

STANDARD

SAE J407e

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Hardenability Bands for Alloy H Steels—SAE J407e

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HARDENABILITY BANDS FOR ALLOY H STEELS—SAE J407e

SAE Standard

Report of Iron and Steel Technical Committee approved August 1947 and last revised November 1977.

[The SAE Iron and Steel Technical Committee—Division 14 in cooperation with the Technical Committee on Alloy Steel Bars of the American Iron and Steel Institute have devised hardenability bands for use in describing certain characteristics of constructional alloy steels. Hardenability limits and their conditions of use were determined by the standard 1-in. end quench hardenability test. Minimum and maximum hardenability limits are tabulated in Rockwell C hardness and rounded off to the nearest full hardness unit.

Tentative hardenability bands for use with H steels were published in July 1944. By joint action, the SAE and AISI Committees removed H steels and corresponding hardenability bands from a tentative status in 1948. The committees continue to collect and compile all information on steels furnished to these hardenability limits to determine what further modifications are needed.]

Grades of Steel—H steels and their corresponding minimum and maximum hardenability limits are shown for all of the alloy steels for which there were sufficient hardenability data and for which grades the standard end quench test can be used. As information is accumulated on other grades, this publication will be supplemented.

Chemical Composition Limits—In order to afford steel producers the latitude in manufacturing operations necessary to meet a common standard of hardenability limits, the chemical composition limits of these steels have been modified somewhat from the ranges or limits applicable to the same grades when specified by chemical composition only. These modifications permit adjustments in manufacturing ranges of chemistry to correct for individual plant

melting characteristics which might otherwise influence the levels and widths of the bands. The modifications have not been great enough to influence the general characteristics of the original compositions of the series under consideration.

The chemical composition limits for both electric furnace and open hearth steels are outlined in Table 1 and are subject to the permissible variations for check analysis outlined in Table 5 of SAE J409.

These chemical compositions apply only to bars, billets, or blooms which are not more than 200 in² in cross sectional area, nor more than 18 in in width, and which weigh not more than 10,000 lb per piece.

Identification—As a means of identifying steels specified to hardenability band limits, the suffix letter "H" has been added to the conventional series number. It is quite important that steel consumers use the suffix letter in specification requirements, as there is no other means of determining when hardenability band limits apply. When the suffix letter is used, all conditions pertaining to chemical composition limits, restrictions, testing technique, and so forth, as outlined herein apply.

Grain Size—The limits set forth for bands are intended to apply to steels manufactured to fine grain steel practice. In cases where coarse grain steel is desired, the hardenability limits shall be a matter of agreement between producer and consumer.

Use of Hardenability Limits—Band limits are shown graphically and are so depicted for convenience in estimating the hardness values obtainable at

(Text continued after Hardenability Bands)

