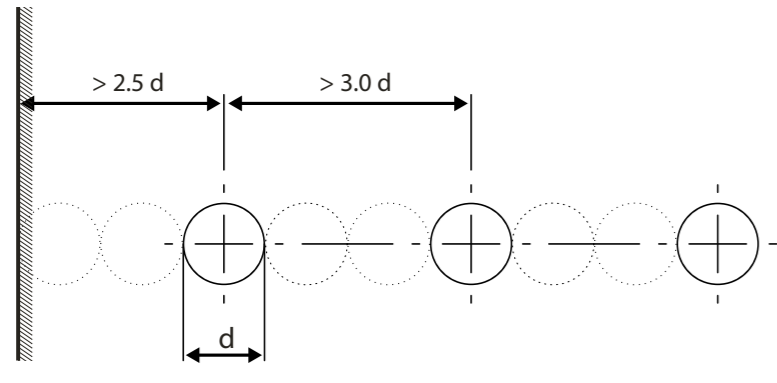
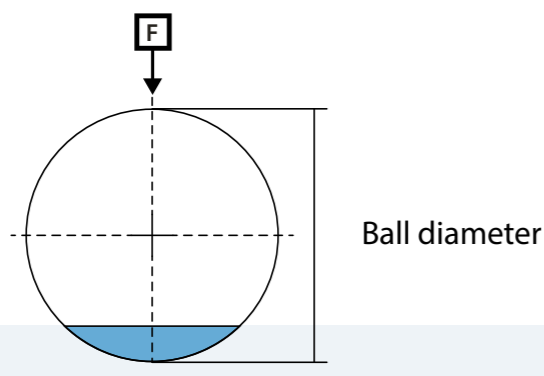


