SAE International™

SURFACE VEHICLE STANDARD

SAE J1868 FEB2010

Issued 1988-02
Revised 2010-02

Superseding J1868 SEP1993

Restricted Hardenability Bands for Selected Alloy Steels

RATIONALE

Page 2 Item 6 Grain Size: Deleted SAE J418 because SAE cancelled that specification in May 1999. Replaced it with equivalent ASTM specification E 112. Page 4 Note 3: Deleted all references to tables because they are currently under review and have not been balloted. Left in reference to SAE J409.

Added ASTM E 112 to section 2.1.2.

1. SCOPE

Restricted hardenability steels have been in use for some time but the specific restrictions for a particular grade depend upon customer needs and vary from mill to mill. Such steels are desirable to provide more controlled heat treatment response and dimensional control for critical parts. Because of increasing interest in steels with restricted hardenability, the SAE Iron and Steel Technical Committee directed Division 8 to prepare a set of standard steels with restricted hardenability.

In 1993, the American Society for Testing and Materials (ASTM) adopted the twelve SAE restricted hardenability steels and added ten more. SAE decided to include in SAE J1868 the additional 10 steels.

In general, steels with restricted hardenability (RH steels) will exhibit a hardness range not greater than 5 HRC at the initial position on the end-quench hardenability bar and not greater than 65% of the hardness range for standard H-band steels (see SAE J1268) in the "inflection" region. Generally the restricted hardenability band follows the middle of the corresponding standard H-band. An example of the RH band compared with the standard H-band is given for SAE 4140 in Figure 1.

2. REFERENCES

2.1 Applicable Publications

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
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SAE WEB ADDRESS: http://www.sae.org

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J404 Chemical Compositions of SAE Alloy Steels

SAE J406 Methods of Determining Hardenability of Steels

SAE J409 Product Analysis—Permissible Variations from Specified Chemical Analysis of a Heat or Cast of Steel

SAE J1268 Hardenability Bands for Carbon and Alloy H Steels

2.1.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM A 914 Standard Specification for Steel Bars Subject to Restricted Hardenability Requirements

ASTM E 112 Standard Test Methods for Determining Average Grain Size

3. GRADES OF STEEL

The RH steels and their corresponding minimum and maximum composition limits are shown in Table 1 for a group of 22 alloy steels covering a nominal carbon content range of 0.10 to 0.60%. As the need arises for restricted hardenability in other grades, they will be added to the standard.

4. CHEMICAL COMPOSITION LIMITS

To meet restricted hardenability, yet provide flexibility for producers, composition limits are the same as those given in SAE J404. (These limits are somewhat narrower than allowed for standard H-steels.) It should be understood that alloys which satisfy the restricted hardenability band will fall within SAE J404 composition limits, but not all steels melted to the composition limits would meet the required RH-band. The limits are given in Table 1, and as indicated in the footnotes, are subject to permissible variations for product analysis and may contain certain levels of elements not specified.

5. IDENTIFICATION

As a means of identifying steels specified to restricted hardenability band limits, the suffix letters RH have been added to the conventional series number. It is important that steel consumers use this special identifying designation in specification requirements, as there is no other means of determining when restricted hardenability band limits apply. When the special identification is used, the steel shall conform to all conditions pertaining to chemical composition limits, restrictions, testing technique, and so forth, as outlined herein.

6. GRAIN SIZE

The limits set forth for RH-bands are intended to apply to steels exhibiting a fine austenitic grain size (ASTM No. 5 or finer; see ASTM E 112).

7. USE OF RESTRICTED HARDENABILITY LIMITS

For specification purposes, one must use the tabulated values of Rockwell hardness (HRC) as a function of distance from the quenched end of the hardenability bar, either in metric (SI) units (millimeters) or U.S. customary units (sixteenths of an inch). Values below 20 HRC are not specified because such values are not as accurate. Band limits are also shown graphically and are so depicted for convenience in estimating the hardness values at various intermediate locations on the end quench test bar and for quick comparisons of the various RH grades. The values of Approximate Diameter of Rounds with Same As-Quenched Hardness shown above each RH-band, were selected from the ranges appearing in Figure 7 of SAE J406. The RH-bands are presented graphically, with distances from the quenched end in both metric (SI) units and U.S. customary units.

The hardenability testing technique used as a basis for acceptance shall be in accordance with SAE J406.

For specification purposes, RH-band steels shall be within the minimum and maximum HRC range specified at the J1 (J1.5 mm) position and shall meet one additional minimum and one additional maximum HRC value. In this specification, the two additional hardness values shall represent the approximate hardness for 50% martensite for the minimum and maximum specified carbon content, respectively (except where hardenability is too high to exhibit 50% martensite hardness; then the additional two control hardness points shall be 5 HRC below the minimum and maximum hardness specified at the J1 (J1.5 mm) position). In general, these points define the critical locations of the Jominy hardenability band for purposes of characterizing heat treatment response. The four specification points are circled in the tables of hardness versus Jominy distance and on the RH-bands. For a portion of the curve not exceeding 5 mm or 3/16 in (not including the control points), a tolerance of two points HRC is permitted.

For example, referring to the right-hand hardness limit table in Figure 1, a hardenability test bar of a steel meeting the requirements for 4140RH must exhibit a hardness at J1 not less than 54 HRC nor more than 59 HRC. At J12, the test bar must exhibit hardness not less than 43 HRC, but the maximum hardness can be as high as 52 HRC (or even 54 HRC if this region of the test bar is chosen as the exception). At J20, the bar must exhibit hardness not greater than 47 HRC, but the minimum hardness can be as low as 37 HRC (or as low as 35 HRC if this region of the test bar is chosen as the exception).

(A similar example, for 4140RH with distances from the quenched end in millimeters, would limit hardness at J1.5 mm to not less than 54 HRC nor more than 59 HRC. At J20 mm, the test bar must exhibit hardness not less than 42 HRC. At J30 mm, the test bar must exhibit hardness not greater than 48 HRC.)

TABLE 1 - COMPOSITIONS OF RESTRICTED HARDENABILITY STEELS

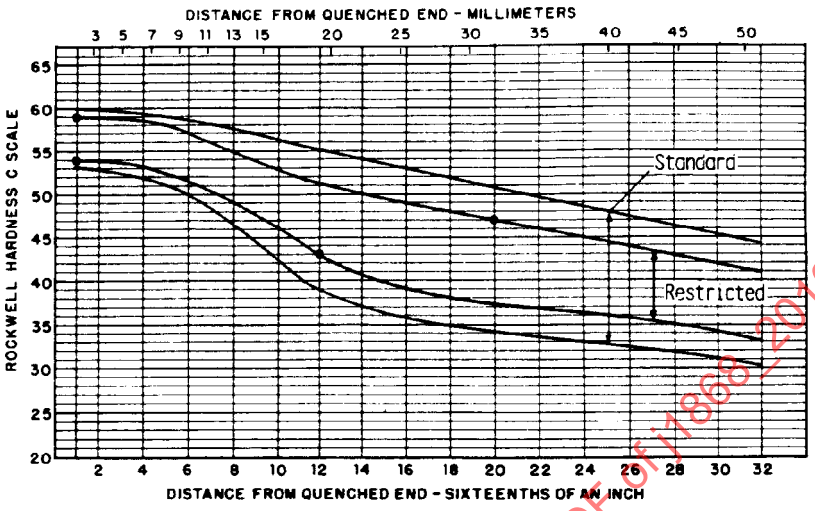
SAE Steel No.	Ladle Chemical Composition, Weight %[1][2][3] C	Ladle Chemical Composition, Weight %[1][2][3] Mn	Ladle Chemical Composition, Weight %[1][2][3] Si	Ladle Chemical Composition, Weight %[1][2][3] Ni	Ladle Chemical Composition, Weight %[1][2][3] Cr	Ladle Chemical Composition, Weight %[1][2][3] Mo
SAE 15B21RH[4]	0.17/0.22	0.80/1.10	0.15/0.35			
SAE 15B35RH[4]	0.33/0.38	0.80/1.10	0.15/0.35			
SAE 3310RH	0.08/0.13	0.40/0.60	0.15/0.35	3.25/3.75	1.40/1.75	
SAE 4027RH	0.25/0.30	0.70/0.90	0.15/0.35	--	--	0.20/0.30
SAE 4118RH	0.18/0.23	0.70/0.90	0.15/0.35	--	0.40/0.60	0.08/0.15
SAE 4120RH	0.18/0.23	0.90/1.20	0.15/0.35	--	0.40/0.60	0.13/0.20
SAE 4130RH	0.28/0.33	0.40/0.60	0.15/0.35	--	0.80/1.10	0.15/0.25
SAE 4140RH	0.38/0.43	0.75/1.00	0.15/0.35	--	0.80/1.10	0.15/0.25
SAE 4145RH	0.43/0.48	0.75/1.00	0.15/0.35	--	0.80/1.10	0.15/0.25
SAE 4161RH	0.56/0.64	0.75/1.00	0.15/0.35	--	0.70/0.90	0.25/0.35
SAE 4320RH	0.17/0.22	0.45/0.65	0.15/0.35	1.65/2.00	0.40/0.60	0.20/0.30
SAE 4620RH	0.17/0.22	0.45/0.65	0.15/0.35	1.65/2.00	--	0.20/0.30
SAE 4820RH	0.18/0.23	0.50/0.70	0.15/0.35	3.25/3.75	--	0.20/0.30
SAE 50B40RH[4]	0.38/0.43	0.75/1.00	0.15/0.35	--	0.40/0.60	
SAE 5130RH	0.28/0.33	0.70/0.90	0.15/0.35	--	0.80/1.10	--
SAE 5140RH	0.38/0.43	0.70/0.90	0.15/0.35	--	0.70/0.90	--
SAE 5160RH	0.56/0.64	0.75/1.00	0.15/0.35	--	0.70/0.90	--
SAE 8620RH	0.18/0.23	0.70/0.90	0.15/0.35	0.40/0.70	0.40/0.60	0.15/0.25
SAE 8622RH	0.20/0.25	0.70/0.90	0.15/0.35	0.40/0.70	0.40/0.60	0.15/0.25
SAE 8720RH	0.18/0.23	0.70/0.90	0.15/0.35	0.40/0.70	0.40/0.60	0.20/0.30
SAE 8822RH	0.20/0.25	0.75/1.00	0.15/0.35	0.40/0.70	0.40/0.60	0.30/0.40
SAE 9310RH	0.08/0.13	0.45/0.65	0.15/0.35	3.00/3.50	1.00/1.40	0.08/0.15

Restricted Hardenability Limits for Steels in Table 1 appear in Figures 2 through 23.

1. Small quantities of certain elements may be found in alloy steel which are not specified or required. These elements are 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%.
2. Maximum sulfur content is 0.040% and maximum phosphorus content is 0.025%.
3. Ranges and limits are subject to the permissible variations for product analysis shown in SAE J409.
4. These steels can be expected to contain 0.0005 to 0.003% boron.