TABLE 1^a—ALLOY H STEEL COMPOSITIONS

UNS No.	SAE or AISI Steel No.	Chemical Composition ^{b,c} , %							UNS No.	SAE or AISI Steel No.	Chemical Composition ^{b,c} , %						
		C	Mn	Si	Ni	Cr	Mo	V			C	Mn	Si	Ni	Cr	Mo	V
H13300	1330 H	0.27-0.33	1.45-2.05	0.15-0.30	—	—	—	—	H51200	5120 H	0.17-0.23	0.60-1.00	0.15-0.30	—	0.60-1.00	—	—
H13350	1335 H	0.32-0.38	1.45-2.05	0.15-0.30	—	—	—	—	H51300	5130 H	0.27-0.33	0.60-1.10	0.15-0.30	—	0.75-1.20	—	—
H13400	1340 H	0.37-0.44	1.45-2.05	0.15-0.30	—	—	—	—	H51320	5132 H	0.29-0.35	0.50-0.90	0.15-0.30	—	0.65-1.10	—	—
H13450	1345 H	0.42-0.49	1.45-2.05	0.15-0.30	—	—	—	—	H51350	5135 H	0.32-0.38	0.50-0.90	0.15-0.30	—	0.70-1.15	—	—
H40270	4027 H	0.24-0.30	0.60-1.00	0.15-0.30	—	—	0.20-0.30	—	H51400	5140 H	0.37-0.44	0.60-1.00	0.15-0.30	—	0.60-1.00	—	—
H40280 ^d	4028 H ^d	0.24-0.30	0.60-1.00	0.15-0.30	—	—	0.20-0.30	—	H51470	5147 H	0.45-0.52	0.60-1.05	0.15-0.30	—	0.80-1.25	—	—
H40320	4032 H	0.29-0.35	0.60-1.00	0.15-0.30	—	—	0.20-0.30	—	H51500	5150 H	0.47-0.54	0.60-1.00	0.15-0.30	—	0.60-1.00	—	—
H40370	4037 H	0.34-0.41	0.60-1.00	0.15-0.30	—	—	0.20-0.30	—	H51550	5155 H	0.50-0.60	0.60-1.00	0.15-0.30	—	0.60-1.00	—	—
H40420	4042 H	0.39-0.46	0.60-1.00	0.15-0.30	—	—	0.20-0.30	—	H51600	5160 H	0.55-0.65	0.65-1.10	0.15-0.30	—	0.60-1.00	—	—
H40470	4047 H	0.44-0.51	0.60-1.00	0.15-0.30	—	—	0.20-0.30	—	H51601 ^e	5160 H ^e	0.55-0.65	0.65-1.10	0.15-0.30	—	0.60-1.00	—	—
H41180	4118 H	0.17-0.23	0.60-1.00	0.15-0.30	—	0.30-0.70	0.08-0.15	—	H61180	6118 H	0.15-0.21	0.40-0.80	0.15-0.30	—	0.40-0.80	—	0.10-0.15
H41300	4130 H	0.27-0.33	0.30-0.70	0.15-0.30	—	0.75-1.20	0.15-0.25	—	H61500	6150 H	0.47-0.54	0.60-1.00	0.15-0.30	—	0.75-1.20	—	0.15
H41350	4135 H	0.32-0.38	0.60-1.00	0.15-0.30	—	0.75-1.20	0.15-0.25	—	H81451 ^f	81845 H ^f	0.42-0.49	0.70-1.05	0.15-0.30	0.15-0.45	0.30-0.60	0.08-0.15	—
H41370	4137 H	0.34-0.41	0.60-1.00	0.15-0.30	—	0.75-1.20	0.15-0.25	—	H86170	8617 H	0.14-0.20	0.60-0.95	0.15-0.30	0.35-0.75	0.35-0.65	0.15-0.25	—
H41400	4140 H	0.37-0.44	0.65-1.10	0.15-0.30	—	0.75-1.20	0.15-0.25	—	H86200	8620 H	0.17-0.23	0.60-0.95	0.15-0.30	0.35-0.75	0.35-0.65	0.15-0.25	—
H41420	4142 H	0.39-0.46	0.65-1.10	0.15-0.30	—	0.75-1.20	0.15-0.25	—	H86220	8622 H	0.19-0.25	0.60-0.95	0.15-0.30	0.35-0.75	0.35-0.65	0.15-0.25	—
H41450	4145 H	0.42-0.49	0.65-1.10	0.15-0.30	—	0.75-1.20	0.15-0.25	—	H86250	8625 H	0.22-0.28	0.60-0.95	0.15-0.30	0.35-0.75	0.35-0.65	0.15-0.25	—
H41470	4147 H	0.44-0.51	0.65-1.10	0.15-0.30	—	0.75-1.20	0.15-0.25	—	H86270	8627 H	0.24-0.30	0.60-0.95	0.15-0.30	0.35-0.75	0.35-0.65	0.15-0.25	—
H41500	4150 H	0.47-0.54	0.65-1.10	0.15-0.30	—	0.75-1.20	0.15-0.25	—	H86300	8630 H	0.27-0.33	0.60-0.95	0.15-0.30	0.35-0.75	0.35-0.65	0.15-0.25	—
H41610	4161 H	0.55-0.65	0.65-1.10	0.15-0.30	—	0.65-0.95	0.25-0.35	—	H86301 ^g	86830 H ^g	0.27-0.33	0.60-0.95	0.15-0.30	0.35-0.75	0.35-0.65	0.15-0.25	—
H43200	4320 H	0.17-0.23	0.40-0.70	0.15-0.30	1.55-2.00	0.35-0.65	0.20-0.30	—	H86370	8637 H	0.34-0.41	0.70-1.05	0.15-0.30	0.35-0.75	0.35-0.65	0.15-0.25	—
H43400	4340 H	0.37-0.44	0.55-0.90	0.15-0.30	1.55-2.00	0.65-0.95	0.20-0.30	—	H86400	8640 H	0.37-0.44	0.70-1.05	0.15-0.30	0.35-0.75	0.35-0.65	0.15-0.25	—
H43406 ^h	84340 H ^h	0.37-0.44	0.60-0.95	0.15-0.30	1.55-2.00	0.65-0.95	0.20-0.30	—	H86420	8642 H	0.39-0.46	0.70-1.05	0.15-0.30	0.35-0.75	0.35-0.65	0.15-0.25	—
H46200	4620 H	0.17-0.23	0.35-0.75	0.15-0.30	1.55-2.00	—	0.20-0.30	—	H86450	8645 H	0.42-0.49	0.70-1.05	0.15-0.30	0.35-0.75	0.35-0.65	0.15-0.25	—
H47180	4718 H	0.15-0.21	0.60-0.95	0.15-0.30	0.85-1.25	0.30-0.60	0.30-0.40	—	H86451 ⁱ	86845 H ⁱ	0.42-0.49	0.70-1.05	0.15-0.30	0.35-0.75	0.35-0.65	0.15-0.25	—
H47200	4720 H	0.17-0.23	0.45-0.75	0.15-0.30	0.85-1.25	0.30-0.60	0.15-0.25	—	H86500	8650 H	0.47-0.54	0.70-1.05	0.15-0.30	0.35-0.70	0.35-0.65	0.15-0.25	—
H48150	4815 H	0.12-0.18	0.30-0.70	0.15-0.30	3.20-3.80	—	0.20-0.30	—	H86550	8655 H	0.50-0.60	0.70-1.05	0.15-0.30	0.35-0.75	0.35-0.65	0.15-0.25	—
H48170	4817 H	0.14-0.20	0.30-0.70	0.15-0.30	3.20-3.80	—	0.20-0.30	—	H86600	8660 H	0.55-0.65	0.70-1.05	0.15-0.30	0.35-0.75	0.35-0.65	0.15-0.25	—
H48200	4820 H	0.17-0.23	0.40-0.80	0.15-0.30	3.20-3.80	—	0.20-0.30	—	H88220	8822 H	0.19-0.25	0.70-1.05	0.15-0.30	0.35-0.75	0.35-0.65	0.30-0.40	—
H50401 ^j	50840 H ^j	0.37-0.44	0.65-1.10	0.15-0.30	—	0.30-0.70	—	—	H92600	9260 H	0.55-0.65	0.65-1.10	1.70-2.20	—	—	—	—
H50441 ^k	50844 H ^k	0.42-0.49	0.65-1.10	0.15-0.30	—	0.30-0.70	—	—	H93100 ^l	9310 H ^l	0.07-0.13	0.40-0.70	0.15-0.30	2.95-3.55	1.00-1.45	0.08-0.15	—
H50460	5046 H	0.43-0.50	0.65-1.10	0.15-0.30	—	0.13-0.43	—	—	H94151 ^m	94815 H ^m	0.12-0.18	0.70-1.05	0.15-0.30	0.25-0.65	0.25-0.55	0.08-0.15	—
H50461 ⁿ	50846 H ⁿ	0.43-0.50	0.65-1.10	0.15-0.30	—	0.13-0.43	—	—	H94171 ⁿ	94817 H ⁿ	0.14-0.20	0.70-1.05	0.15-0.30	0.25-0.65	0.25-0.55	0.08-0.15	—
H50501 ^o	50850 H ^o	0.47-0.54	0.65-1.10	0.15-0.30	—	0.30-0.70	—	—	H94301 ^p	94830 H ^p	0.27-0.33	0.70-1.05	0.15-0.30	0.25-0.65	0.25-0.55	0.08-0.15	—
H50601 ^q	50860 H ^q	0.55-0.65	0.65-1.10	0.15-0.30	—	0.30-0.70	—	—									