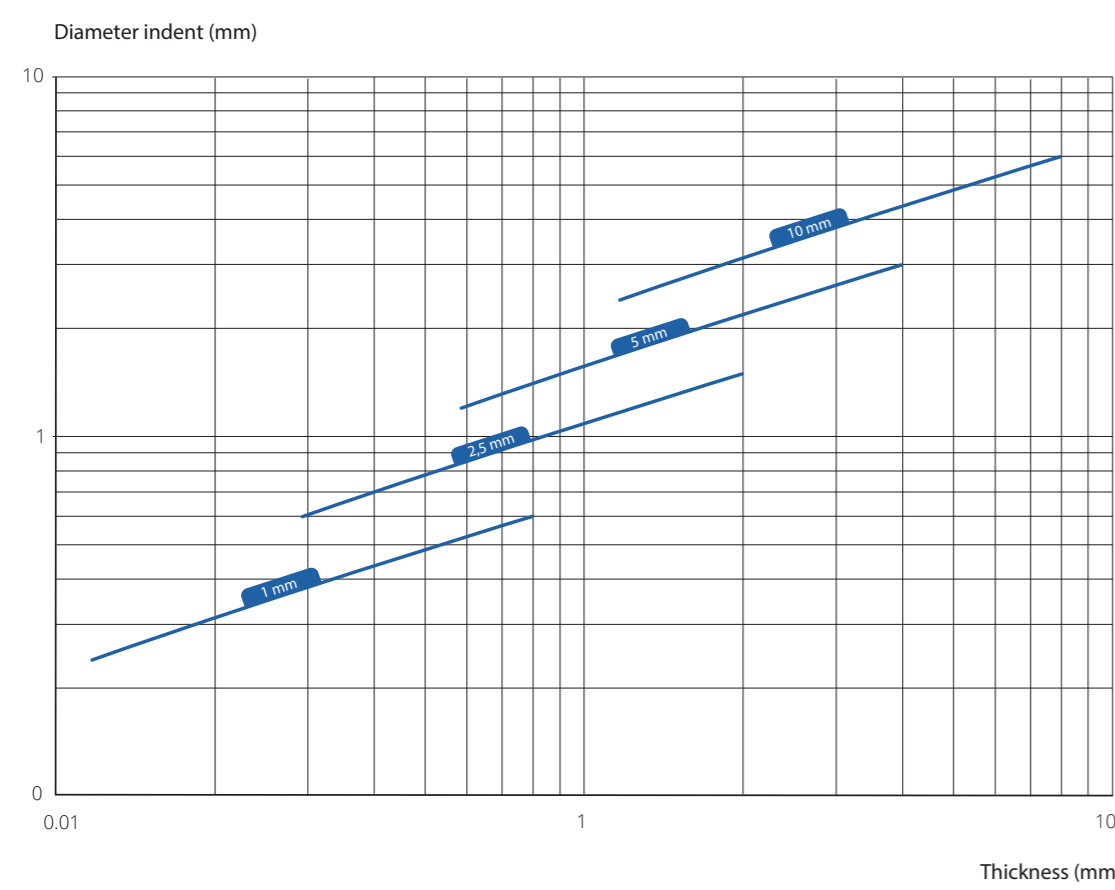
BRINELL ISO 6506



BRINELL SCALES

Material	Scale	Indenter (mm)	Load F (N)	Force diam. ratio 0,102 x F/D²	Hardness range HBW
Lead/Tin	HBW 10/100	10	980.7	1	3.18 - 21.8
	HBW 5/25	5	245.2		
	HBW 2.5/6.25	2.5	61.29		
Light metal and thin alloys	HBW 1/1	1	9.807	2.5	7.96 - 54.5
	HBW 10/250	10	245.2		
	HBW 5/62.5	5	61.29		
Light metal Copper/Aluminum Copper alloy without heat treatment	HBW 2.5/15.625	2.5	153.2	5	15.9 - 109
	HBW 1/2.5	1	24.52		
	HBW 10/500	10	490.3		
Light metal Copper/Aluminum Copper alloy Aluminium alloys	HBW 5/125	5	126.6	10	31.8 - 218
	HBW 2.5/31.25	2.5	306.5		
	HBW 1/10	1	98.07		
Steel/Nickel alloys Titanium alloys Cast Iron	HBW 10/3000	10	2942.0	30	95.5 - 653
	HBW 5/750	5	735.5		
	HBW 2.5/187.5	2.5	183.9		
HBW 1/30	1	29.42			

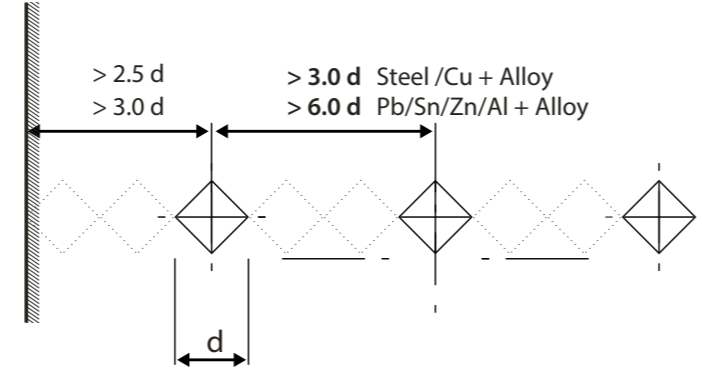
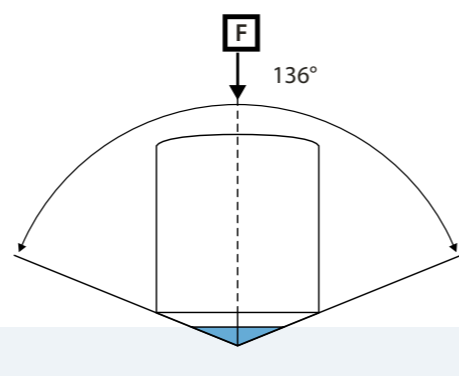
BRINELL MIN. THICKNESS



BRINELL ISO 6506-2

Hardness	Permissible repeatability (%)	Permissible error (±%)
Load factor 30		
< 250 HBW	3.0	3.0
250 < HBW < 450	2.5	2.5
> 450 HBW	2.0	2.0
Load factor 10		
< 100 HBW	3.0	3.0
100 < HBW < 200	3.0	3.0
> 200 HBW	3.0	3.0
Load factor 5		
< 70 HBW	3.0	3.0
70 < HBW < 100	3.0	3.0
> 100 HBW	3.0	3.0
Load factor 2.5		
< 70 HBW	3.0	3.0
> 70 HBW	3.0	3.0
-	3.0	3.0

