mm² (2)		N/mm² (2)
⩽ 19	865	12	695
> 19 ⩽ 25	790	15	555
> 25 ⩽ 32	725	20	450
> 32 ⩽ 38	695	28	340
> 38 ⩽ 45	650	28	310

(2) N/mm² = 1 MPa.

Section six. Specific requirements for sizes and tolerances

6.1 Sizes

6.1.1 Billets for forging. Billets for forging shall be supplied in accordance with the nominal sizes given in table 16.

6.1.2 Black and bright bar. The sizes of black and bright bars shall be selected from BS 4229 : Part 2.

NOTE. Sizes other than those in BS 4229 : Part 2 may be available.

6.2 Mass/unit length tolerances

Billets for forging shall be supplied in accordance with table 16.

6.3 Dimensional tolerances

6.3.1 Black and bright bar. Black and bright bar tolerances shall be in accordance with tables 17 to 19 and 20 to 22, respectively.

6.3.2 Drop and press forgings and upset forgings made on horizontal forging machines. Drop and press forgings and upset forgings made on horizontal forging machines shall comply with BS 4114 unless otherwise agreed between the purchaser and the supplier.

6.4 Straightness

6.4.1 Billets and bars for machining. Billets and bars for machining shall be straightened to within 2 mm in any 1 m length.

6.4.2 Billets and bars for forging. Billets and bars for forging shall be straight to within 1/250 in any unit length.

6.5 Length

The standard tolerance on length for random length bars shall be 600 mm.

NOTE. Closer tolerances may be agreed between the purchaser and the supplier.

Table 16. Billets (other than stainless steel) for forging : standard mass per metre and tolerances

Round cornered square billets (38)			Round billets		
Nominal size (39) across flats	Standard mass	Permissible variations on mass	Nominal size (40) diameter	Standard mass	Permissible variations on mass
mm	kg/m	%	mm	kg/m	%
50	19.3	± 2.5 or, when a minimum mass is specified, +5, -0; when a maximum mass is specified, +0, -5.	76	35.6	± 2.5 or, when a minimum mass is specified, +5, -0; when a maximum mass is specified, +0, -5.
51	20.1		80	39.5	
55	23.3		85	44.5	
57	25.0		90	49.9	
60	27.7		95	55.6	
63	30.6		100	61.7	
65	32.7		105	68.0	
67	34.6		110	74.6	
70	37.7		115	81.5	
73	41.0		120	88.8	
75	43.2		125	96.3	
76	44.4		130	104.2	
80	49.1		135	112.4	
83	52.9		140	120.8	
85	55.5		145	129.6	
86	56.8		150	138.7	
90	62.2		155	148.1	
92	65.2		160	157.8	
95	69.5		165	167.8	
98	74.0		170	178.2	
100	77.0		175	188.8	
105	84.9		180	199.8	
108	89.8		185	211.0	
110	93.1		190	222.6	
115	101.7		195	234.4	
120	110.2		200	246.6	
127	124.0		205	259.1	
130	129.7		210	271.9	
135	140.3		215	285.0	
140	151.3		220	298.4	

(38) When round cornered square billets are supplied to the mass/unit length requirements of this table, it should be realized that, because of the differences in roll pass design, i.e. corner radius and angle between sides, which may exist from mill to mill, there may be slight differences in the actual size of billet of the same standard mass.

(39) These are preferred sizes for round cornered square billets.

(40) For other sizes of round billets, standard masses shall be calculated using the formula:

$$\text{Standard mass (in kg/m)} = \frac{\pi \times (\text{nominal size, in mm})^2 \times 0.00785}{4}$$

Table 12. Case hardening steels : heat treatment and maximum hardness requirements