^aThe ranges and limits in this table apply only to material not exceeding 200 sq. in. in cross sectional area, 18 in. in width, or 10,000 lb per piece in weight. Ranges and limits are subject to the permissible variations for check analysis shown in Table 4 of SAE J409.

^bSmall quantities of certain elements may be found in alloy steel which are not specified or required. These elements are to be considered as incidental and acceptable to the following maximum amounts: copper to 0.35%, nickel to 0.25%, chromium to 0.20%, and molybdenum to 0.06%.

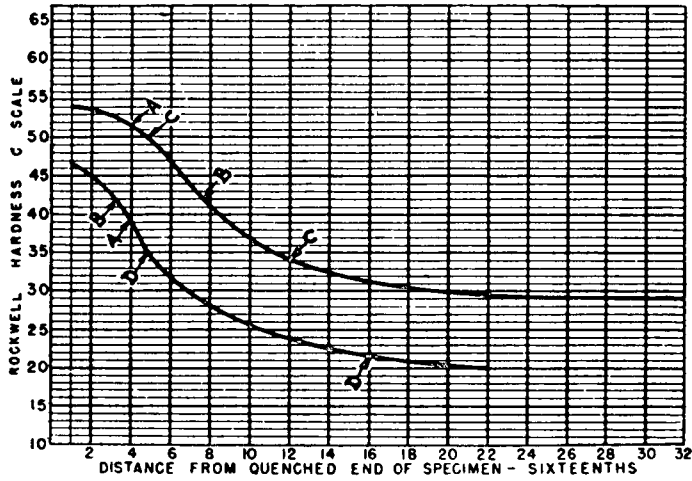
^cFor open hearth and basic oxygen steels maximum sulfur content is to be 0.040% and maximum phosphorus content is to be 0.035%. Maximum phosphorus and sulfur in basic electric furnace steels are to be 0.025% each.