HARDENABILITY BAND SAE 4140 H/RH

	%C	%Mn	%Si	%Ni	%Cr	%Mo	
H	0.37/0.44	0.65/1.10	0.15/0.35	--	0.75/1.20	0.15/0.25	
RH	0.38/0.43	0.75/1.00	0.15/0.35	--	0.80/1.10	0.15/0.25	



HARDNESS LIMITS FOR SPECIFICATION PURPOSES

"J" DISTANCE MILLIMETERS	MAX HRC		MIN HRC	
	4140 H	4140 RH	4140 RH	4140 H
1.5	60	(59)	(54)	53
3	60	59	54	52
5	60	59	53	52
7	59	59	53	51
9	59	58	52	50
11	58	56	50	48
13	57	55	49	46
15	57	54	47	43
20	55	51	(42)	38
25	53	49	39	35
30	51	(48)	38	33
35	49	46	37	32
40	48	44	36	32
45	46	43	35	31
50	45	41	33	30

HEAT TREATING TEMPERATURES

*NORMALIZE	870 °C
AUSTENITIZE	845 °C

*For forged or rolled specimens only

HARDNESS LIMITS FOR SPECIFICATION PURPOSES

"J" DISTANCE SIXTEENTHS OF AN INCH	MAX HRC		MIN HRC	
	4140 H	4140 RH	4140 RH	4140 H
1	60	(59)	(54)	53
2	60	59	54	53
3	60	59	54	52
4	59	59	53	51
5	59	58	52	51
6	58	57	51	50
7	58	56	50	48
8	57	55	49	47
9	57	54	48	44
10	56	53	46	42
11	56	52	44	40
12	55	52	(43)	39
13	55	51	42	38
14	54	50	41	37
15	54	50	40	36
16	53	49	39	35
18	52	48	38	34
20	51	(47)	37	33
22	49	46	37	33
24	48	45	36	32
26	47	44	35	32
28	46	43	35	31
30	46	42	34	31
32	44	41	33	30

HEAT TREATING TEMPERATURES

*NORMALIZE	1600 °F
AUSTENITIZE	1550 °F

*For forged or rolled specimens only

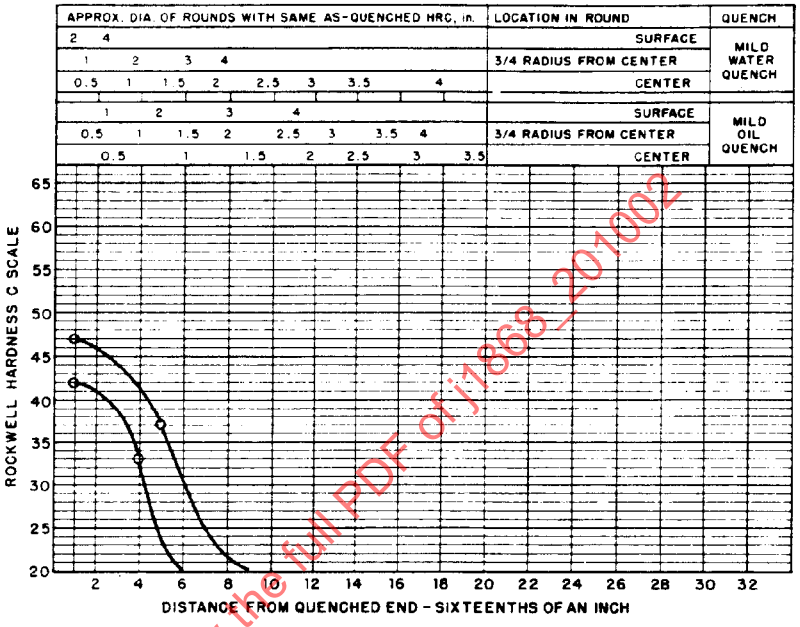
FIGURE 1 - COMPARISON OF H-BAND AND RH-BAND FOR SAE 4140 STEEL

HARDENABILITY BAND SAE 15B21 RH

%C	%Mn	%Si	%Ni	%Cr	%Mo	%B
0.17/0.22	0.80/1.10	0.15/0.35	--	--	--	*

* can be expected to contain 0.0005/0.003 percent boron.

HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	HRC MAX.	HRC MIN.
1	(47)	(42)
2	46	41
3	44	39
4	42	(33)
5	(37)	24
6	30	20
7	24	--
8	22	--
9	20	--
10	--	--
11		
12		
13		
14		
15		
16		
18		
20		
22		
24		
26		
28		
30		
32		
HEAT TREATING TEMPERATURES		
*NORMALIZE	1700 °F	
AUSTENITIZE	1700 °F	
*For forged or rolled specimens only		



HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE MILLIMETERS	HRC MAX.	HRC MIN.
1.5	(47)	(42)
3	46	41
5	44	38
7	40	(29)
9	(32)	21
11	24	--
13	22	--
15	20	--
20	--	--
25		
30		
35		
40		
45		
50		
HEAT TREATING TEMPERATURES		
*NORMALIZE	925 °C	
AUSTENITIZE	925 °C	
*For forged or rolled specimens only		

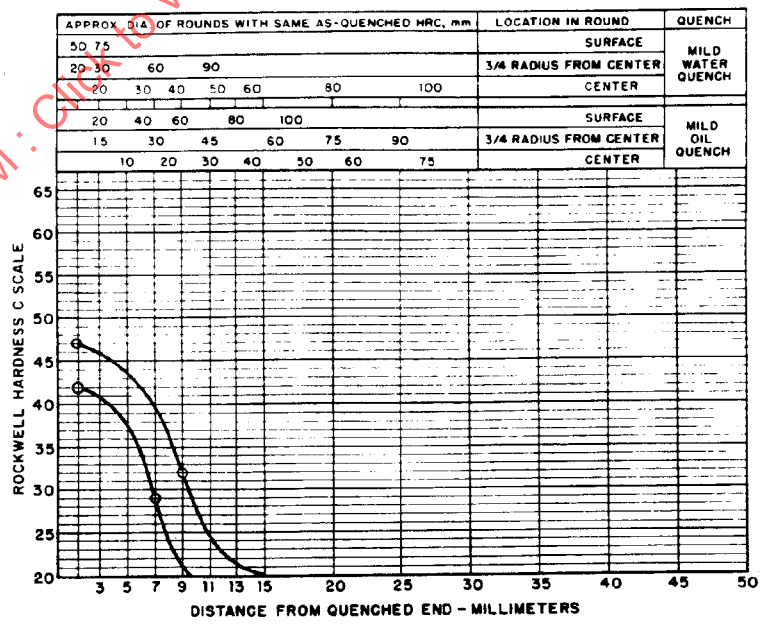


FIGURE 2 - LIMITS FOR HARDENABILITY BAND 15B21RH

HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	HRC MAX.	HRC MIN.
1	(57)	(52)
2	55	51
3	54	50
4	53	49
5	50	(41)
6	46	33
7	(42)	28
8	36	24
9	32	23
10	28	21
11		
12	25	--
13		
14	24	--
15		
16	23	--
18		
20	22	--
22		
24	20	--
26		
28	--	--
30		
32		

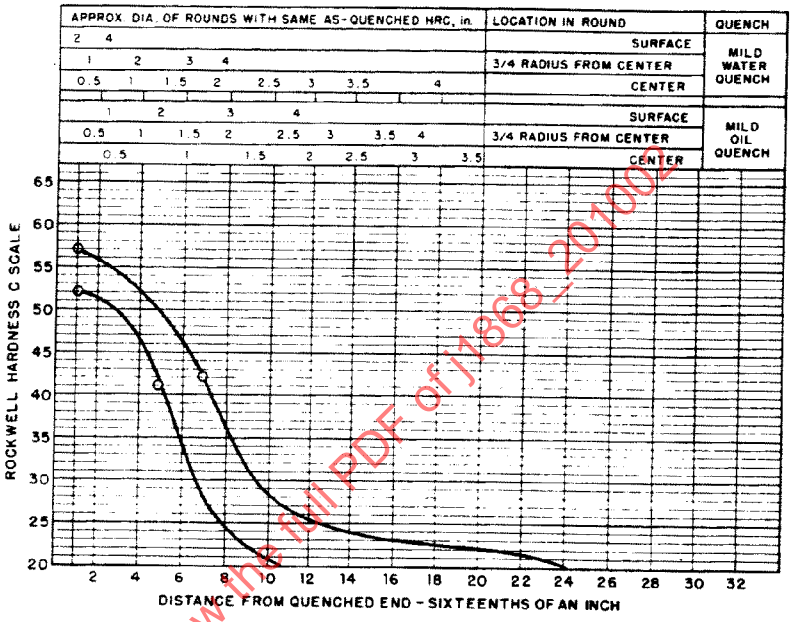
HEAT TREATING TEMPERATURES	
*NORMALIZE	1600 °F
AUSTENITIZE	1550 °F

*For forged or rolled specimens only

HARDENABILITY BAND SAE 15B35 RH

%C	%Mn	%Si	%Ni	%Cr	%Mo	%B
0.33/0.38	0.80/1.10	0.15/0.35	--	--	--	*

* can be expected to contain 0.0005/0.003 percent boron.



HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE MILLIMETERS	HRC MAX.	HRC MIN.
1.5	(57)	(52)
3	55	51
5	54	50
7	52	46
9	47	(35)
11	(42)	28
13	35	24
15	30	21
20	25	--
25	23	--
30	22	--
35	21	--
40	20	--
45		
50		