Steel			Requirements for hardenability test		Maximum hardness HB (when specified on the order) in the condition of delivery			
					Bars and billets for forging	Forgings and bars for machining		
Category 1 (1)	Category 2 (1)	Hardening temperature	Preheat treatment temperature	Austenitizing temperature		Normalized	Sub-critically annealed	Normalized and tempered
Carbon, carbon manganese steels								
		°C	°C	°C				
045M10		900–930						
080M15		900–930						
130M15		900–930						
210M15		900–930						
214M15		900–930						
Boron steels								
170H15		–	930–950	925				
173H16		–	930–950	925				
174H20		–	930–950	925				
175H23		–	930–950	925				
Alloy steels								
523H15		–	930–950	925	207	207		
523M15		820–840	–	–	207	207		
527H17		–	930–950	925	–	217		
527M17		820–840	–	–	–	217		
590H17		–	930–950	870	–	217		
590M17		820–840	–	–	–	217		
	635H15	–	*930–950*	*925*	207	*207*		
	635M15	*820–840*	–	–	207	*207*		
	637H17	–	*930–950*	*925*	217	*217*		
	637M17	*820–840*	–	–	217	*217*		
	655H13	–	*880–900*	*830*	255	–	*255*	*223*
	655M13	*800–820*	–	–	255	–	*255*	*223*
	665H17	–	*930–950*	*925*	207	*207*		
	665H20	–	*930–950*	*925*	207	*207*		
	665H23	–	*930–950*	*925*	229	*229*		
	665M17	*820–840*	–	–	207	*207*		
	665M20	*820–840*	–	–	207	*207*		
	665M23	*820–840*	–	–	229	*229*		
708H20		–	930–950	925	–	–	–	217
708M20		830–840	–	–				
	805H17	–	*930–950*	*925*	207	*207*		
805H20		–	930–950	925	207	207		
805H22		–	930–950	925	217	217		
	805M17	*820–840*	–	–	*207*	*207*		
805M20		820–840	–	–	207	207		
805M22		820–840	–	–	217	217		
808H17		–	930–950	925	–	–		
808M17		820–840	–	–	–	–		
815H17		–	930–950	925	255	–	255	241
815M17		820–840	–	–	255	–	255	241
820H17		–	880–900	830	277	–	269	248
820M17		820–840	–	–	277	–	269	248
822H17		–	880–900	830	277	–	269	255
822M17		820–840	–	–	277	–	269	255
	832H13	–	*880–900*	*830*	*255*	–	*255*	*248*
	832M13	*800–820*	–	–	*255*	–	*255*	*248*
835H15		–	880–900	830	277	–	277	269
835M15		800–820 (30)	–	–	277	–	277	269

(1) See note to **1.4.1.**

(30) Shall also be stress relieved at a temperature not exceeding 200 °C.

Table 17. Tolerances for hot rolled round and square bar and rough turned rounds

Size	Permitted variation					
	General applications				Special applications	
	Primary-rolled round material		Re-rolled material		Re-rolled material	
	Diameter	Out of section (41)	Diameter or width across flats	Out of section (41)	Diameter or width across flats	Out of section (41)
mm	± mm	mm	± mm	mm	± mm	mm
⩽ 16	–	–	0.2	0.3	0.2	0.3
> 16 ⩽ 26	–	–	0.3	0.5	0.2	0.3
> 26 ⩽ 38	–	–	0.4	0.6	0.25	0.4
> 38 ⩽ 51	–	–	0.5	0.8	0.3	0.5
> 51 ⩽ 64	–	–	0.6	0.9	0.4	0.6
> 64 ⩽ 76	–	–	0.7	1.1	0.5	0.8
> 76 ⩽ 90	1.3	2.0	0.7	1.1		
> 90 ⩽ 120	1.5	2.3	0.8	1.2		
> 120 ⩽ 160	2.0	3.0				
> 160 ⩽ 200	2.5	3.8				
> 200	3.0	4.5				

(41) In relation to table 17, the definition of 'out of section' is as follows:

Round bar. The difference between the maximum and the minimum diameter of the bar measured at the same cross section.

Square bar. The difference between the two dimensions measured across the two pairs of opposing (parallel) sides at a common cross section of the bar.

NOTE. By agreement between purchaser and supplier, the tolerances may be all plus or all minus, e.g. the general applications tolerance for 16 mm round may be either plus 0.4 mm or minus 0.4 mm.

Table 18. Tolerances for hot rolled hexagonal bar

Size	Permitted variation			
	General applications		Special applications	
	Re-rolled material		Re-rolled material	
	Width across flats	Out of section (41)	Width across flats	Out of section (41)
mm	± mm	mm	± mm	mm
⩽ 16	0.2	0.3	0.2	0.3
> 16 ⩽ 26	0.3	0.5	0.2	0.3
> 26 ⩽ 38	0.4	0.6	0.25	0.4
> 38 ⩽ 51	0.5	0.8	0.3	0.5
> 51 ⩽ 64	0.6	0.9	0.4	0.6
> 64 ⩽ 76	0.7	1.1	0.5	0.8

(41) In relation to table 18, the definition of 'out of section' is as follows:

Hexagonal bar. The difference between the least and the greatest dimensions measured across the three pairs of opposing (parallel) flats at a common cross section of the bar.