^dElectric furnace steel.

^eBaron content is 0.0005% min.

^fSulfur content range is 0.035-0.050%.

The ϕ symbol is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. If the symbol is next to the report title, it indicates a complete revision of the report.

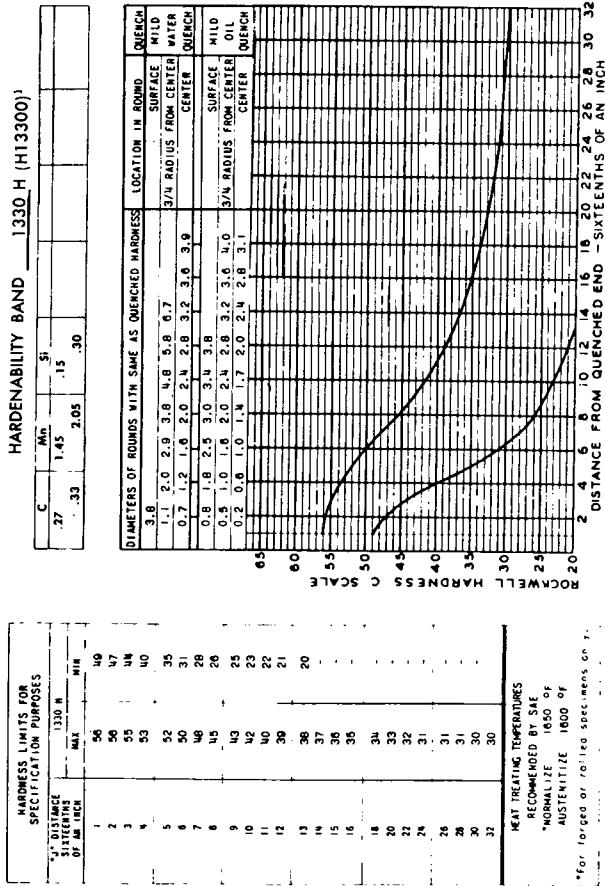


IN CASES WHERE IT IS CONSIDERED DESIRABLE, THE MAXIMUM AND MINIMUM LIMITS AT THE 1/4-IN. POINT MAY BE SPECIFIED IN ADDITION TO THE OTHER TWO POINTS.

IN CASES WHERE IT IS NECESSARY TO SPECIFY MORE THAN TWO POINTS ON THE HARDENABILITY BAND (EXCLUSIVE OF THE MAXIMUM AND MINIMUM LIMITS AT 1/4-IN.) A TOLERANCE OF TWO POINTS ROCKWELL C OVER ANY SMALL PORTION OF EITHER CURVE (EXCEPT AT 1/4 IN.) IS TO BE PERMITTED. THIS IS NECESSARY BECAUSE IT WILL BE FOUND THAT CURVES OF INDIVIDUAL HEATS MAY VARY SOMEWHAT IN SHAPE FROM THE STANDARD BAND LIMITS, AND THUS MAY DEVIATE SLIGHTLY AT ONE OR TWO POSITIONS IF THE FULL LENGTH CURVES ARE SPECIFIED. THE HARDENABILITY SPECIFICATION SHOULD BE BASED UPON ONE OF THE FOLLOWING, BUT NOT BOTH:

1. TWO SPECIFIC POINTS ON THE HARDENABILITY BAND (PLUS 1/4-IN. LIMITS IF DESIRED), IN WHICH CASE THE TOLERANCE DESCRIBED ABOVE DOES NOT APPLY.
2. MORE THAN TWO SPECIFIC POINTS UP TO THE ENTIRE HARDENABILITY BAND, IN WHICH CASE THE TOLERANCE DESCRIBED ABOVE DOES APPLY. METHOD 1 IS USUALLY PREFERRED AS MORE PERTINENT.