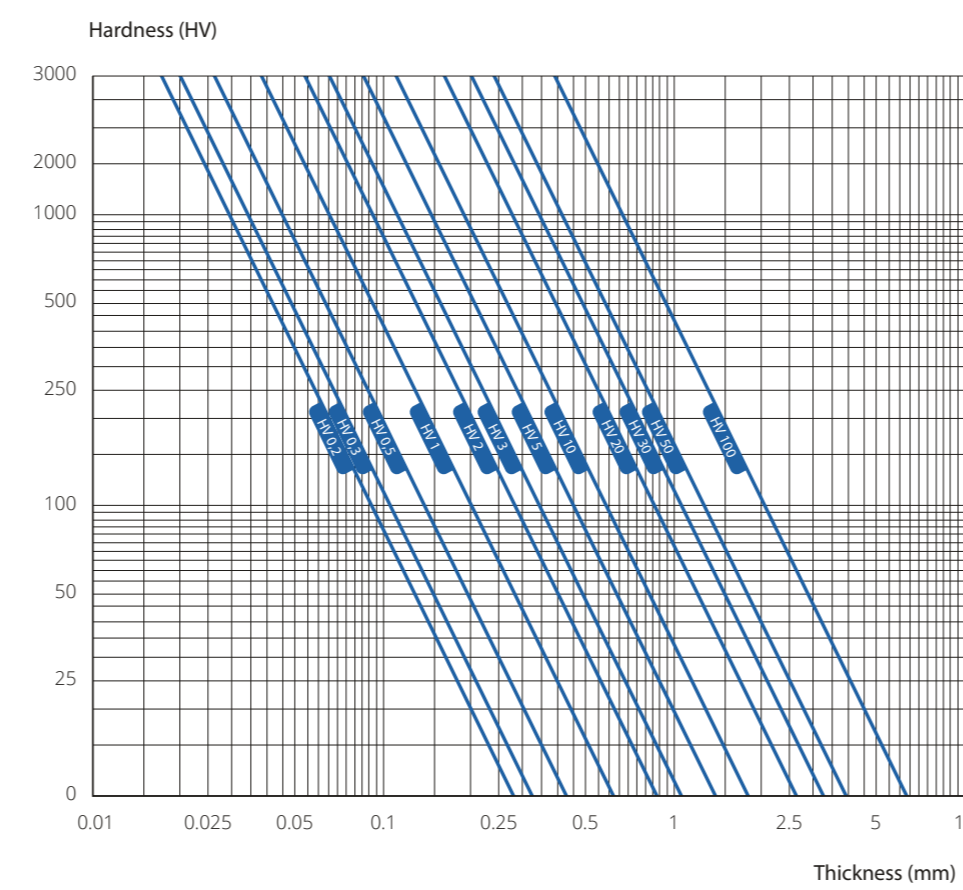
VICKERS ISO 6507



VICKERS SCALES

Micro Vickers		Low force Vickers		Vickers	
Scale	Force (N)	Scale	Force (N)	Scale	Force (N)
HV 0.01	0.09807	HV 0.2	1.961	HV 5	49.03
HV 0.015	0.1471	HV 0.3	2.942	HV 10	98.07
HV 0.02	0.1961	HV 0.5	4.903	HV 20	196.1
HV 0.025	0.2452	HV 1	9.807	HV 30	294.2
HV 0.05	0.4903	HV 2	19.61	HV 50	490.3
HV 0.01	0.9807	HV 3	29.42	HV 100	980.7

VICKERS MIN. THICKNESS



VICKERS ISO 6507-2

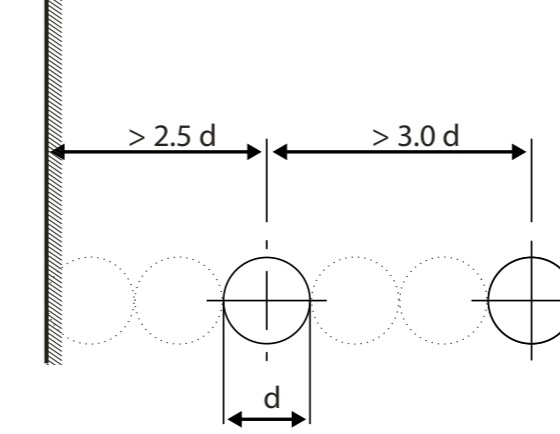
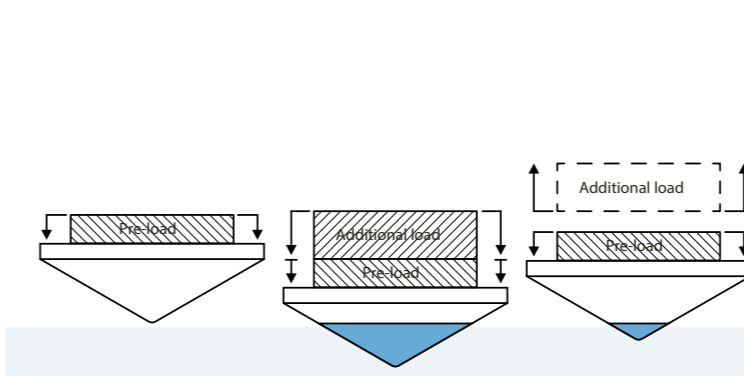
Hardness (HV)	Permissible repeatability (%)		
	HV 5 < HV ≤ 100	HV 0.2 ≤ HV < 5	HV < 0.2
≤ 250 HV	6	12	18
> 250 HV	4	8	12

Lower hardness materials often exhibit higher values of repeatability than those for higher hardness materials.