HEAT TREATING TEMPERATURES	
*NORMALIZE	870 °C
AUSTENITIZE	845 °C

*For forged or rolled specimens only

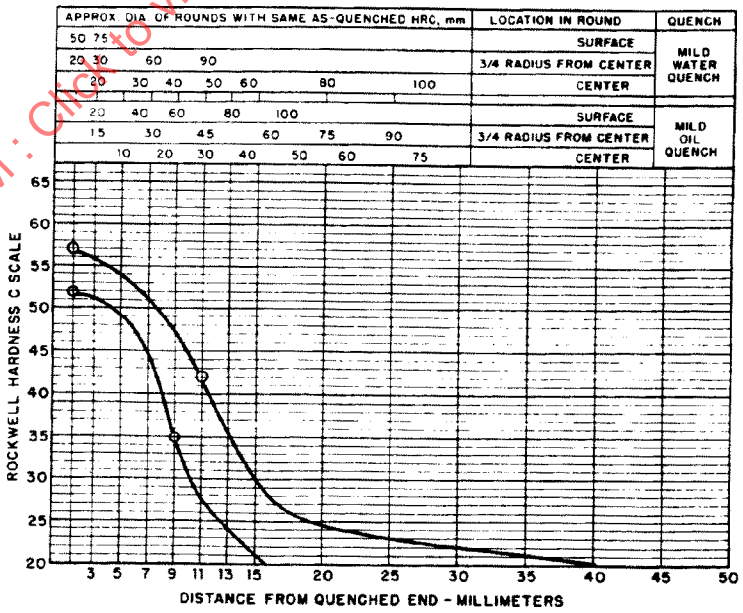


FIGURE 3 - LIMITS FOR HARDENABILITY BAND 15B35RH

HARDENABILITY BAND SAE 3310 RH

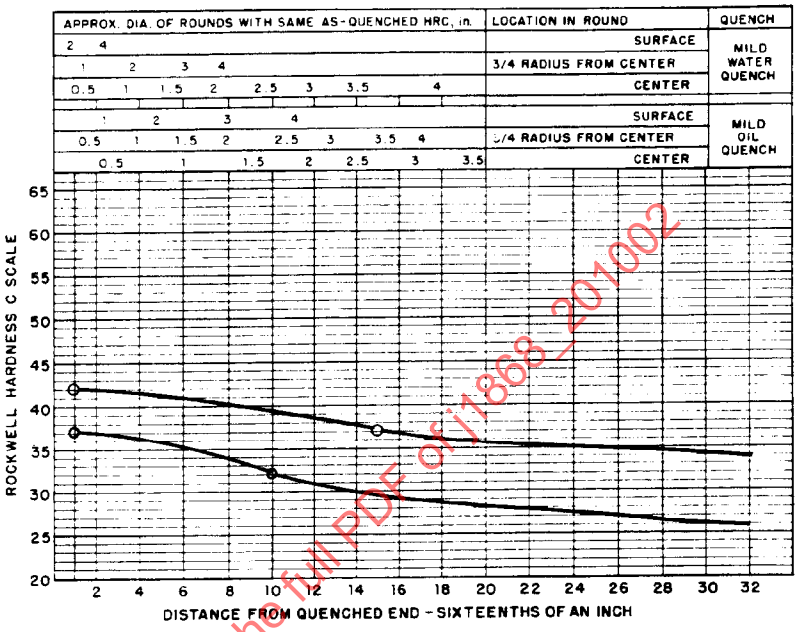
%C	%Mn	%Si	%Ni	%Cr	%Mo	
0.08/0.13	0.40/0.60	0.15/0.35	3.25/3.75	1.40/1.75	--	

HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	HRC MAX.	HRC MIN.
1	(42)	(37)
2	42	37
3	42	37
4	41	36
5	41	36
6	41	35
7	40	34
8	40	33
9	39	32
10	39	(32)
11	39	31
12	39	31
13	38	30
14	38	30
15	(37)	29
16	37	29
18	36	28
20	36	28
22	35	27
24	35	27
26	35	27
28	34	26
30	34	26
32	34	26

HEAT TREATING TEMPERATURES

*NORMALIZE	1700 °F
AUSTENITIZE	1550 °F

*For forged or rolled specimens only



HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE MILLIMETERS	HRC MAX.	HRC MIN.
1.5	(42)	(37)
3	42	37
5	42	37
7	41	36
9	41	35
11	40	34
13	40	33
15	39	(32)
20	38	30
25	(37)	29
30	36	28
35	35	27
40	35	27
45	34	26
50	34	26

HEAT TREATING TEMPERATURES

*NORMALIZE	925 °C
AUSTENITIZE	845 °C

*For forged or rolled specimens only

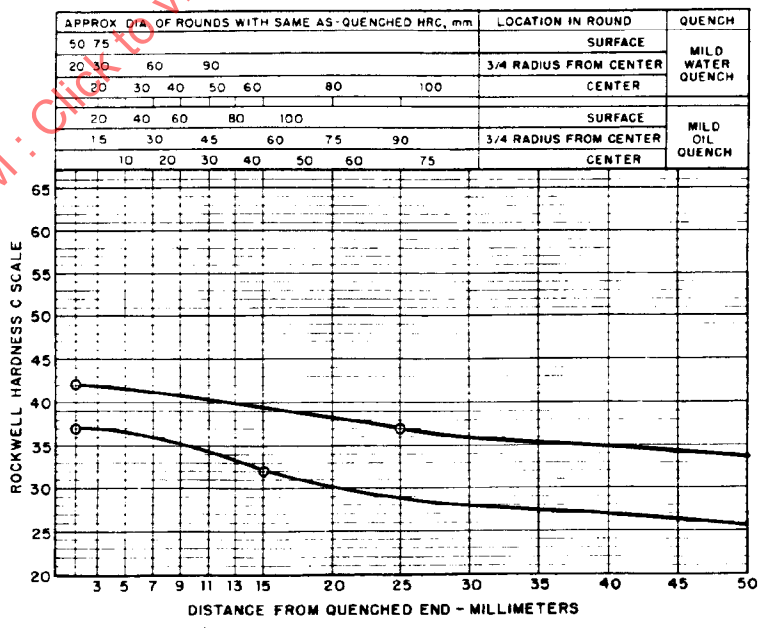


FIGURE 4 - LIMITS FOR HARDENABILITY BAND 3310 RH

HARDENABILITY BAND SAE 4027 RH

%C	%Mn	%Si	%Ni	%Cr	%Mo	
0.25/0.30	0.70/0.90	0.15/0.35	--	--	0.20/0.30	

HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	HRC MAX.	HRC MIN.
1	(51)	(46)
2	48	42
3	43	(34)
4	(37)	28
5	32	24
6	28	22
7	26	20
8	24	--
9	23	--
10	22	--
11	22	--
12	21	--
13	21	--
14	20	--
15	--	--
16		
18		
20		
22		
24		
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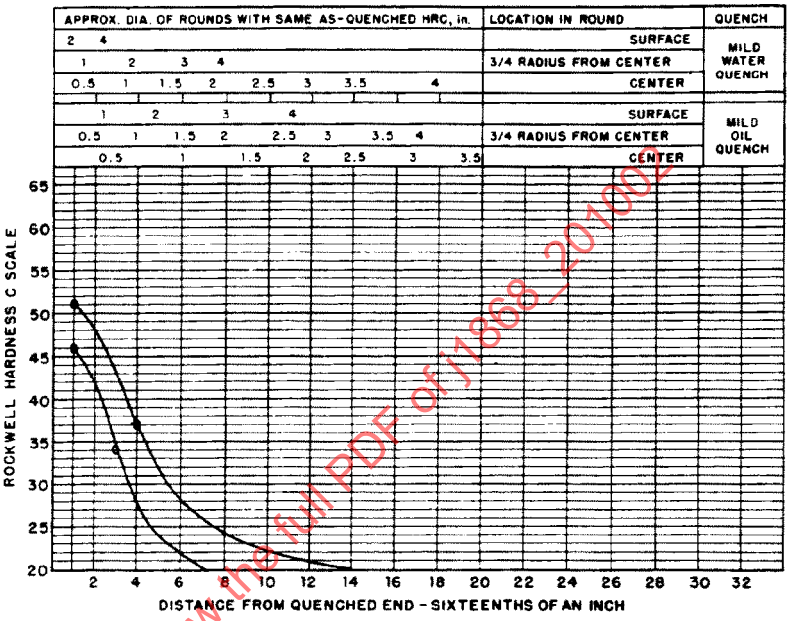
32		

HEAT TREATING TEMPERATURES

*NORMALIZE	1650 °F
AUSTENITIZE	1600 °F

*For forged or rolled specimens only



HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE MILLIMETERS	HRC MAX.	HRC MIN.
1.5	(51)	(46)
3	48	42
5	42	(33)
7	(35)	26
9	29	23
11	26	20
13	24	--
15	23	--
20	21	--
25	--	--
30		
35		
40		
45		
50		

HEAT TREATING TEMPERATURES

*NORMALIZE	900 °C
AUSTENITIZE	870 °C

*For forged or rolled specimens only

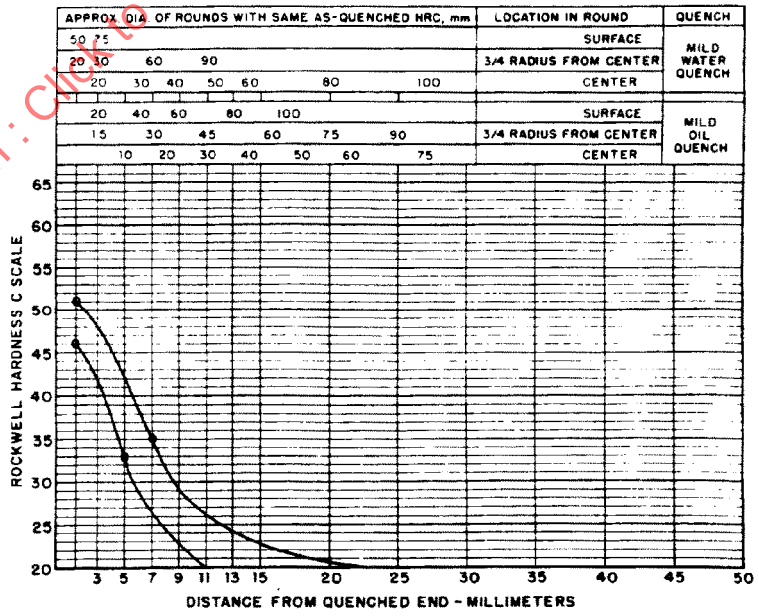


FIGURE 5 - LIMITS FOR HARDENABILITY BAND 4027 RH

HARDENABILITY BAND SAE 4118 RH

%C	%Mn	%Si	%Ni	%Cr	%Mo	
0.18/0.23	0.70/0.90	0.15/0.35	--	0.40/0.60	0.08/0.15	

HARDNESS LIMITS FOR SPECIFICATION PURPOSES

"J" DISTANCE SIXTEENTHS OF AN INCH	HRC MAX.	HRC MIN.
1	(47)	(42)
2	44	38
3	38	(30)
4	(33)	25
5	29	22
6	27	20
7	25	--
8	24	--
9	23	--
10	22	--
11	21	--
12	20	--
13	--	--
14		
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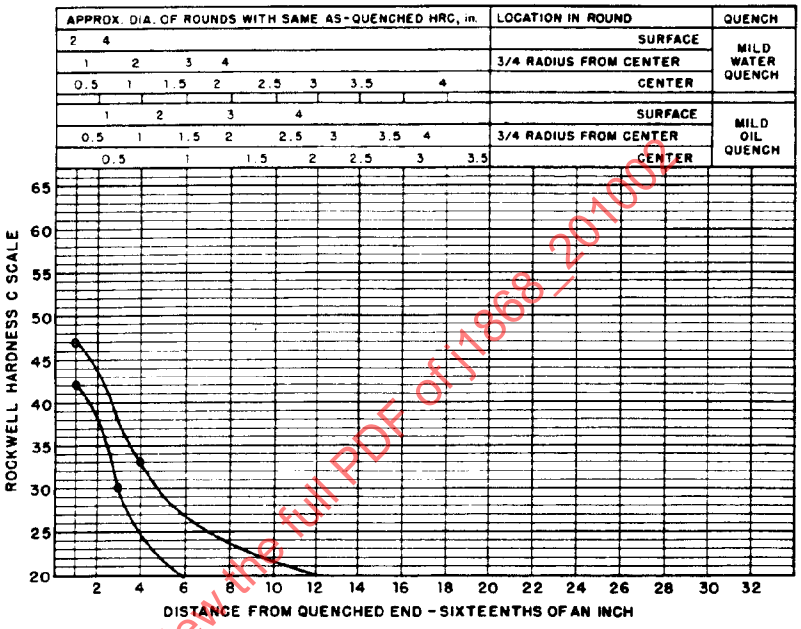
HEAT TREATING TEMPERATURES