FIG. 1—SAMPLE GRAPH ILLUSTRATING METHODS OF SPECIFYING REQUIREMENTS. (TABULATED VALUES MUST BE USED IN ORDERING)

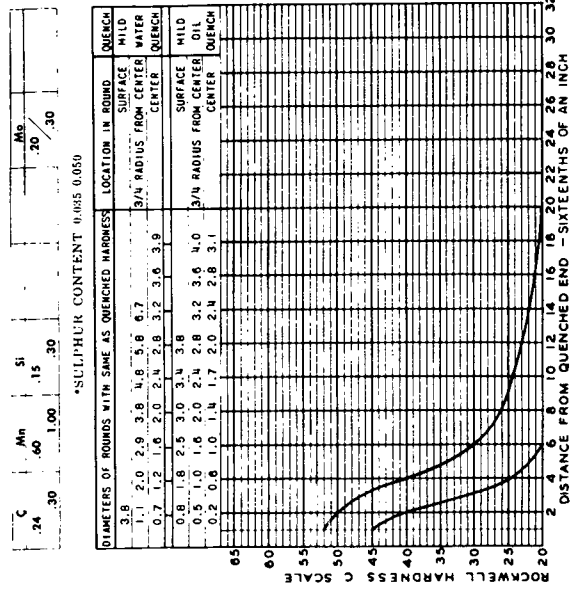


4027 H & (H40270 &
HARDENABILITY BAND 4028 H* (H40280*)

C	Mn	Si	Ni	Cr	Mo
42	1.45	2.05	.15	.30	

HARDNESS LIMITS FOR SPECIFICATION PURPOSES	1345 H	MIN.	MAX.
1	63	56	
2	63	56	
3	62	55	
4	61	54	
5	61	53	
6	60	52	
7	60	51	
8	59	50	
9	58	49	
10	57	48	
11	56	47	
12	55	46	
13	54	45	
14	53	44	
15	52	43	
16	51	42	
17	50	41	
18	49	40	
19	48	39	
20	47	38	
21	46	37	
22	45	36	
23	44	35	
24	43	34	
25	42	33	
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41	26	17	
42	25	16	
43	24	15	
44	23	14	
45	22	13	
46	21	12	
47	20	11	
48	19	10	
49	18	9	
50	17	8	
51	16	7	
52	15	6	
53	14	5	
54	13	4	
55	12	3	
56	11	2	
57	10	1	
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HARDNESS LIMITS FOR SPECIFICATION PURPOSES	4027 H	MIN.	MAX.
1	52	45	
2	50	40	
3	46	31	
4	40	25	
5	34	22	
6	30	20	
7	28		
8	26		
9	25		
10	24		
11	23		
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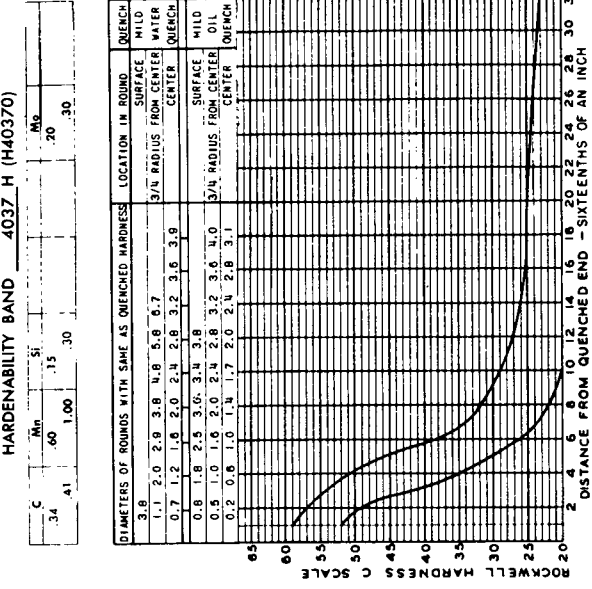


HARDENABILITY BAND 4032 H (H40320)

C	Mn	Si	Mo
.29	.60	.15	.30

HARDNESS LIMITS FOR SPECIFICATION PURPOSES	4032 H	MIN.	MAX.
1	57	50	
2	54	45	
3	51	38	
4	46	29	
5	38	25	
6	34	23	
7	31	22	
8	29	21	
9	28	20	
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HARDNESS LIMITS FOR SPECIFICATION PURPOSES	4037 H	MIN.	MAX.
1	59	52	
2	57	49	
3	54	42	
4	51	35	
5	45	30	
6	38	24	
7	32	23	
8	32	22	
9	30	21	
10	29	20	
11	28		
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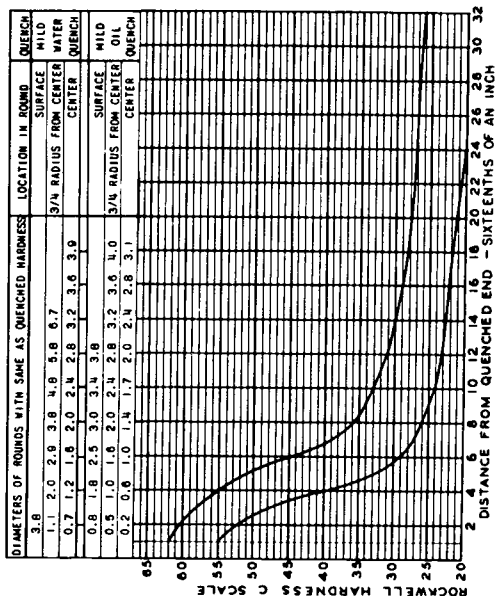