NOTE. By agreement between purchaser and supplier, the tolerances may be all plus or all minus, e.g. the general applications tolerance for 16 mm section may be either plus 0.4 mm or minus 0.4 mm.

Table 19. Tolerances for hot rolled flat bar

Size	Permitted variation	
	General applications	Special applications
mm	± mm	± mm
Width		
⩾ 10 ⩽ 35	0.5	0.4
> 35 ⩽ 75	0.8	0.6
> 75 ⩽ 100	1.0	0.7
> 100 ⩽ 125	1.3	0.9
> 125 ⩽ 150	1.5	1.0
Thickness		
⩽ 10	0.4	0.3
> 10 ⩽ 20	0.5	0.3
> 20 ⩽ 40	0.6	0.4
> 40 ⩽ 60	0.8	0.5
> 60	1.0	0.7

NOTE. By agreement between purchaser and supplier, the tolerances may be all plus or all minus, e.g. the standard tolerance on width for 35 mm wide flats may be either plus 1.0 mm or minus 1.0 mm.

Table 20. Tolerances for turned or ground bar

Size, diameter or width across flats	Permitted variation
mm	mm
⩾ 6 ⩽ 18	+0, -0.070
> 18 ⩽ 30	+0, -0.085
> 30 ⩽ 50	+0, -0.100
> 50 ⩽ 80	+0, -0.120
> 80 ⩽ 120	+0, -0.140
> 120 ⩽ 180	+0, -0.160
> 180 ⩽ 250	+0, -0.185
> 250 ⩽ 315	+0, -0.210
> 315 ⩽ 400	+0, -0.230
> 400	+0, -0.250

NOTE 1. This table covers bars which have been hot rolled, possibly thermally treated, and turned or ground, and which are normally going to be further processed prior to being put into service (see also note 1 to table 22).

NOTE 2. Bars can be supplied to other permitted variations by agreement between supplier and purchaser. The tolerances may be specified all positive if required.

NOTE 3. In the case of bars supplied to a permitted length variation greater than 150 mm, measurement of the diameter shall be carried out not less than 150 mm from the end of the bar. When supplied with sawn ends up to and including a permitted length variation of 150 mm, bars shall be measured not less than 10 mm from the end of the bar.

NOTE 4. Measurement of cross-sectional dimensions shall also take into account the deformation that occurs on all bars with cold sheared ends. Tolerances on these bars shall be measured at a distance from the end of the bar not less than the thickness of the material.

Table 22. Tolerances for precision ground bar

Surface texture shall be 0.8 µm centre line average maximum (0.8 µm R_a max.) in accordance with BS 1134 : Part 1.

NOTE. Finer surface textures may be supplied by agreement between the purchaser and the supplier.

Section	Size, diameter	Overall tolerance	
		Normal	Fine
	mm	mm	mm
Round	⩾ 6 ⩽ 75	0.050	0.025

NOTE 1. This table covers bars which have been hot worked, possibly thermally treated, and either cold drawn to specific properties and precision ground, or turned and ground. These bars are normally put into service in the condition of supply (see also note 1 to table 20).

NOTE 2. The tolerance offered may be adjusted to suit individual requirements. Finer tolerances than those stated may be available by agreement.

NOTE 3. Maximum deviation from straightness shall be 0.15 mm total indicator reading (TIR) in any 300 mm length.

NOTE 4. Maximum deviation from 'out of round' shall be no more than half the ordered tolerance, as measured using a 60 ° 3-point gauge.

NOTE 5. Bars with cold sheared ends shall be measured at a distance from the end not less than the diameter of the material.