Scale	Permissible error (%)														
HV 0.001	10	25	50	100	200	300	400	500	600	700	800	900	1000	1500	2000
HV 0.002	16	25	35	-	-	-	-	-	-	-	-	-	-	-	-
HV 0.005	10	15	21	29	-	-	-	-	-	-	-	-	-	-	-
HV 0.015	8	12	16	23	32	39	-	-	-	-	-	-	-	-	-
HV 0.01	6	9	12	16	20	23	28	35	39	-	-	-	-	-	-
HV 0.015	5	7	10	14	19	23	26	29	32	34	37	39	-	-	-
HV 0.02	4	6	9	12	16	20	23	25	28	30	32	34	35	-	-
HV 0.025	4	6	8	11	15	18	21	23	25	27	29	30	32	39	-
HV 0.05	3	4	6	8	11	13	15	16	18	19	21	22	23	28	32
HV 0.1	3	3	4	6	8	9	11	12	13	14	15	16	16	20	23
HV 0.2	3	3	3	4	6	7	8	9	9	10	11	11	12	14	16
HV 0.3	3	3	3	4	5	6	7	7	8	8	9	9	10	12	14
HV 0.5	3	3	3	3	4	5	5	6	6	7	7	8	8	9	11
HV 1	3	3	3	3	3	4	4	4	5	5	5	6	6	7	8
HV 2	3	3	3	3	3	3	3	4	4	4	4	4	4	5	6
HV 2.5	3	3	3	3	3	3	3	3	3	4	4	4	4	4	5
HV 3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	5
HV 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4
HV 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4
HV 10	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

For intermediate values, the error may be obtained by interpolation. The values are rounded down to an integer.

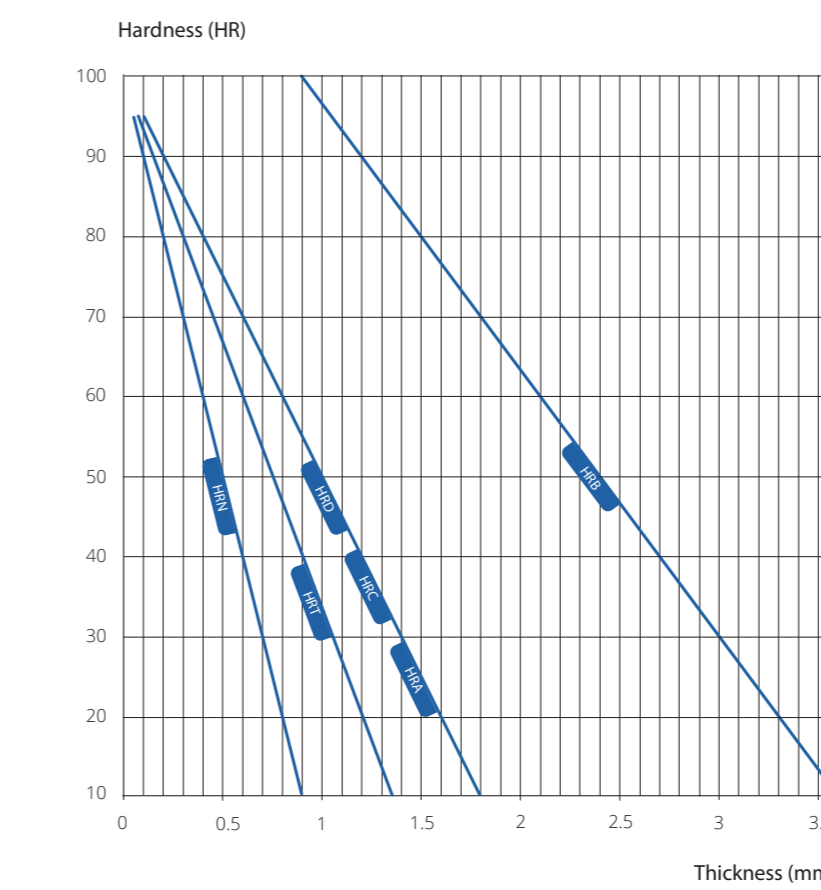
ROCKWELL ISO 6508



ROCKWELL SCALES

Scale	Type of indenter	Preliminary force (N)	Total force (N)	Range
HRA	Diamond cone	98.07	588.4	20 - 95 HRA
HRB	1/16" Ball	98.07	980.7	10 - 100 HRB
HRC	Diamond cone	98.07	1471	20 - 70 HRC
HRD	Diamond cone	98.07	980.7	40 - 77 HRD
HRE	1/8" Ball	98.07	980.7	70 - 200 HRE
HRF	1/16" Ball	98.07	588.4	60 - 100 HRF
HRG	1/16" Ball	98.07	1471	30 - 94 HRG
HRH	1/8" Ball	98.07	588.4	80 - 100 HRH
HRK	1/8" Ball	98.07	1471	40 - 100 HRK
HR15N	Diamond cone	29.42	147.1	70 - 94 HR15N
HR30N	Diamond cone	29.42	294.2	42 - 86 HR30N
HR45N	Diamond cone	29.42	441.3	20 - 77 HR45N
HR15T	1/16" Ball	29.42	147.1	67 - 93 HR15T
HR30T	1/16" Ball	29.42	294.2	29 - 82 HR30T
HR45T	1/16" Ball	29.42	441.3	10 - 72 HR45T