HARDENABILITY BAND 4042 H (H40420)

HARDNESS LIMITS FOR SPECIFICATION PURPOSES			
1" DISTANCE FROM TOP OF PISTON OF TESTER	1012 R		MIN
	MAX		
1	62	55	
2	60	52	
3	58	48	
4	55	40	
5	50	33	
6	45	20	
7	39	27	
8	35	26	
9	34	25	
10	33	24	
11	32	24	
12	31	23	
13	30	23	
14	30	23	
15	29	22	
16	28	22	
17	28	22	
18	28	22	
19	28	21	
20	28	20	
21	27	20	
22	27	-	
23	27	-	
24	26	-	
25	26	-	
26	26	-	
27	26	-	
28	26	-	
29	26	-	
30	26	-	
31	26	-	
32	26	-	

HEAT TREATING TEMPERATURES
RECOMMENDED BY SAE
*NORMALIZE 1600 OF
AUSTENITIZE 1650 OF

*For forged or rolled specimens only.

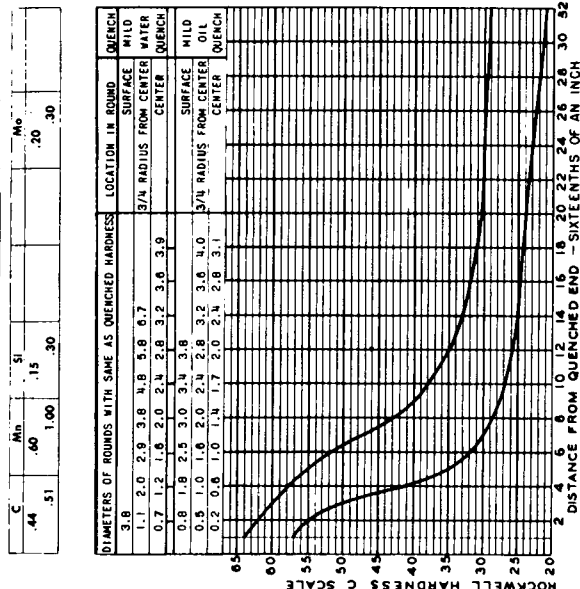


HARDNESS LIMITS FOR SPECIFICATION PURPOSES			
J ^a DISTANCE BETWEEN SINTERING OF AN INCH	HKT II		HRA
	MAX	MIN	
1	64	57	
2	62	55	
3	60	50	
4	58	42	
5	55	35	
6	52	32	
7	47	30	
8	43	28	
9	40	26	
10	38	27	
11	37	26	
12	35	26	
13	34	25	
14	33	25	
15	33	25	
16	32	25	
18	31	24	
20	30	24	
22	30	23	
24	30	23	
26	30	22	
28	29	22	
30	29	21	
32	29	21	

HEAT TREATING TEMPERATURES RECOMMENDED BY SAE

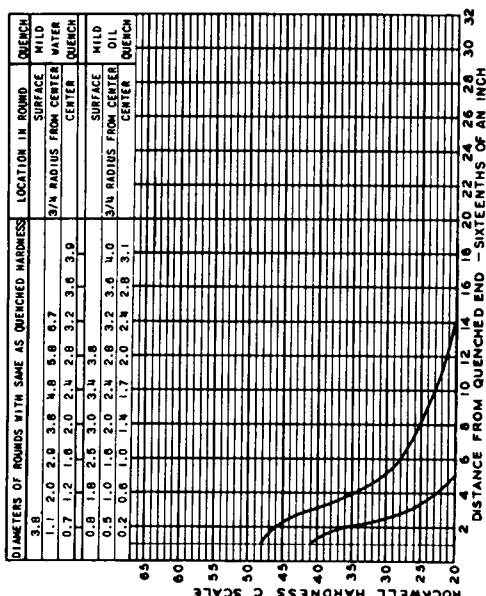
*NORMALIZE 1600 OF AUSTENITIZE 1800 of

^aFor forged or rolled specimens only.