Table 21. Tolerances for cold drawn bar

Section	Size, diameter or width across flats	Permitted variation
	mm	mm
Round	⩾ 6 ⩽ 18	+0 -0.070
	> 18 ⩽ 30	+0 -0.085
	> 30 ⩽ 50	+0 -0.100
	> 50 ⩽ 80	+0 -0.120
	> 80 ⩽ 100	+0 -0.140
Square and hexagon	⩾ 6 ⩽ 18	+0 -0.090
	> 18 ⩽ 30	+0 -0.110
	> 30 ⩽ 50	+0 -0.130
	> 50 ⩽ 80	+0 -0.160
	> 80	by arrangement
Flat (width)	⩾ 10 ⩽ 18	+0 -0.110
	> 18 ⩽ 30	+0 -0.130
	> 30 ⩽ 50	+0 -0.160
	> 50 ⩽ 80	+0 -0.190
	> 80 ⩽ 100	+0 -0.220
	> 100 ⩽ 120	+0 -0.350
	> 120 ⩽ 180	+0 -0.400
	> 180	by arrangement
Flat (thickness)	⩾ 10 ⩽ 18	+0 -0.110
	> 18 ⩽ 30	+0 -0.130
	> 30 ⩽ 50	+0 -0.250
	> 50	by arrangement

NOTE 1. In the case of round bars supplied to a length tolerance greater than 150 mm, measurement of the diameter shall be carried out not less than 150 mm from the end of the bar. When supplied with sawn ends up to and including a length tolerance of 150 mm, bars shall be measured not less than 10 mm from the end of the bar.

NOTE 2. Measurement of cross-sectional dimensions shall also take into account the deformation that occurs on all bars with cold sheared ends. Tolerances on these bars shall be measured at a distance from the end of the bar not less than the thickness of the material.

Appendix A

Hardenability curves for through hardening and case hardening steels

This appendix presents the hardenability data for the H grades specified in sections three and four in graphical form. This enables a pictorial assessment of the hardenability characteristics of a particular steel to be made and, also, facilitates the comparison of one H grade with another.

It is important that these graphs are not used for specification purposes. The values to be used are those specified in tables 8 and 9 (through hardening steels) and 10 (case hardening steels). They should be selected as recommended in BS 4437.

The graphs contained in this appendix are as follows:

A.1 Hardenability curves for through hardening steels

A.1.1 Carbon steels

A.1.1.1 *080H36*
A.1.1.2 *080H41*
A.1.1.3 080H46

A.1.2 Boron steels

A.1.2.1 170H20
A.1.2.2 170H36
A.1.2.3 170H41
A.1.2.4 185H40

A.1.3 Alloy steels

A.1.3.1 530H32
A.1.3.2 530H36
A.1.3.3 530H40
A.1.3.4 *605H32*
A.1.3.5 *605H37*
A.1.3.6 708H37
A.1.3.7 708H42
A.1.3.8 708H45