*NORMALIZE	1700 °F
AUSTENITIZE	1700 °F

*For forged or rolled specimens only



HARDNESS LIMITS FOR SPECIFICATION PURPOSES

"J" DISTANCE MILLIMETERS	HRC MAX.	HRC MIN.
1.5	(47)	(42)
3	44	38
5	37	(29)
7	(31)	24
9	28	21
11	25	20
13	24	--
15	23	--
20	20	--
25	--	--
30		
35		
40		
45		
50		

HEAT TREATING TEMPERATURES

*NORMALIZE	925 °C
AUSTENITIZE	925 °C

*For forged or rolled specimens only

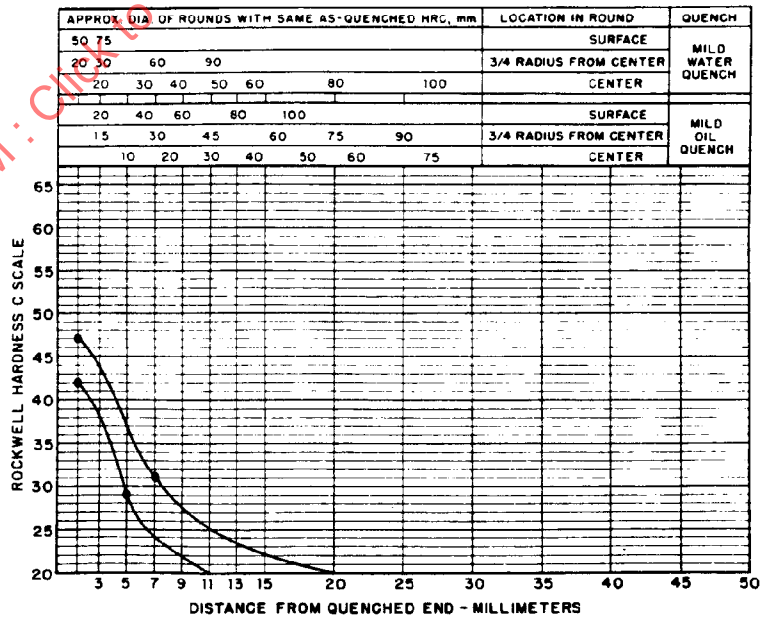


FIGURE 6 - LIMITS FOR HARDENABILITY BAND 4118 RH

HARDENABILITY BAND SAE 4120 RH

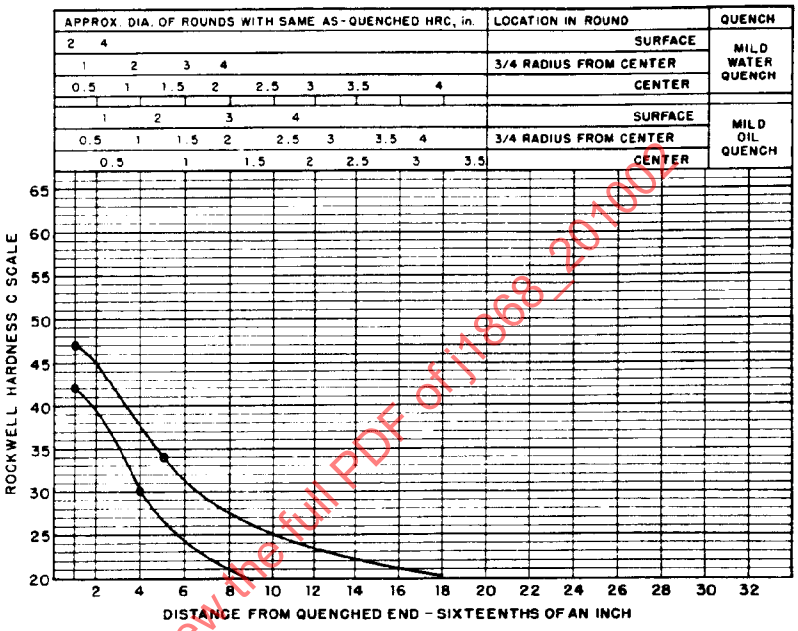
%C	%Mn	%Si	%Ni	%Cr	%Mo	
0.18/0.23	0.90/1.20	0.15/0.35	--	0.40/0.60	0.13/0.20	

HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	HRC MAX.	HRC MIN.
1	(47)	(42)
2	45	39
3	41	35
4	38	(30)
5	(34)	26
6	31	24
7	29	22
8	28	21
9	26	20
10	25	--
11	24	--
12	23	--
13	23	--
14	22	--
15	22	--
16	21	--
18	20	--
20	--	--
22		
24		
26		
28		
30		
32		

HEAT TREATING TEMPERATURES

*NORMALIZE 1700 °F
AUSTENITIZE 1700 °F

*For forged or rolled specimens only



HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE MILLIMETERS	HRC MAX.	HRC MIN.
1.5	(47)	(42)
3	45	39
5	41	(34)
7	(36)	28
9	32	25
11	29	22
13	28	21
15	26	20
20	23	--
25	21	--
30	--	--
35		
40		
45		
50		

HEAT TREATING TEMPERATURES

*NORMALIZE 925 °C
AUSTENITIZE 925 °C

*For forged or rolled specimens only

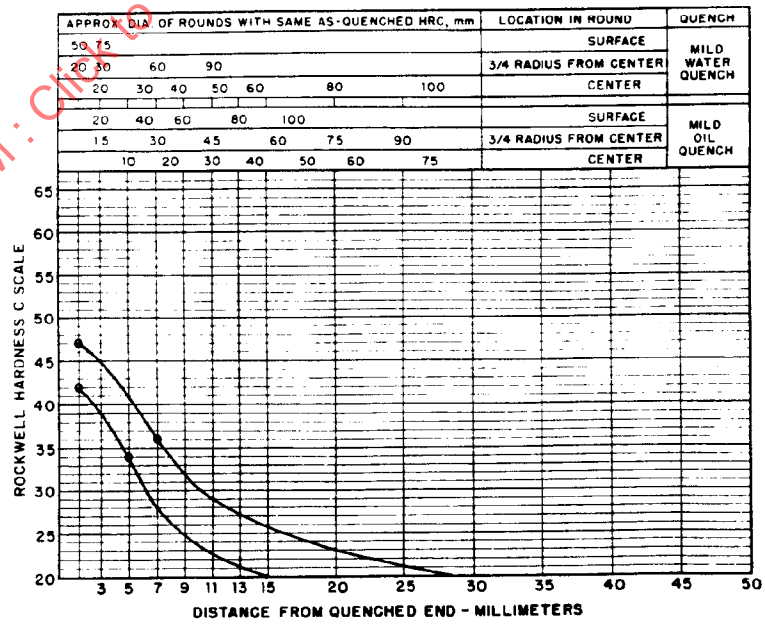


FIGURE 7 - LIMITS FOR HARDENABILITY BAND 4120 RH

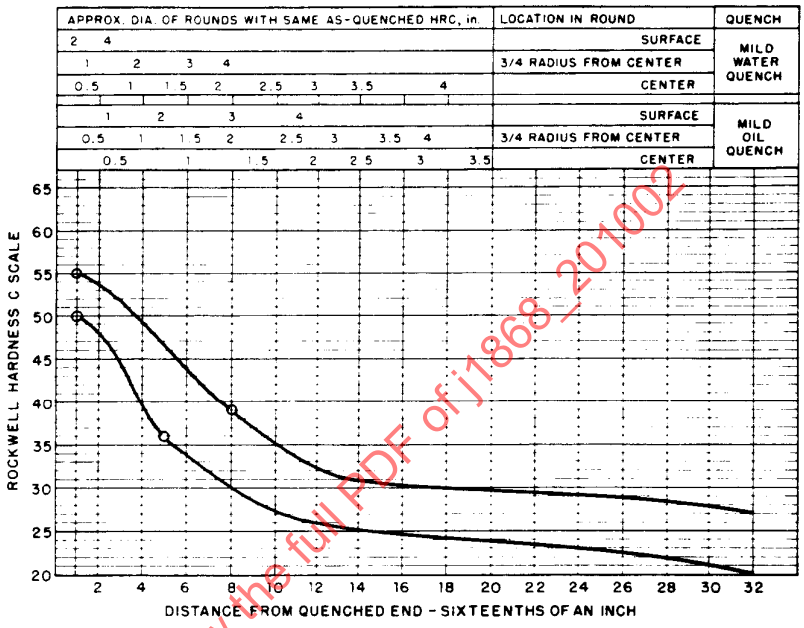
HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	HRC MAX.	HRC MIN.
1	(55)	(50)
2	54	48
3	52	44
4	49	40
5	46	(36)
6	44	34
7	41	32
8	(39)	30
9	37	28
10	35	27
11	33	26
12	32	26
13	32	26
14	31	25
15	31	25
16	31	25
18	30	24
20	30	23
22	30	23
24	29	22
26	29	22
28	28	21
30	28	21
32	27	20

HEAT TREATING TEMPERATURES	
*NORMALIZE	1650 °F
AUSTENITIZE	1600 °F

*For forged or rolled specimens only

HARDENABILITY BAND SAE 4130 RH

%C	%Mn	%Si	%Ni	%Cr	%Mo	
0.28/0.33	0.40/0.60	0.15/0.35	--	0.80/1.10	0.15/0.25	



HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE MILLIMETERS	HRC MAX.	HRC MIN.
1.5	(55)	(50)
3	54	48
5	51	43
7	48	38
9	45	(35)
11	41	32
13	(39)	30
15	36	27
20	32	26
25	31	25
30	30	24
35	30	23
40	29	22
45	28	21
50	27	20