HARDENABILITY BAND 4047 H (H40470)

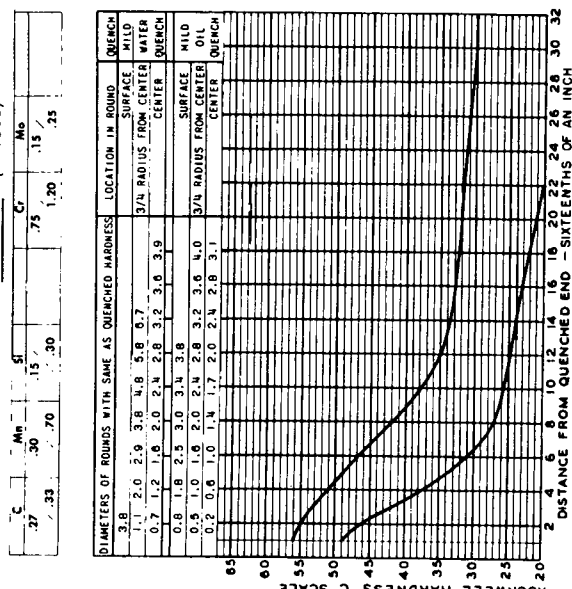
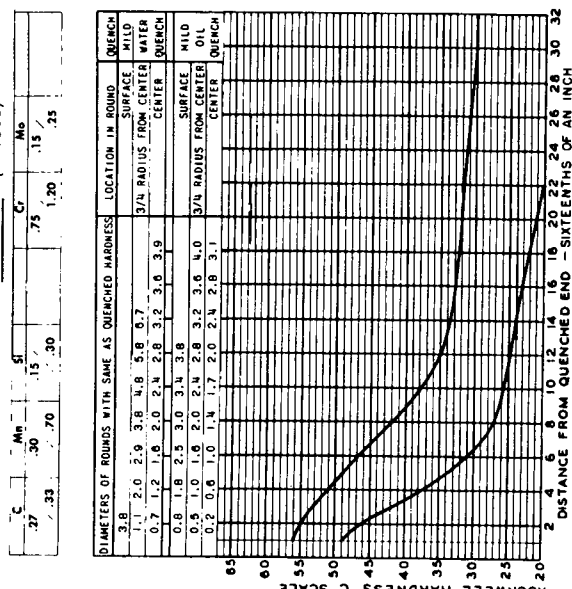
HARDNESS LIMITS FOR SPECIFICATION PURPOSES				
VIT DISTANCE FROM FACE OF AN INCH	VIT H			HIR
	MAX	MIN		
1	50	41		
2	3	34	30	
3	3	31	27	
4	3	35	23	
5	31		20	
6	28			
7	28			
8	27			
9	24			
10	23			
11	22			
12	21			
13	21			
14	20			
15	-			
16	-			
18	-			
20	-			
22	-			
24	-			
26	-			
28	-			
30	-			
32	-			

HEAT TREATING TEMPERATURES
 * RECOMMENDED BY SAE
 * NORMALIZE 1700 OF
 AUSTENITIZE 1700 OF
 For forged or rolled specimens only.



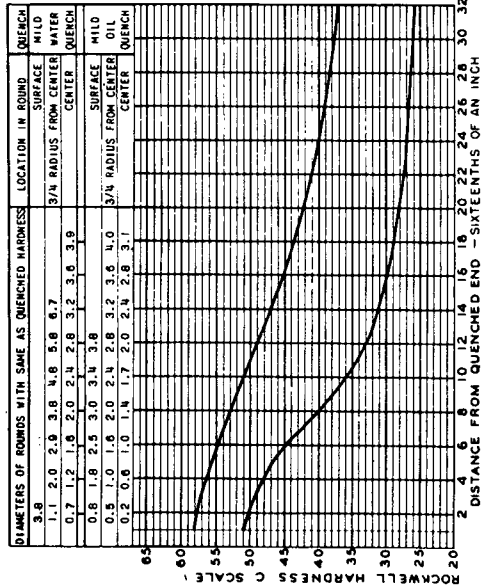
HARDNESS LIMITS FOR SPECIFICATION PURPOSES			
J ¹ DISTANCE OF 1/16 IN.	MIN	MAX	R ₁₃₀ R
1	56	49	
2	55	46	
3	53	42	
4	51	38	
5	49	34	
6	47	31	
7	44	29	
8	42	27	
9	40	26	
10	38	26	
11	36	25	
12	35	25	
13	34	24	
14	34	24	
15	33	23	
16	33	23	
18	32	22	
20	32	21	
22	32	20	
24	31	-	
26	31	-	
28	30	-	
30	30	-	
32	29	-	

HEAT TREATING TEMPERATURES
 RECOMMENDED BY SAE
 *NORMALIZE 1450 °F
 AUSTENITIZE 1600 °F
 For forged or rolled specimens only.