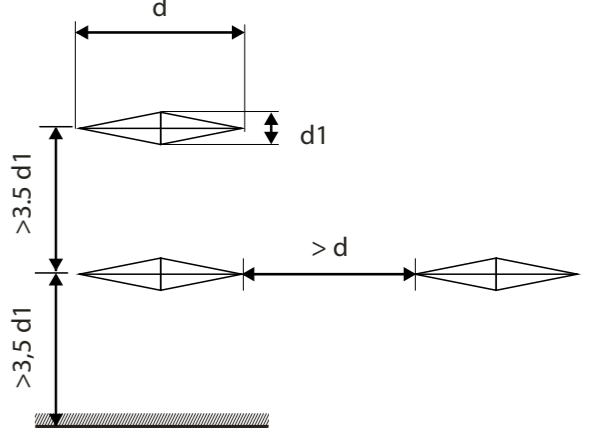
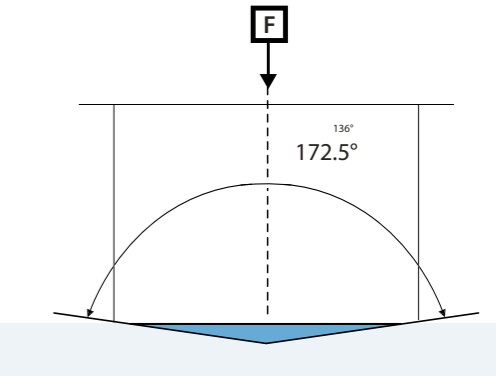
ROCKWELL MIN. THICKNESS



ROCKWELL ISO 6508-2

Scale	Hardness	Error (HR)	Permissible repeatability (HR)
HRA	20 ≤ HR ≤ 75	2	≤ 0.02 (100 - \bar{H}) or 0.8
	75 < HR ≤ 95	1.5	
HRB	10 ≤ HR ≤ 45	4	≤ 0.04 (130 - \bar{H})
	45 < HR ≤ 80	3	
HRC	10 ≤ HR ≤ 70	1.5	≤ 0.02 (100 - \bar{H}) or 0.8
	70 < HR ≤ 77	2	
HRD	40 ≤ HR ≤ 70	2	≤ 0.02 (100 - \bar{H}) or 0.8
	70 < HR ≤ 77	1.5	
HRE	70 ≤ HR ≤ 90	2.5	≤ 0.04 (130 - \bar{H})
	90 < HR ≤ 100	2	
HRF	60 ≤ HR ≤ 90	3	≤ 0.04 (130 - \bar{H})
	90 < HR ≤ 100	2	
HRG	30 ≤ HR ≤ 50	6	≤ 0.04 (130 - \bar{H})
	50 < HR ≤ 75	4.5	
HRH	75 < HR ≤ 94	3	≤ 0.04 (130 - \bar{H})
	80 ≤ HR ≤ 100	2	
HRK	40 ≤ HR ≤ 60	4	≤ 0.04 (130 - \bar{H})
	60 < HR ≤ 80	3	
HRN	80 < HR ≤ 100	2	≤ 0.04 (100 - \bar{H}) or 1.2
	80 < HR ≤ 100	2	
HRT	All	3	≤ 0.06 (100 - \bar{H}) or 2.4