HEAT TREATING TEMPERATURES	
*NORMALIZE	900 °C
AUSTENITIZE	870 °C

*For forged or rolled specimens only

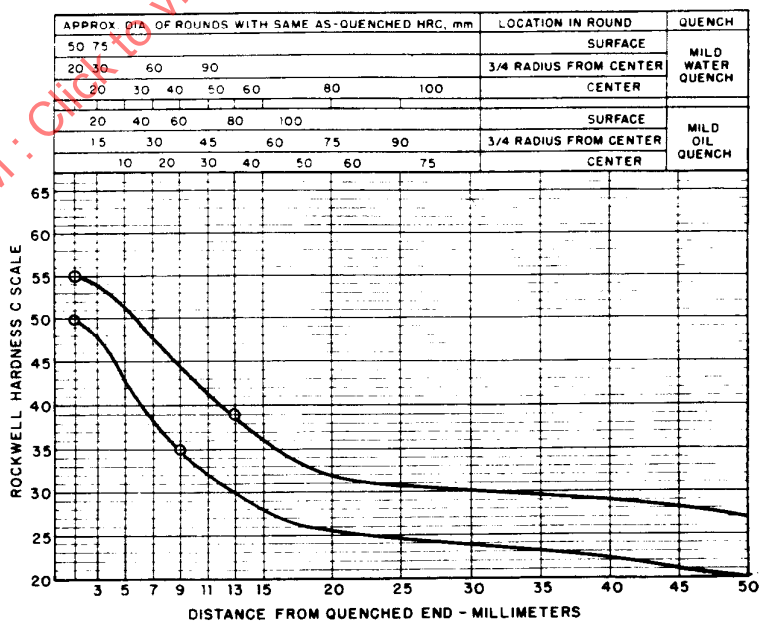


FIGURE 8 - LIMITS FOR HARDENABILITY BAND 4130 RH

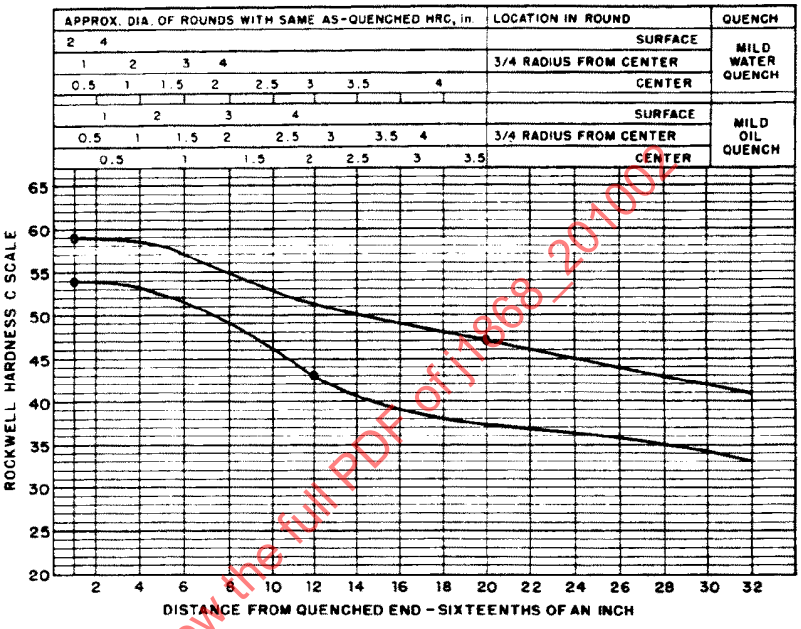
HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	HRC MAX.	HRC MIN.
1	(59)	(54)
2	59	54
3	59	54
4	59	53
5	58	52
6	57	51
7	56	50
8	55	49
9	54	48
10	53	46
11	52	44
12	52	(43)
13	51	42
14	50	41
15	50	40
16	49	39
18	48	38
20	(47)	37
22	46	37
24	45	36
26	44	35
28	43	35
30	42	34
32	41	33

HEAT TREATING TEMPERATURES	
*NORMALIZE	1600 °F
AUSTENITIZE	1550 °F

*For forged or rolled specimens only

HARDENABILITY BAND SAE 4140 RH

%C	%Mn	%Si	%Ni	%Cr	%Mo	
0.38/0.43	0.75/1.00	0.15/0.35	--	0.80/1.10	0.15/0.25	



HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE MILLIMETERS	HRC MAX.	HRC MIN.
1.5	(59)	(54)
3	59	54
5	59	54
7	59	53
9	58	52
11	56	50
13	55	49
15	54	47
20	51	(42)
25	49	39
30	(48)	38
35	46	37
40	44	36
45	43	35
50	41	33

HEAT TREATING TEMPERATURES	
*NORMALIZE	870 °C
AUSTENITIZE	845 °C

*For forged or rolled specimens only

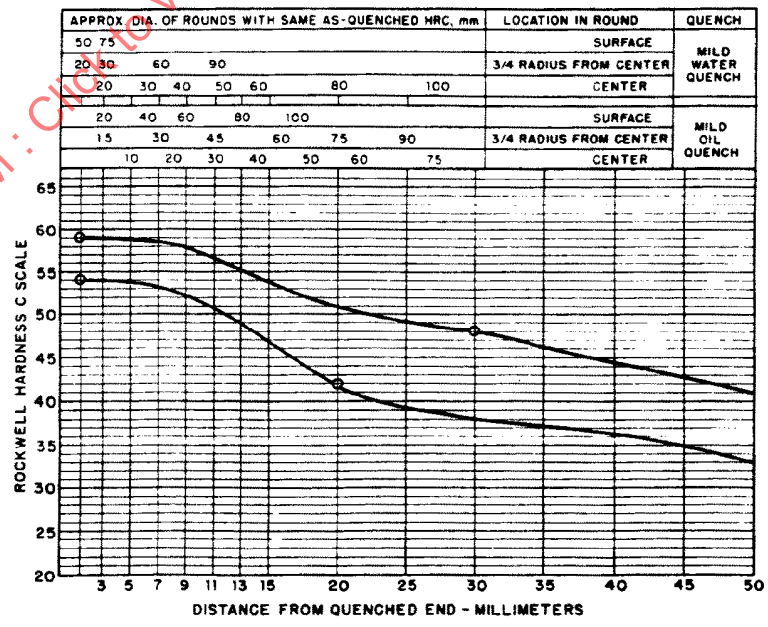
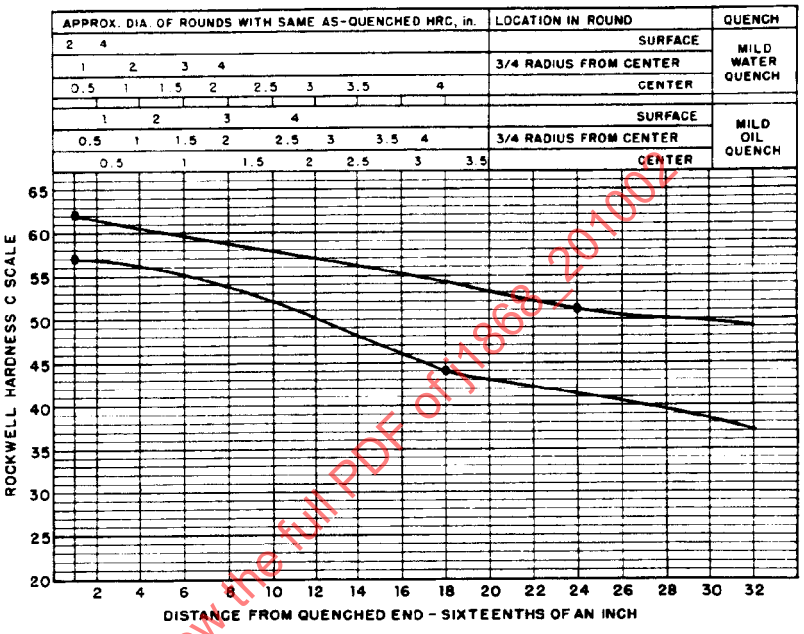


FIGURE 9 - LIMITS FOR HARDENABILITY BAND 4140 RH

HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	HRC MAX.	HRC MIN.
1	(62)	(57)
2	62	57
3	61	56
4	61	56
5	60	55
6	60	55
7	59	54
8	59	53
9	58	52
10	58	52
11	58	51
12	57	50
13	57	49
14	56	48
15	56	47
16	55	46
18	54	(44)
20	53	43
22	52	42
24	(51)	40
26	51	40
28	50	39
30	50	38
32	49	37
HEAT TREATING TEMPERATURES		
*NORMALIZE	1600 °F	
AUSTENITIZE	1550 °F	
*For forged or rolled specimens only		

HARDENABILITY BAND SAE 4145 RH

%C	%Mn	%Si	%Ni	%Cr	%Mo	
0.43/0.48	0.75/1.00	0.15/0.35	--	0.80/1.10	0.15/0.25	



HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE MILLIMETERS	HRC MAX.	HRC MIN.
1.5	(62)	(57)
3	62	57
5	61	56
7	61	56
9	60	55
11	59	54
13	59	53
15	58	52
20	57	49
25	55	46
30	54	(44)
35	52	42
40	(51)	40
45	50	39
50	49	37
HEAT TREATING TEMPERATURES		
*NORMALIZE	870 °C	
AUSTENITIZE	845 °C	
*For forged or rolled specimens only		

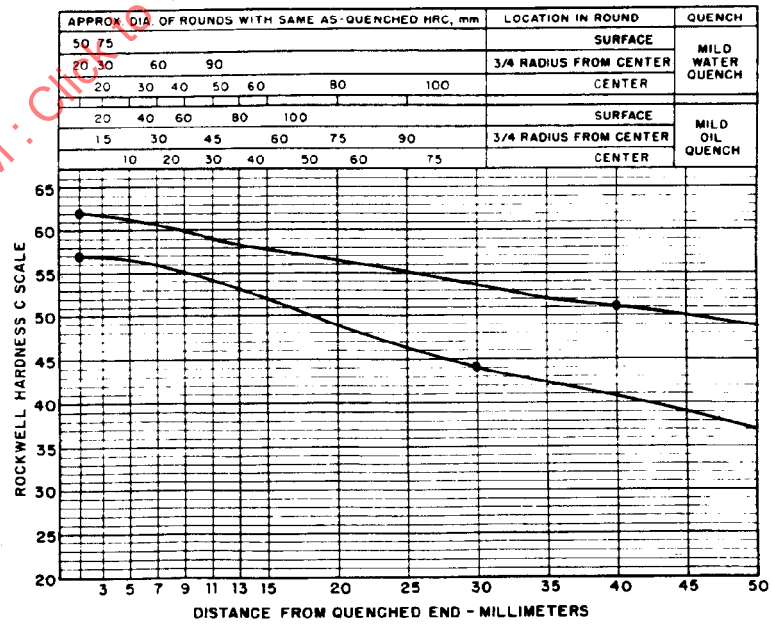


FIGURE 10 - LIMITS FOR HARDENABILITY BAND 4145 RH

HARDENABILITY BAND SAE 4161 RH

%C	%Mn	%Si	%Ni	%Cr	%Mo	
0.56/0.64	0.75/1.00	0.15/0.35	--	0.70/0.90	0.25/0.35	

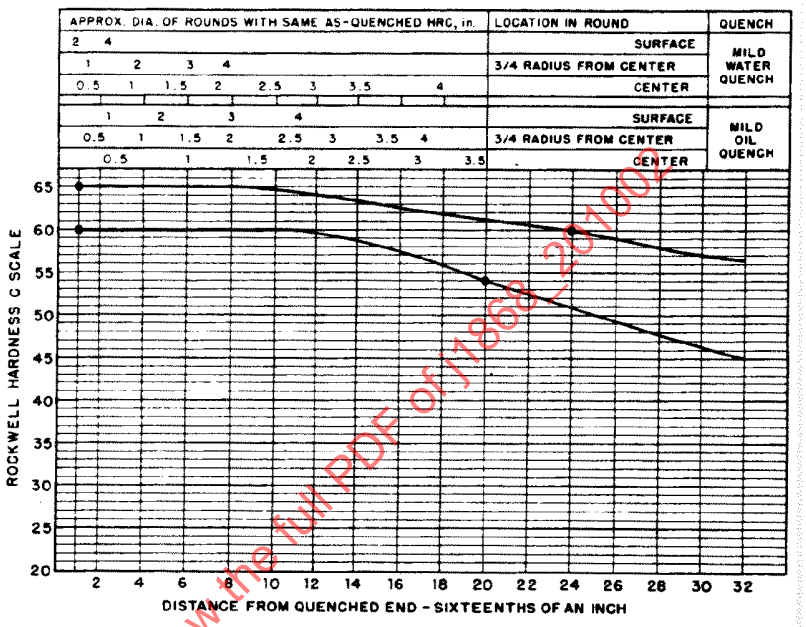
HARDNESS LIMITS FOR SPECIFICATION PURPOSES