A.2 Hardenability curves for case hardening steels

A.2.1 Boron steels

A.2.1.1 170H15
A.2.1.2 173H16
A.2.1.3 174H20
A.2.1.4 175H23

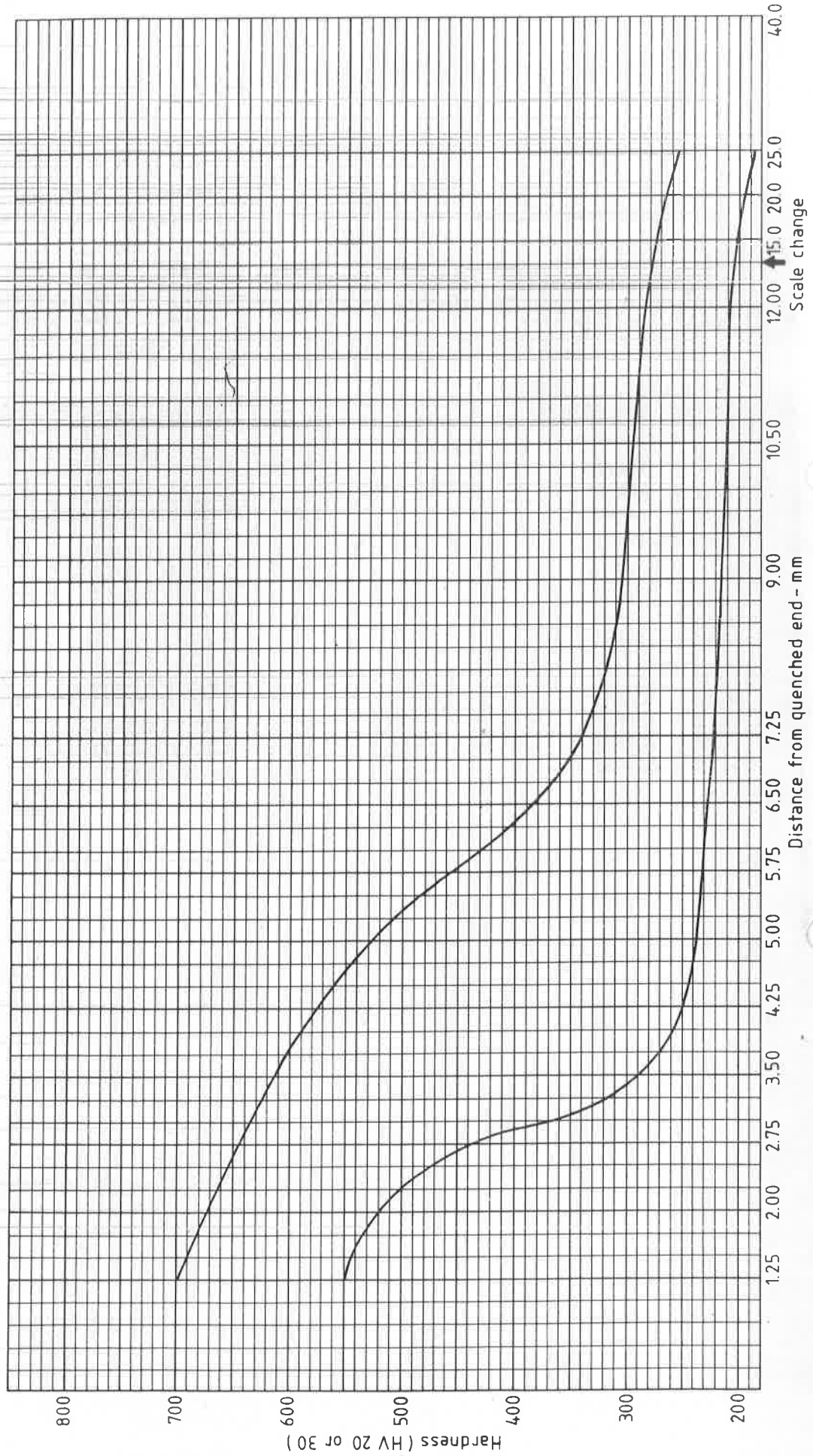
A.2.2 Alloy steels

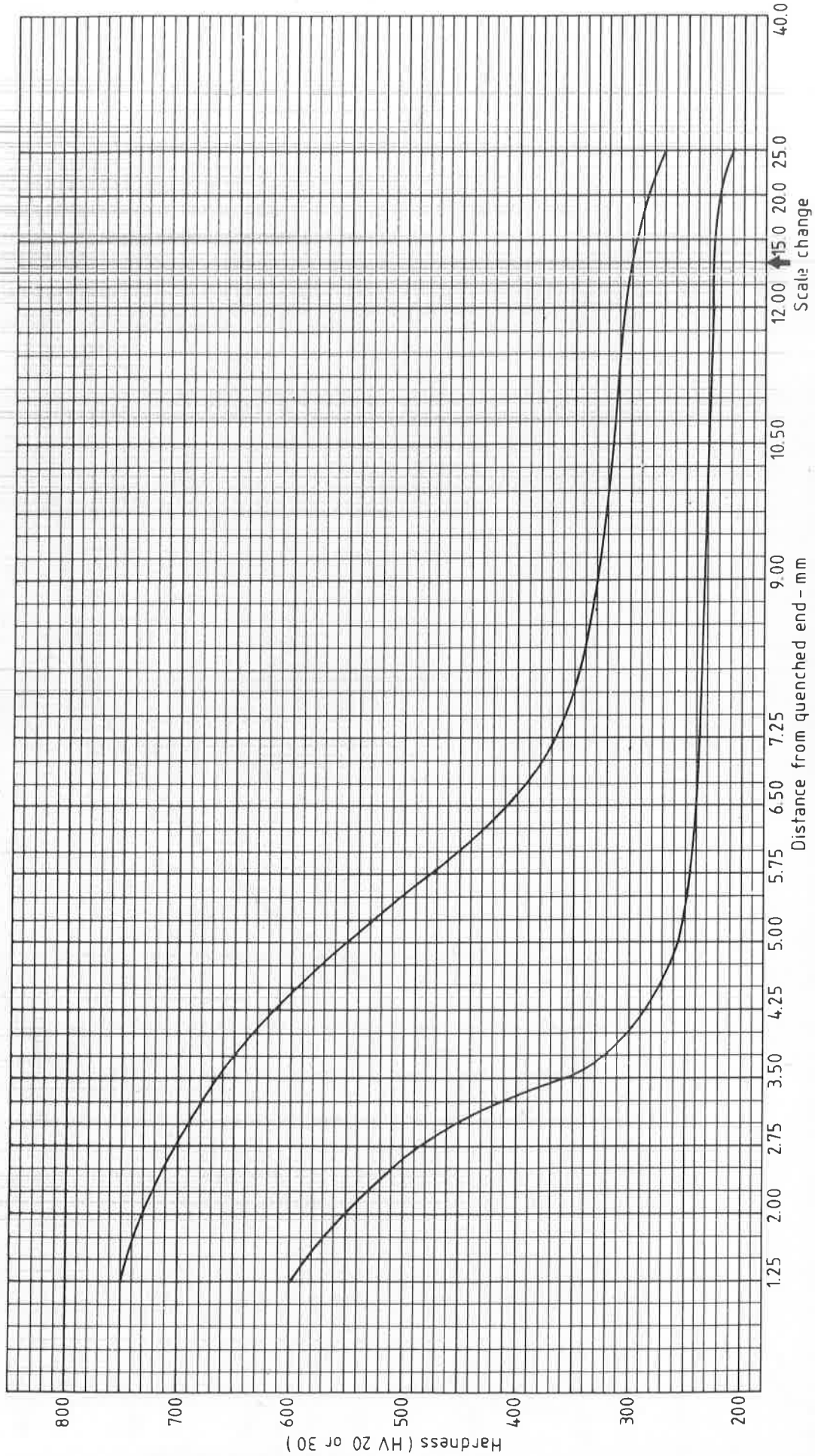
A.2.2.1 523H15
A.2.2.2 527H17
A.2.2.3 590H17
A.2.2.4 *635H15*
A.2.2.5 *637H17*
A.2.2.6 *655H13*
A.2.2.7 *665H17*
A.2.2.8 *665H20*
A.2.2.9 *665H23*
A.2.2.10 708H20
A.2.2.11 805H17
A.2.2.12 805H20
A.2.2.13 *805H22*
A.2.2.14 808H17
A.2.2.15 815H17
A.2.2.16 820H17
A.2.2.17 822H17
A.2.2.18 *832H13*
A.2.2.19 835H15