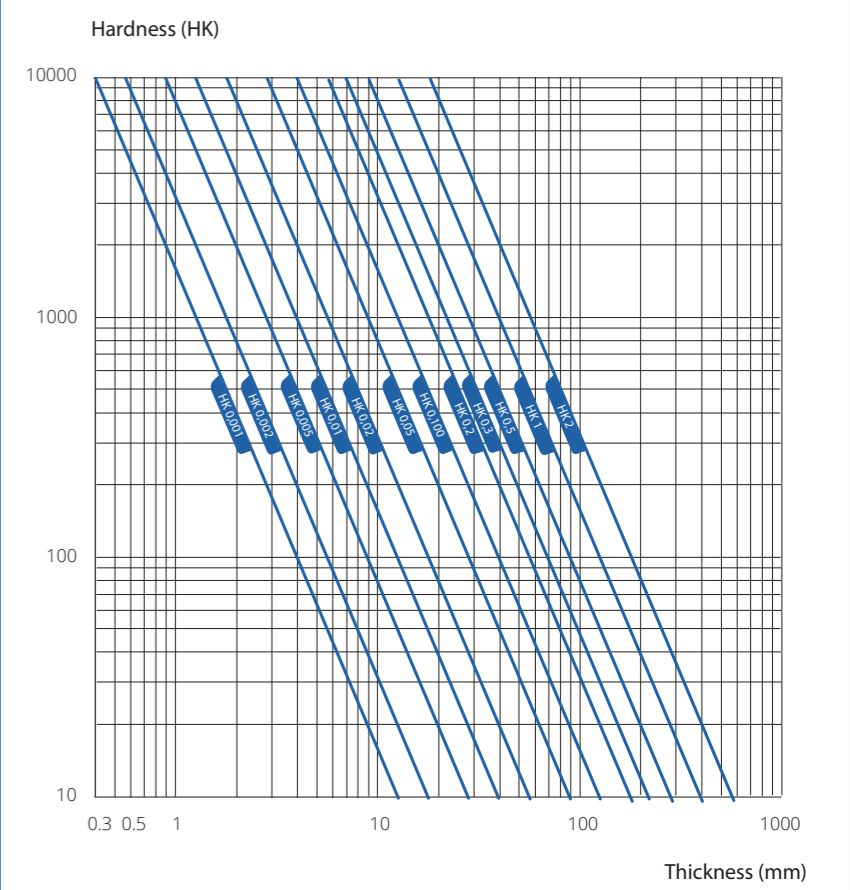
KNOOP ISO 4545



KNOOP SCALES

Hardness symbol	Total force (N)	Approximate kgf equivalent
HK 0.01	0.09807	0.010
HK 0.02	0.1961	0.020
HK 0.025	0.2452	0.025
HK 0.05	0.4903	0.050
HK 0.1	0.9807	0.100
HK 0.2	1.961	0.200
HK 0.3	2.942	0.300
HK 0.5	4.903	0.500
HK 1	9.807	1.000
HK 2	19.61	2.000

KNOOP MIN. THICKNESS



KNOOP ISO 4545-2

Hardness (HK)	Load (N)	Permissible repeatability (%)	Permissible error (±%)
100 ≤ HK ≤ 250		18	
100 < HK ≤ 650	F ≤ 4.903N	10	2
HK > 650		8	
100 ≤ HK ≤ 250	F > 4.903N	16	
250 < HK ≤ 650		10	
HK > 650		8	

Scale	Permissible error (%)												
HK 0.001	10	25	50	100	200	300	400	500	600	700	800	900	1000
HK 0.002	6	10	14	20	28	34	-	-	-	-	-	-	-
HK 0.005	4	6	8	12	15	17	20	22	23	25	26	28	-
HK 0.01	4	4	6	8	11	12	14	15	16	17	19	20	-
HK 0.02	4	4	4	6	7	8	10	11	11	12	13	14	-
HK 0.025	4	4	4	4	5	6	8	9	10	11	12	12	-
HK 0.05	4	4	4	4	4	5	6	6	7	8	8	8	-
HK 0.1	4	4	4	4	4	4	4	4	5	5	6	6	-
HK 0.2	4	4	4	4	4	4	4	4	4	4	4	4	-
HK 0.3	4	4	4	4	4	4	4	4	4	4	4	4	-
HK 0.5	4	4	4	4	4	4	4	4	4	4	4	4	-
HK 1	4	4	4	4	4	4	4	4	4	4	4	4	-
HK 2	4	4	4	4	4	4	4	4	4	4	4	4	-