"J" DISTANCE SIXTEENTHS OF AN INCH	HRC MAX.	HRC MIN.
1	(65)	(60)
2	65	60
3	65	60
4	65	60
5	65	60
6	65	60
7	65	60
8	65	60
9	65	60
10	65	60
11	65	60
12	64	59
13	64	59
14	64	59
15	63	58
16	63	57
18	62	56
20	62	(54)
22	61	53
24	(60)	51
26	59	49
28	58	47
30	57	46
32	57	45

HEAT TREATING TEMPERATURES

*NORMALIZE	1600 °F
AUSTENITIZE	1550 °F

*For forged or rolled specimens only



HARDNESS LIMITS FOR SPECIFICATION PURPOSES

"J" DISTANCE MILLIMETERS	HRC MAX.	HRC MIN.
1.5	(65)	(60)
3	65	60
5	65	60
7	65	60
9	65	60
11	65	60
13	65	60
15	65	60
20	64	59
25	63	57
30	62	(55)
35	(61)	53
40	59	50
45	58	47
50	57	45

HEAT TREATING TEMPERATURES

*NORMALIZE	870 °C
AUSTENITIZE	845 °C

*For forged or rolled specimens only

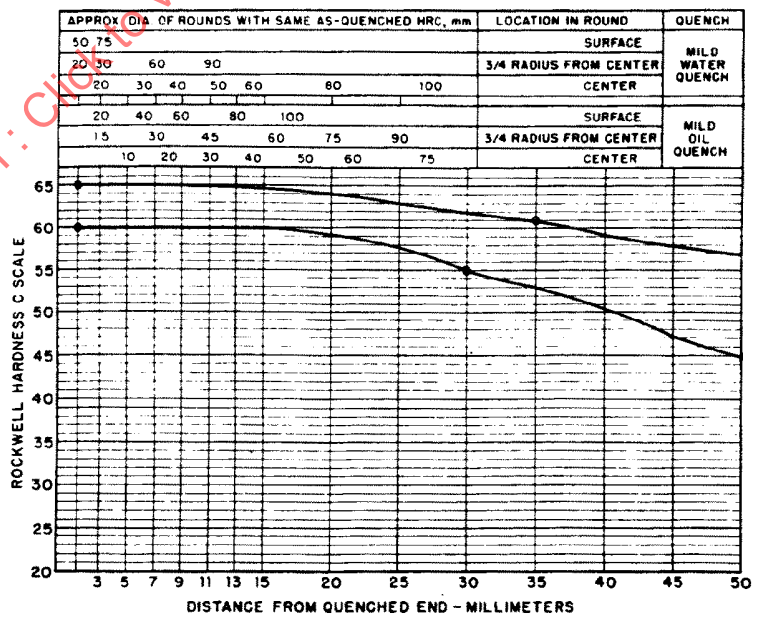


FIGURE 11 - LIMITS FOR HARDENABILITY BAND 4161 RH

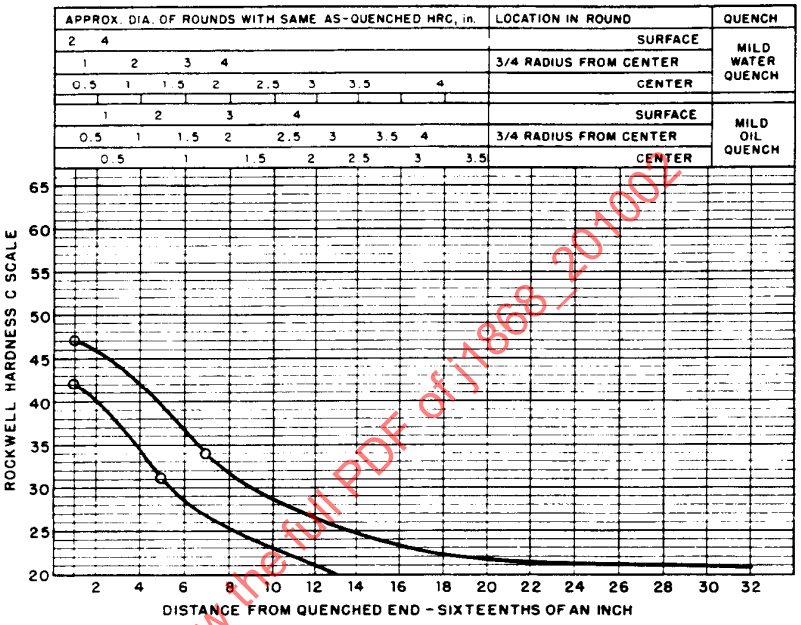
HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	HRC MAX.	HRC MIN.
1	(47)	(42)
2	46	40
3	44	37
4	41	34
5	39	(31)
6	36	29
7	(34)	27
8	32	25
9	31	24
10	29	23
11	28	22
12	26	21
13	25	20
14	24	--
15	24	--
16	23	--
18	22	--
20	22	--
22	21	--
24	21	--
26	21	--
28	21	--
30	21	--
32	21	--

HEAT TREATING TEMPERATURES	
*NORMALIZE	1700 °F
AUSTENITIZE	1700 °F

*For forged or rolled specimens only

HARDENABILITY BAND SAE 4320 RH

%C	%Mn	%Si	%Ni	%Cr	%Mo	
0.17/0.22	0.45/0.65	0.15/0.35	1.65/2.00	0.40/0.60	0.20/0.30	



HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE MILLIMETERS	HRC MAX.	HRC MIN.
1.5	(47)	(42)
3	46	40
5	44	37
7	40	33
9	37	(30)
11	(34)	27
13	31	25
15	30	23
20	25	20
25	23	--
30	22	--
35	21	--
40	21	--
45	21	--
50	21	--

HEAT TREATING TEMPERATURES	
*NORMALIZE	925 °C
AUSTENITIZE	925 °C

*For forged or rolled specimens only

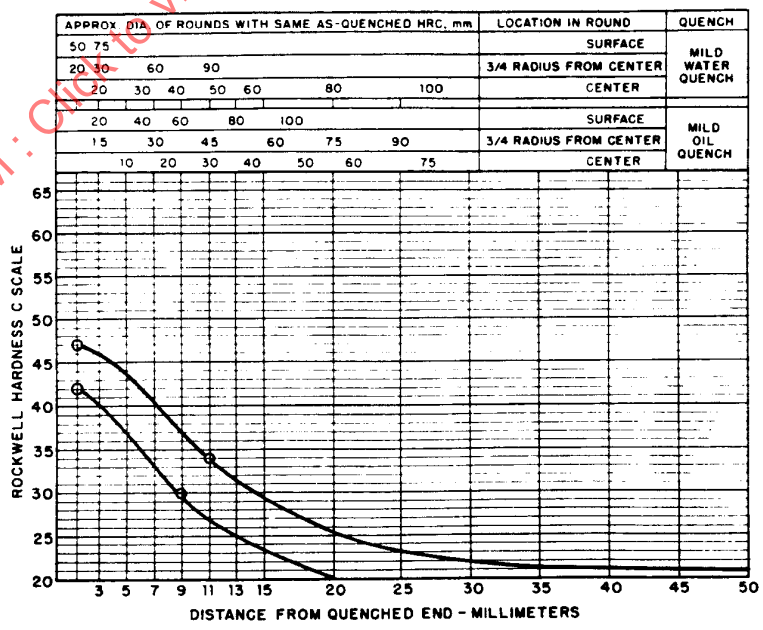
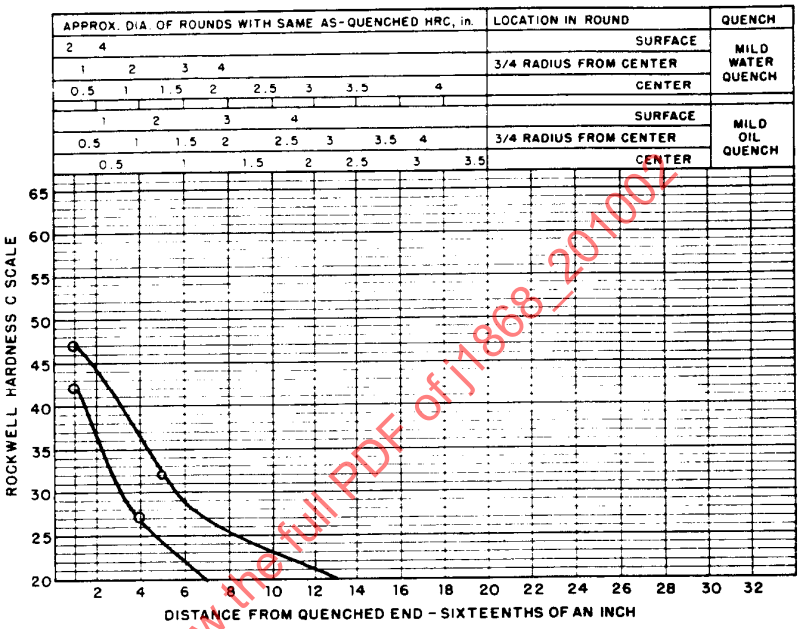


FIGURE 12 - LIMITS FOR HARDENABILITY BAND 4320 RH

HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	HRC MAX.	HRC MIN.
1	(47)	(42)
2	44	37
3	40	30
4	37	(27)
5	(32)	24
6	29	21
7	27	20
8	25	--
9	24	--
10	23	--
11	22	--
12	21	--
13	20	--
14	--	--
15		
16		
18		
20		
22		
24		
26		
28		
30		
32		
HEAT TREATING TEMPERATURES		
*NORMALIZE	1700 °F	
AUSTENITIZE	1700 °F	
*For forged or rolled specimens only		

HARDENABILITY BAND SAE 4620 RH

%C	%Mn	%Si	%Ni	%Cr	%Mo	
0.17/0.22	0.45/0.65	0.15/0.35	1.65/2.00	--	0.20/0.30	



HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE MILLIMETERS	HRC MAX.	HRC MIN.
1.5	(47)	(42)
3	44	37
5	39	(29)
7	35	26
9	(30)	22
11	27	20
13	25	--
15	23	--
20	21	--
25	--	--
30		
35		
40		
45		
50		
HEAT TREATING TEMPERATURES		
*NORMALIZE	925 °C	
AUSTENITIZE	925 °C	
*For forged or rolled specimens only		