HARDENABILITY BAND 4118 H (H41180)HARDENABILITY BAND 4130 H (H41300)

HARDENABILITY BAND 4135 H (H41350)

C	Mn	Si	Cr	Mo
.32	.60	.15	.75	.15
.38	1.00	.30	1.20	.25



HARDNESS LIMITS FOR SPECIFICATION PURPOSES		4135 H	
"A" DISTANCE FROM QUENCHED END OF AN INCH	MAX	MIN	
1	56	51	
2	56	51	
3	56	51	
4	56	51	
5	56	51	
6	56	51	
7	56	51	
8	56	51	
9	56	51	
10	56	51	
11	56	51	
12	56	51	
13	56	51	
14	56	51	
15	56	51	
16	56	51	
18	56	51	
20	56	51	
22	56	51	
24	56	51	
26	56	51	
28	56	51	
30	56	51	
32	56	51	

HEAT TREATING TEMPERATURES
RECOMMENDED BY SAE
*NORMALIZE 1400 OF
AUSTENITIZE 1550 OF

*For forged or rolled specimens only.

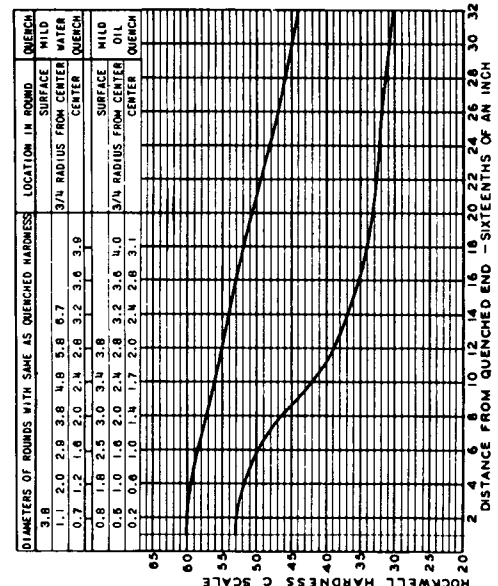
HARDNESS LIMITS FOR SPECIFICATION PURPOSES		4135 H	
"A" DISTANCE FROM QUENCHED END OF AN INCH	MAX	MIN	
1	56	51	
2	56	51	
3	56	51	
4	56	51	
5	56	51	
6	56	51	
7	56	51	
8	56	51	
9	56	51	
10	56	51	
11	56	51	
12	56	51	
13	56	51	
14	56	51	
15	56	51	
16	56	51	
18	56	51	
20	56	51	
22	56	51	
24	56	51	
26	56	51	
28	56	51	
30	56	51	
32	56	51	

HEAT TREATING TEMPERATURES
RECOMMENDED BY SAE
*NORMALIZE 1400 OF
AUSTENITIZE 1550 OF

*For forged or rolled specimens only.

HARDENABILITY BAND 4140 H (H41400)

C	Mn	Si	Cr	Mo
.37	.65	.15	.75	.15
.44	1.10	.30	1.20	.25



HARDNESS LIMITS FOR SPECIFICATION PURPOSES		4140 H	
"A" DISTANCE FROM QUENCHED END OF AN INCH	MAX	MIN	
1	62	55	
2	62	55	
3	62	55	
4	62	55	
5	62	55	
6	62	55	
7	62	55	
8	62	55	
9	62	55	
10	62	55	
11	62	55	
12	62	55	
13	62	55	
14	62	55	
15	62	55	
16	62	55	
18	62	55	
20	62	55	
22	62	55	
24	62	55	
26	62	55	
28	62	55	
30	62	55	
32	62	55	

HEAT TREATING TEMPERATURES
RECOMMENDED BY SAE
*NORMALIZE 1400 OF
AUSTENITIZE 1550 OF

*For forged or rolled specimens only.

HARDNESS LIMITS FOR SPECIFICATION PURPOSES		4140 H	
"A" DISTANCE FROM QUENCHED END OF AN INCH	MAX	MIN	
1	60	53	
2	60	53	
3	60	53	
4	60	53	
5	60	53	
6	60	53	
7	60	53	
8	60	53	
9	60	53	
10	60	53	
11	60	53	
12	60	53	
13	60	53	
14	60	53	
15	60	53	
16	60	53	
18	60	53	
20	60	53	
22	60	53	
24	60	53	
26	60	53	
28	60	53	
30	60	53	
32	60	53	

HEAT TREATING TEMPERATURES
RECOMMENDED BY SAE
*NORMALIZE 1400 OF
AUSTENITIZE 1550 OF

*For forged or rolled specimens only.