BRINELL HARDNESS VALUES

Indenter	10			5			2.5			(mm)		
	3000	750	187.5	1000	250	62.5	500	125	31.25	10	5	2.5
HBW30	HBW10			HBW5								
95.5	6.00	3.00	1.50	31.8	6.00	3.00	1.50	15.9	6.00	3.00	1.50	
96.9	5.96	2.98	1.49	32.3	5.96	2.98	1.49	16.2	5.96	2.98	1.49	
98.4	5.92	2.96	1.48	32.8	5.92	2.96	1.48	16.4	5.92	2.96	1.48	
99.9	5.88	2.94	1.47	33.3	5.88	2.94	1.47	16.7	5.88	2.94	1.47	
101	5.84	2.92	1.46	33.8	5.84	2.92	1.46	16.9	5.84	2.92	1.46	
103	5.80	2.90	1.45	34.3	5.80	2.90	1.45	17.2	5.80	2.90	1.45	
105	5.76	2.88	1.44	34.9	5.76	2.88	1.44	17.4	5.76	2.88	1.44	
106	5.72	2.86	1.43	35.4	5.72	2.86	1.43	17.7	5.72	2.86	1.43	
108	5.68	2.84	1.42	36.0	5.68	2.84	1.42	18.0	5.68	2.84	1.42	
110	5.64	2.82	1.41	36.5	5.64	2.82	1.41	18.3	5.64	2.82	1.41	
111	5.60	2.80	1.40	37.1	5.60	2.80	1.40	18.6	5.60	2.80	1.40	
113	5.56	2.78	1.39	37.7	5.56	2.78	1.39	18.9	5.56	2.78	1.39	
115	5.52	2.76	1.38	38.3	5.52	2.76	1.38	19.2	5.52	2.76	1.38	
117	5.48	2.74	1.37	38.9	5.48	2.74	1.37	19.5	5.48	2.74	1.37	
119	5.44	2.72	1.36	39.6	5.44	2.72	1.36	19.8	5.44	2.72	1.36	
121	5.40	2.70	1.35	40.2	5.40	2.70	1.35	20.1	5.40	2.70	1.35	
123	5.36	2.68	1.34	40.9	5.36	2.68	1.34	20.4	5.36	2.68	1.34	
125	5.32	2.66	1.33	41.5	5.32	2.66	1.33	20.8	5.32	2.66	1.33	
127	5.28	2.64	1.32	42.2	5.28	2.64	1.32	21.1	5.28	2.64	1.32	
129	5.24	2.62	1.31	42.9	5.24	2.62	1.31	21.5	5.24	2.62	1.31	
131	5.20	2.60	1.30	43.7	5.20	2.60	1.30	21.8	5.20	2.60	1.30	
133	5.16	2.58	1.29	44.4	5.16	2.58	1.29	22.2	5.16	2.58	1.29	
135	5.12	2.56	1.28	45.1	5.12	2.56	1.28	22.6	5.12	2.56	1.28	
138	5.08	2.54	1.27	45.9	5.08	2.54	1.27	23.0	5.08	2.54	1.27	
140	5.04	2.52	1.26	46.7	5.04	2.52	1.26	23.4	5.04	2.52	1.26	
143	5.00	2.50	1.25	47.5	5.00	2.50	1.25	23.8	5.00	2.50	1.25	
145	4.96	2.48	1.24	48.3	4.96	2.48	1.24	24.2	4.96	2.48	1.24	
148	4.92	2.46	1.23	49.2	4.92	2.46	1.23	24.6	4.92	2.46	1.23	
150	4.88	2.44	1.22	50.1	4.88	2.44	1.22	25.0	4.88	2.44	1.22	
153	4.84	2.42	1.21	51.0	4.84	2.42	1.21	25.5	4.84	2.42	1.21	
156	4.80	2.40	1.20	51.9	4.80	2.40	1.20	25.9	4.80	2.40	1.20	
158	4.76	2.38	1.19	52.8	4.76	2.38	1.19	26.4	4.76	2.38	1.19	
161	4.72	2.36	1.18	53.8	4.72	2.36	1.18	26.9	4.72	2.36	1.18	
164	4.68	2.34	1.17	54.8	4.68	2.34	1.17	27.4	4.68	2.34	1.17	
167	4.64	2.32	1.16	55.8	4.64	2.32	1.16	27.9	4.64	2.32	1.16	
170	4.60	2.30	1.15	56.8	4.60	2.30	1.15	28.4	4.60	2.30	1.15	
174	4.56	2.28	1.14	57.9	4.56	2.28	1.14	28.9	4.56	2.28	1.14	
177	4.52	2.26	1.13	59.0	4.52	2.26	1.13	29.5	4.52	2.26	1.13	
180	4.48	2.24	1.12	60.1	4.48	2.24	1.12	30.0	4.48	2.24	1.12	
184	4.44	2.22	1.11	61.2	4.44	2.22	1.11	30.6	4.44	2.22	1.11	
187	4.40	2.20	1.10	62.4	4.40	2.20	1.10	31.2	4.40	2.20	1.10	
191	4.36	2.18	1.09	63.6	4.36	2.18	1.09	31.8	4.36	2.18	1.09	
195	4.32	2.16	1.08	64.9	4.32	2.16	1.08	32.4	4.32	2.16	1.08	
198	4.28	2.14	1.07	66.2	4.28	2.14	1.07	33.1	4.28	2.14	1.07	