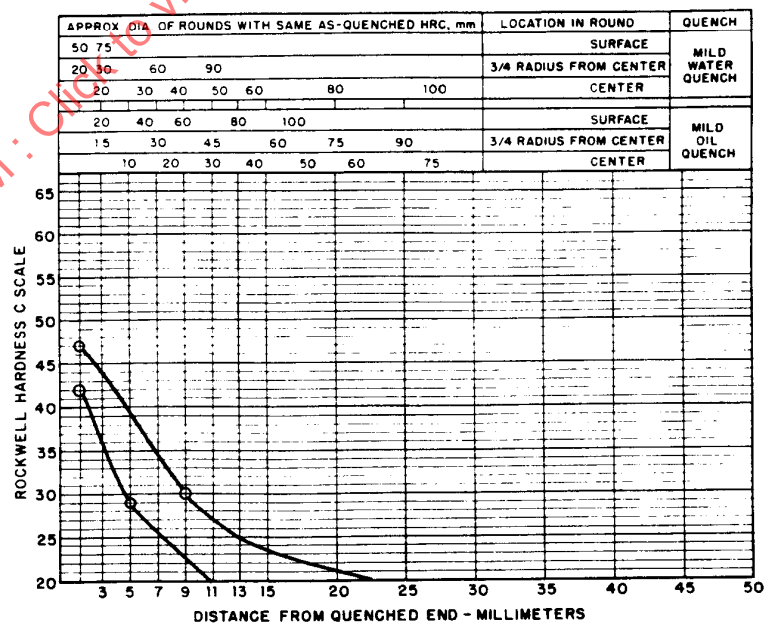


FIGURE 13 - LIMITS FOR HARDENABILITY BAND 4620 RH

HARDENABILITY BAND SAE 4820 RH

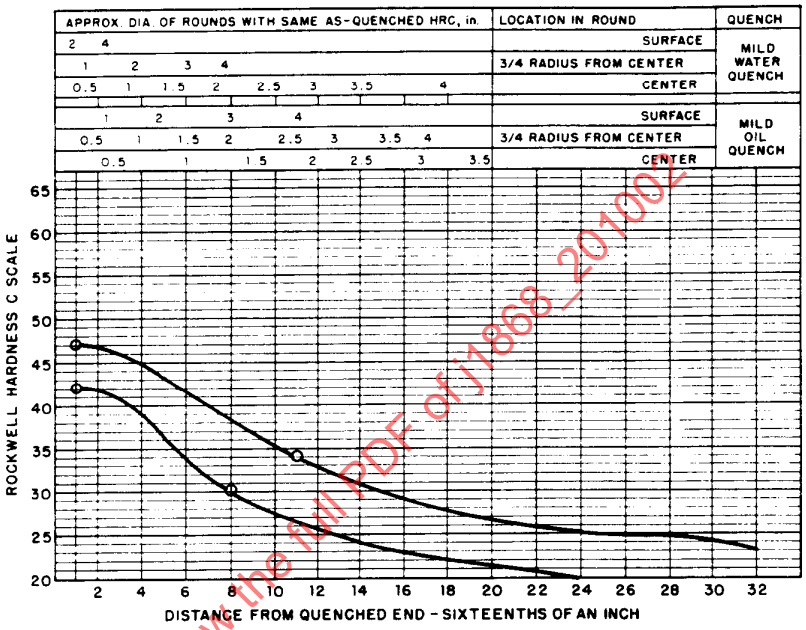
%C	%Mn	%Si	%Ni	%Cr	%Mo	
0.18/0.23	0.50/0.70	0.15/0.35	3.25/3.75	--	0.20/0.30	

HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	HRC MAX.	HRC MIN.
1	(47)	(42)
2	47	42
3	46	41
4	45	40
5	43	36
6	41	33
7	40	32
8	38	(30)
9	36	28
10	35	27
11	(34)	26
12	33	25
13	32	24
14	31	24
15	30	23
16	29	23
18	28	22
20	27	22
22	26	21
24	25	20
26	25	20
28	25	--
30	24	--
32	23	--

HEAT TREATING TEMPERATURES

*NORMALIZE 1700 °F
AUSTENITIZE 1550 °F

*For forged or rolled specimens only



HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE MILLIMETERS	HRC MAX.	HRC MIN.
1.5	(47)	(42)
3	47	42
5	46	41
7	44	38
9	42	34
11	40	(32)
13	38	30
15	(35)	27
20	32	24
25	29	23
30	27	22
35	26	21
40	25	20
45	24	--
50	23	--

HEAT TREATING TEMPERATURES

*NORMALIZE 925 °C
AUSTENITIZE 845 °C

*For forged or rolled specimens only

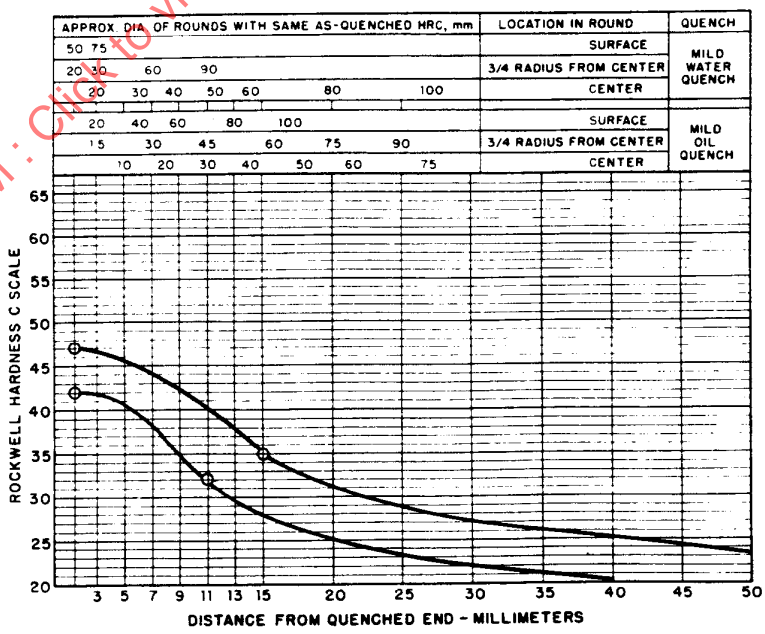


FIGURE 14 - LIMITS FOR HARDENABILITY BAND 4820 RH

HARDENABILITY BAND SAE 50B40 RH

%C	%Mn	%Si	%Ni	%Cr	%Mo	%B
0.38/0.43	0.75/1.00	0.15/0.35	--	0.40/0.60	--	*

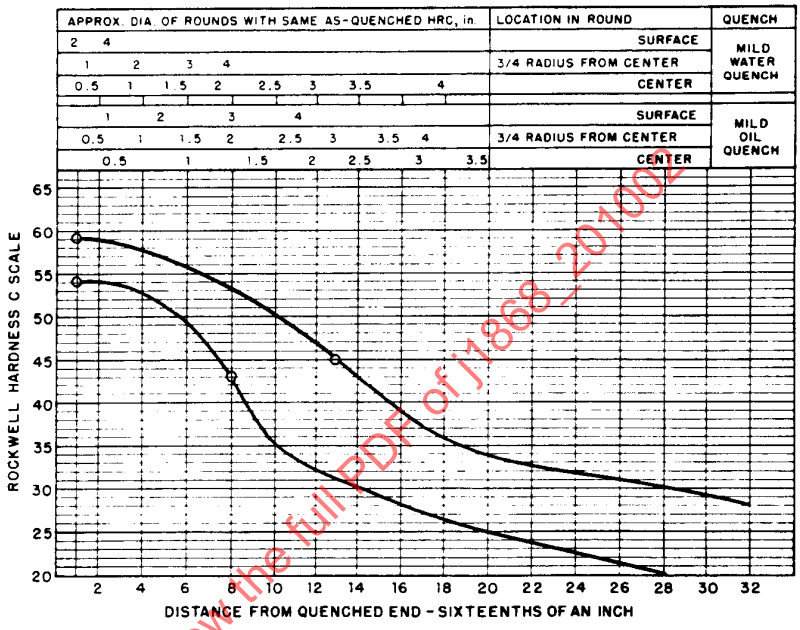
* can be expected to contain 0.0005/0.003 percent boron.

HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	HRC MAX.	HRC MIN.
1	(59)	(54)
2	59	54
3	58	53
4	58	53
5	57	52
6	56	50
7	55	47
8	54	(43)
9	52	38
10	50	35
11	49	33
12	47	32
13	(45)	31
14	44	30
15	41	29
16	38	28
18	36	26
20	34	24
22	33	23
24	32	22
26	31	21
28	30	20
30	29	--
32	28	--

HEAT TREATING TEMPERATURES

*NORMALIZE	1600 °F
AUSTENITIZE	1550 °F

*For forged or rolled specimens only



HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE MILLIMETERS	HRC MAX.	HRC MIN.
1.5	(59)	(54)
3	59	54
5	58	53
7	58	53
9	56	51
11	55	47
13	54	(42)
15	51	36
20	(46)	31
25	39	28
30	35	25
35	33	23
40	31	21
45	29	20
50	28	--