A.1 Hardenability curves for through hardening steels (for guidance only)

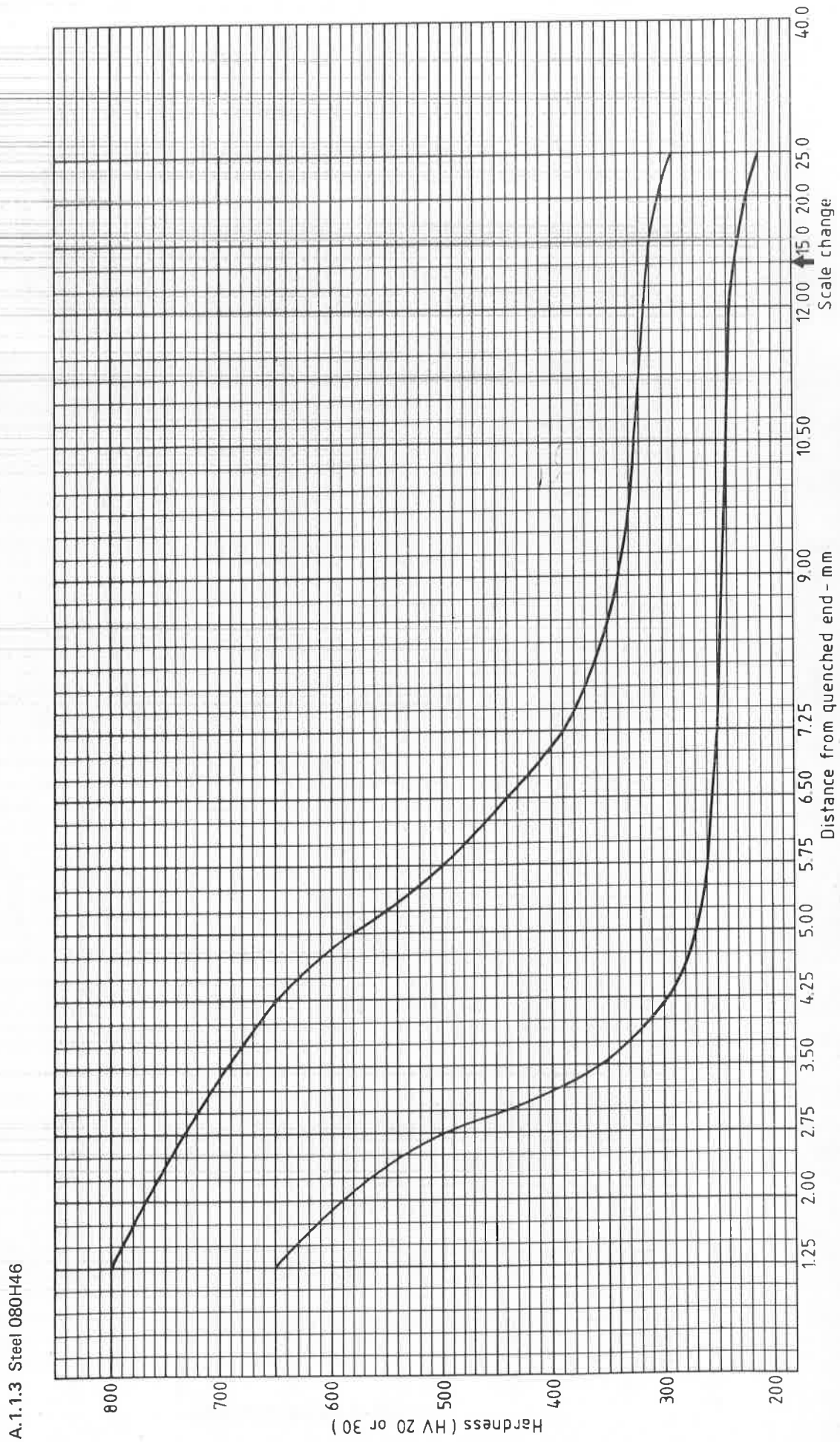
A.1.1. *Carbon steels*

A.1.1.1 *Steel 080H36*