202	4.24	2.12	1.06	67.5	4.24	2.12	1.06	33.7	4.24	2.12	1.06	
207	4.20	2.10	1.05	68.8	4.20	2.10	1.05	34.4	4.20	2.10	1.05	
211	4.16	2.08	1.04	70.2	4.16	2.08	1.04	35.1	4.16	2.08	1.04	
215	4.12	2.06	1.03	71.7	4.12	2.06	1.03	35.8	4.12	2.06	1.03	
219	4.08	2.04	1.02	73.2	4.08	2.04	1.02	36.6	4.08	2.04	1.02	
224	4.04	2.02	1.01	74.7	4.04	2.02	1.01	37.3	4.04	2.02	1.01	
229	4.00	2.00	1.00	76.3	4.00	2.00	1.00	38.1	4.00	2.00	1.00	
234	3.96	1.98	0.99	77.9	3.96	1.98	0.99	38.9	3.96	1.98	0.99	
239	3.92	1.96	0.98	79.5	3.92	1.96	0.98	39.8	3.92	1.96	0.98	
244	3.88	1.94	0.97	81.3	3.88	1.94	0.97	40.6	3.88	1.94	0.97	
249	3.84	1.92	0.96	83.0	3.84	1.92	0.96	41.5	3.84	1.92	0.96	
255	3.80	1.90	0.95	84.9	3.80	1.90	0.95	42.4	3.80	1.90	0.95	
260	3.76	1.88	0.94	86.8	3.76	1.88	0.94	43.4	3.76	1.88	0.94	
266	3.72	1.86	0.93	88.7	3.72	1.86	0.93	44.4	3.72	1.86	0.93	
272	3.68	1.84	0.92	90.7	3.68	1.84	0.92	45.4	3.68	1.84	0.92	
278	3.64	1.82	0.91	92.8	3.64	1.82	0.91	46.4	3.64	1.82	0.91	
285	3.60	1.80	0.90	95.0	3.60	1.80	0.90	47.5	3.60	1.80	0.90	
292	3.56	1.78	0.89	97.2	3.56	1.78	0.89	48.6	3.56	1.78	0.89	
298	3.52	1.76	0.88	99.5	3.52	1.76	0.88	49.7	3.52	1.76	0.88	
306	3.48	1.74	0.87	102	3.48	1.74	0.87	50.9	3.48	1.74	0.87	
313	3.44	1.72	0.86	104	3.44	1.72	0.86	52.2	3.44	1.72	0.86	
321	3.40	1.70	0.85	107	3.40	1.70	0.85	53.4	3.40	1.70	0.85	
329	3.36	1.68	0.84	110	3.36	1.68	0.84	54.8	3.36	1.68	0.84	
337	3.32	1.66	0.83	112	3.32	1.66	0.83	56.1	3.32	1.66	0.83	
345	3.28	1.64	0.82	115	3.28	1.64	0.82	57.5	3.28	1.64	0.82	
354	3.24	1.62	0.81	118	3.24	1.62	0.81	59.0	3.24	1.62	0.81	
363	3.20	1.60	0.80	121	3.20	1.60	0.80	60.5	3.20	1.60	0.80	
373	3.16	1.58	0.79	124	3.16	1.58	0.79	62.1	3.16	1.58	0.79	
383	3.12	1.56	0.78	128	3.12	1.56	0.78	63.8	3.12	1.56	0.78	
393	3.08	1.54	0.77	131	3.08	1.54	0.77	65.5	3.08	1.54	0.77	
404	3.04	1.52	0.76	135	3.04	1.52	0.76	67.3	3.04	1.52	0.76	
415	3.00	1.50	0.75	138	3.00	1.50	0.75	69.1	3.00	1.50	0.75	
426	2.96	1.48	0.74	142	2.96	1.48	0.74	71.0	2.96	1.48	0.74	
438	2.92	1.46	0.73	146	2.92	1.46	0.73	73.0	2.92	1.46	0.73	
451	2.88	1.44	0.72	150	2.88	1.44	0.72	75.1	2.88	1.44	0.72	
464	2.84	1.42	0.71	155	2.84	1.42	0.71	77.3	2.84	1.42	0.71	
477	2.80	1.40	0.70	159	2.80	1.40	0.70	79.6	2.80	1.40	0.70	
492	2.76	1.38	0.69	164	2.76	1.38	0.69	81.9	2.76	1.38	0.69	
507	2.72	1.36	0.68	169	2.72	1.36	0.68	84.4	2.72	1.36	0.68	
522	2.68	1.34	0.67	174	2.68	1.34	0.67	87.0	2.68	1.34	0.67	
538	2.64	1.32	0.66	179	2.64	1.32	0.66	89.7	2.64	1.32	0.66	
555	2.60	1.30	0.65	185	2.60	1.30	0.65	92.6	2.60	1.30	0.65	
573	2.56	1.28	0.64	191	2.56	1.28	0.64	95.5	2.56	1.28	0.64	
592	2.52	1.26	0.63	197	2.52	1.26	0.63	98.6	2.52	1.26	0.63	
611	2.48	1.24	0.62	204	2.48	1.24	0.62	102	2.48	1.24	0.62	
632	2.44	1.22	0.61	211	2.44	1.22	0.61	105	2.44	1.22	0.61	
653	2.40	1.20	0.60	218	2.40	1.20	0.60	109	2.40	1.20	0.60	

VICKERS HARDNESS VALUES