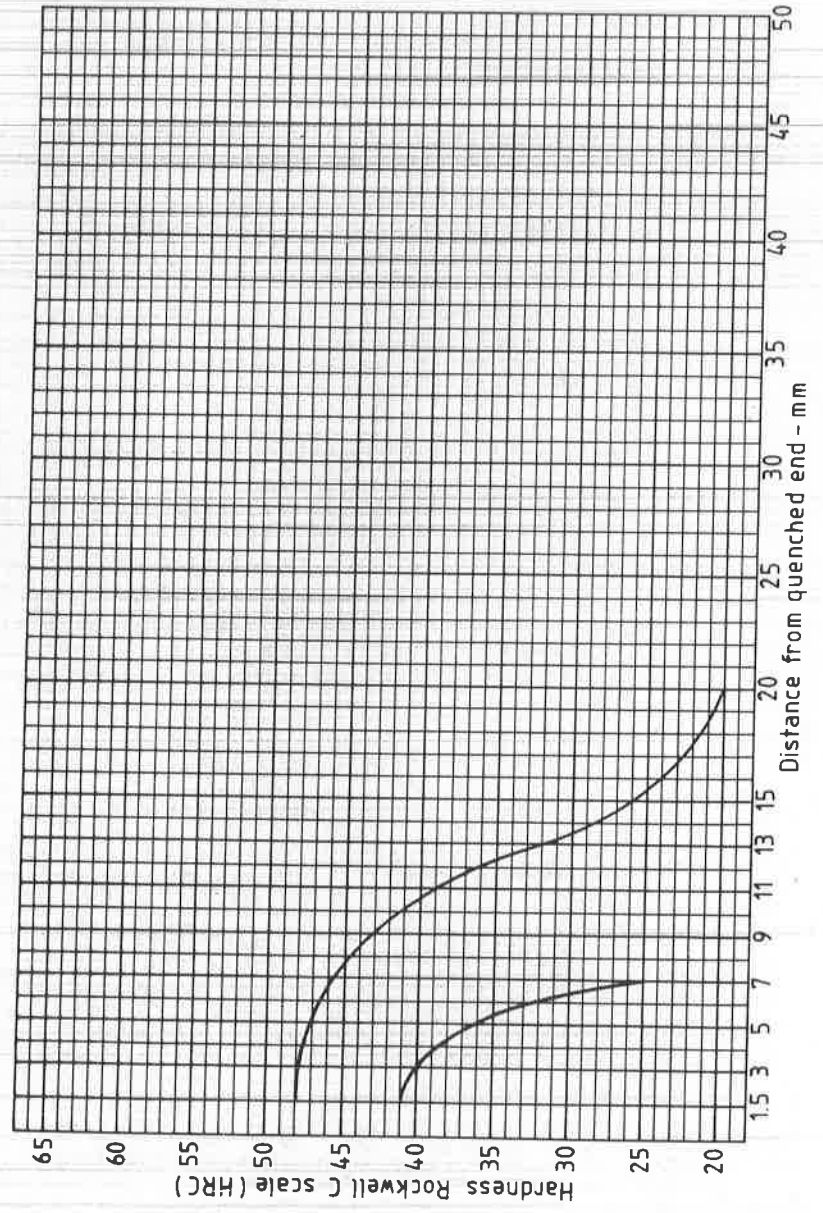
A.1.1.2 *Steel 080H41*

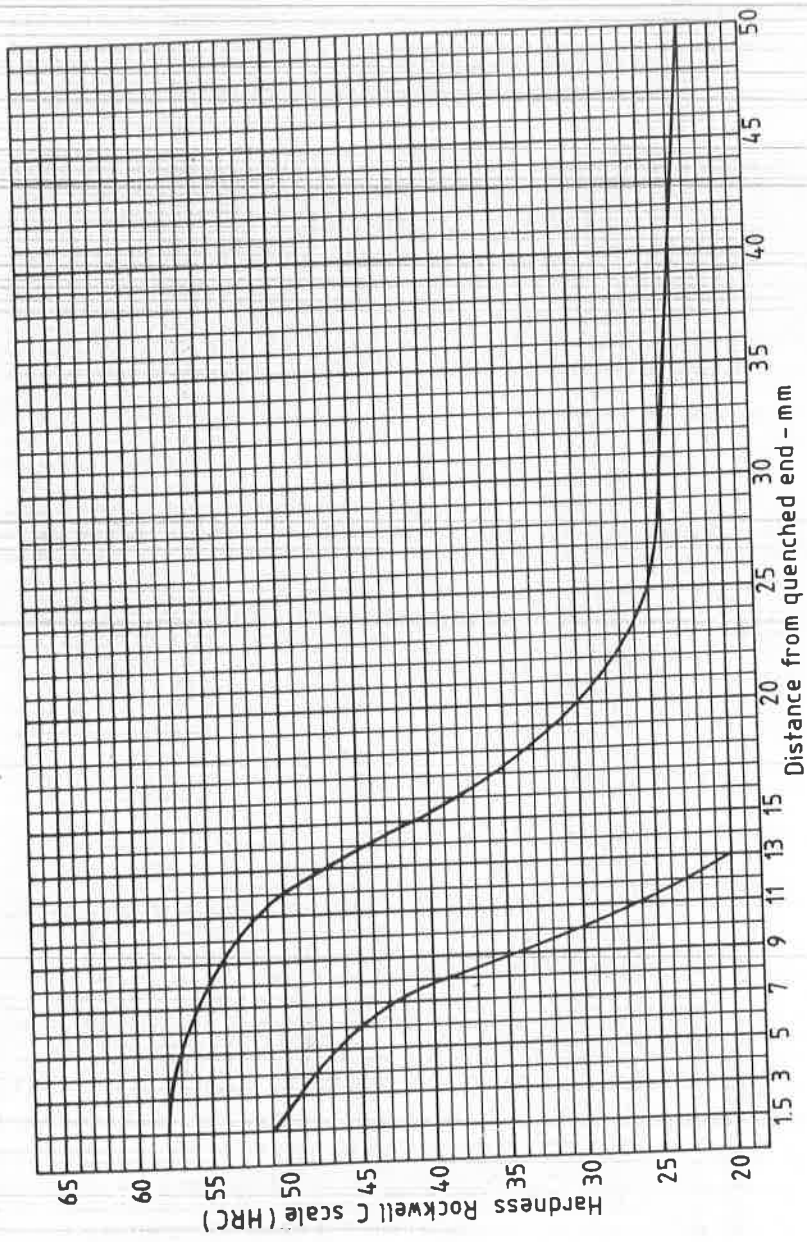


A.1.1.3 Steel 080H46

A.1.2 *Boron steels*

A.1.2.1 Steel 170H20





A.1.2.2 Steel 170H36