HEAT TREATING TEMPERATURES

*NORMALIZE	870 °C
AUSTENITIZE	845 °C

*For forged or rolled specimens only

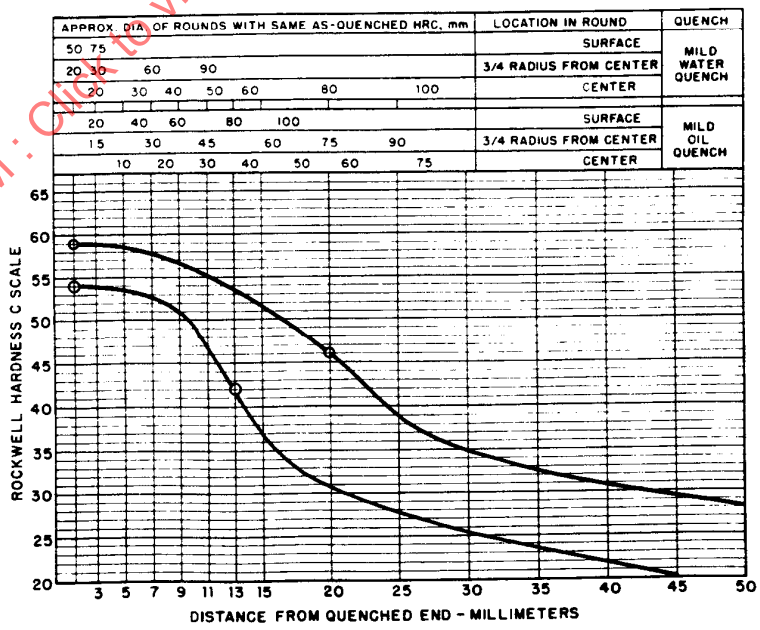


FIGURE 15 - LIMITS FOR HARDENABILITY BAND 50B40 RH

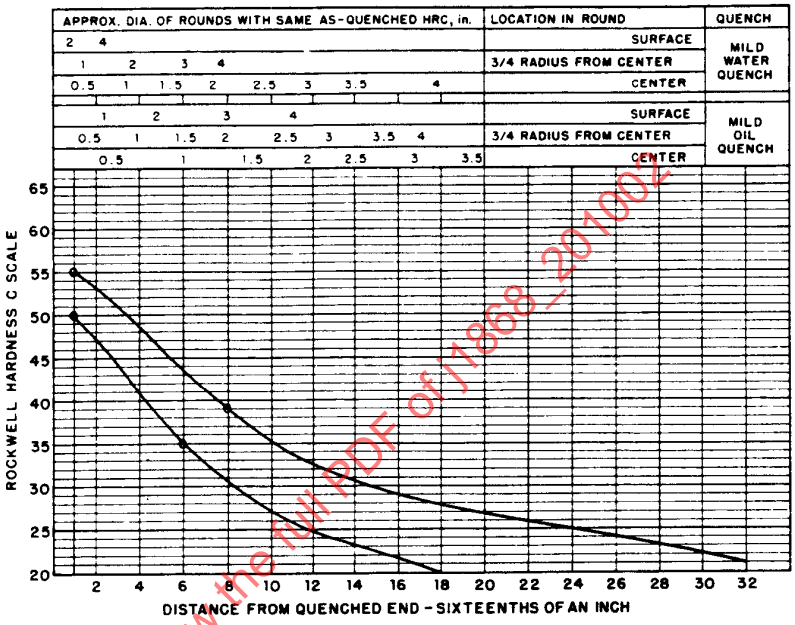
HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	HRC MAX.	HRC MIN.
1	(55)	(50)
2	53	47
3	51	44
4	49	41
5	46	37
6	44	(35)
7	42	33
8	(39)	31
9	37	29
10	35	27
11	34	26
12	33	25
13	32	24
14	31	23
15	30	22
16	29	21
18	28	20
20	27	--
22	26	--
24	25	--
26	24	--
28	23	--
30	22	--
32	21	--

HEAT TREATING TEMPERATURES		
*NORMALIZE	1650	°F
AUSTENITIZE	1600	°F

*For forged or rolled specimens only

HARDENABILITY BAND SAE 5130 RH

%C	%Mn	%Si	%Ni	%Cr	%Mo	
0.28/0.33	0.70/0.90	0.15/0.35	--	0.80/1.10	--	



HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE MILLIMETERS	HRC MAX.	HRC MIN.
1.5	(55)	(50)
3	53	47
5	51	44
7	48	39
9	45	(36)
11	42	33
13	(39)	31
15	36	28
20	32	24
25	29	21
30	28	20
35	26	--
40	24	--
45	23	--
50	21	--

HEAT TREATING TEMPERATURES		
*NORMALIZE	900	°C
AUSTENITIZE	870	°C

*For forged or rolled specimens only

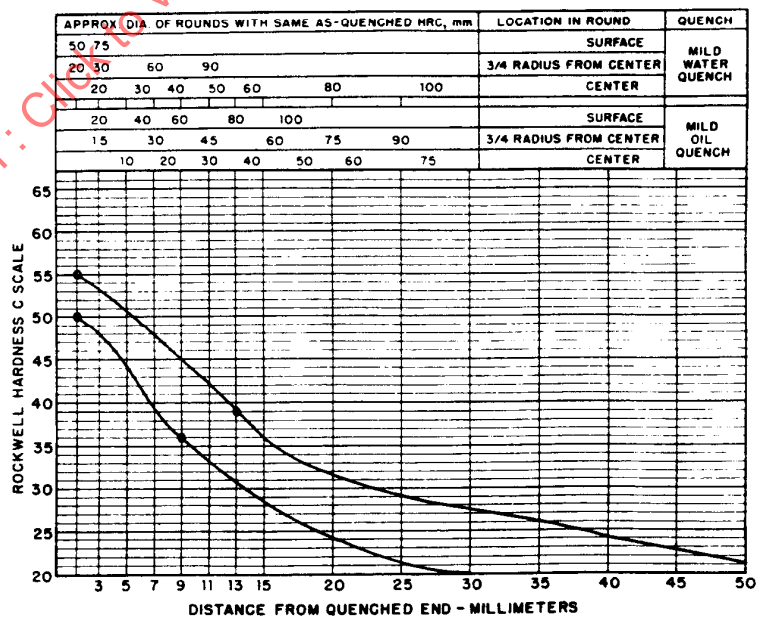


FIGURE 16 - LIMITS FOR HARDENABILITY BAND 5130 RH

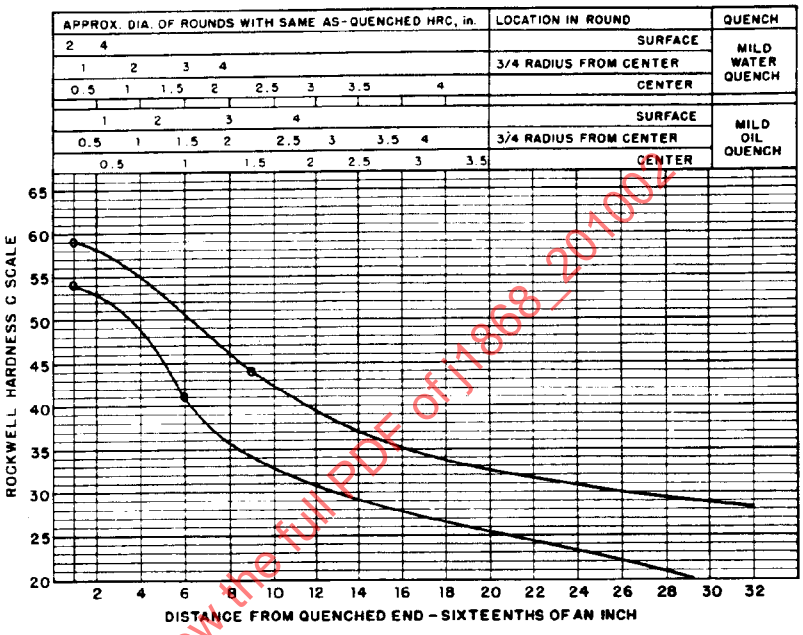
HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	HRC MAX.	HRC MIN.
1	(59)	(54)
2	58	53
3	57	51
4	55	49
5	53	45
6	51	(41)
7	48	38
8	46	36
9	(44)	34
10	43	33
11	41	32
12	40	31
13	39	30
14	37	29
15	36	28
16	35	27
18	34	26
20	33	25
22	32	24
24	31	23
26	30	22
28	30	21
30	29	20
32	29	--

HEAT TREATING TEMPERATURES	
*NORMALIZE	1600 °F
AUSTENITIZE	1550 °F

*For forged or rolled specimens only

HARDENABILITY BAND SAE 5140 RH

%C	%Mn	%Si	%Ni	%Cr	%Mo	
0.38/0.43	0.70/0.90	0.15/0.35	--	0.70/0.90	--	



HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE MILLIMETERS	HRC MAX.	HRC MIN.
1.5	(59)	(54)
3	58	53
5	57	51
7	55	47
9	52	(42)
11	48	38
13	46	36
15	(44)	34
20	39	30
25	35	27
30	33	25
35	32	24
40	31	22
45	30	21
50	29	20

HEAT TREATING TEMPERATURES	
*NORMALIZE	870 °C
AUSTENITIZE	845 °C

*For forged or rolled specimens only

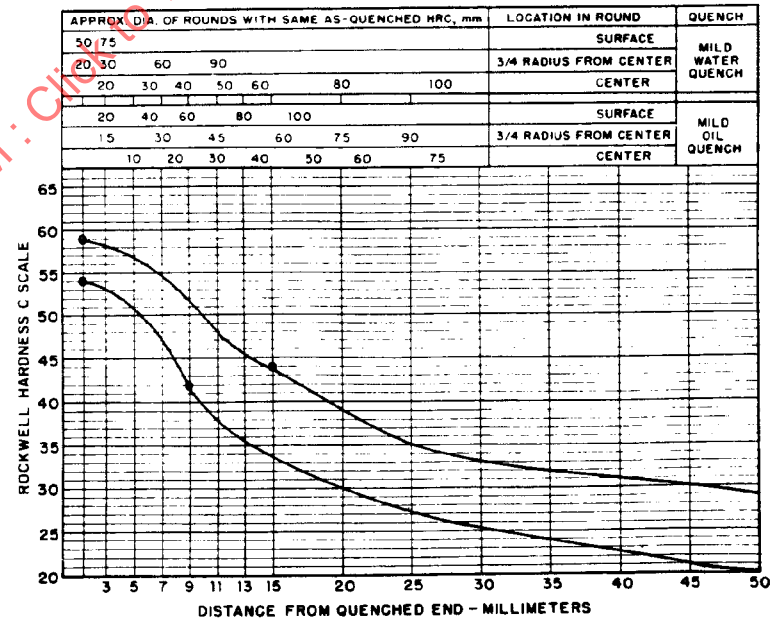


FIGURE 17 - LIMITS FOR HARDENABILITY BAND 5140 RH

HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	HRC	
	MAX.	MIN.
1	(65)	(60)
2	65	60
3	65	60
4	65	59
5	64	58
6	63	57
7	62	54
8	60	(50)
9	58	45
10	56	42
11	55	40
12	53	39
13	(51)	38
14	50	37
15	48	36
16	47	36
18	44	35
20	43	34
22	42	33
24	41	32
26	40	31
28	39	30
30	39	29
32	38	29

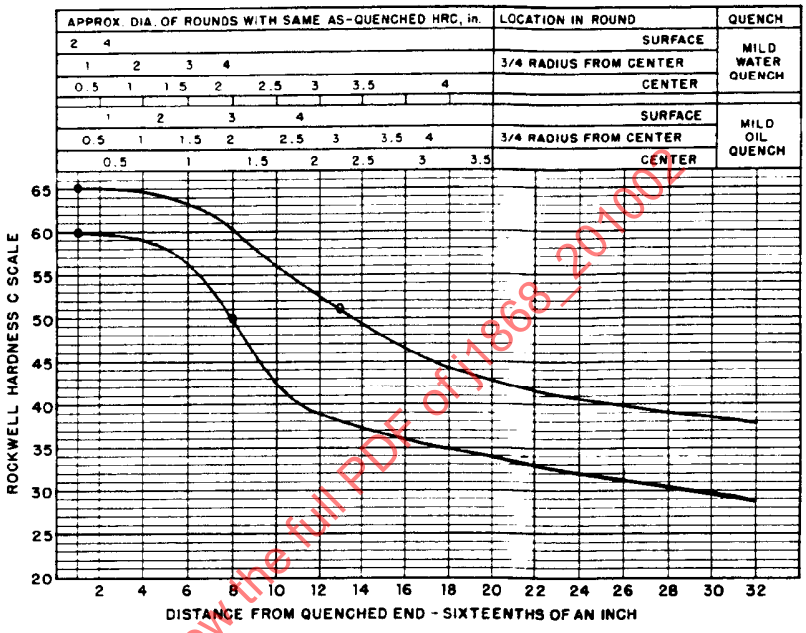
HEAT TREATING TEMPERATURES

*NORMALIZE	1600 °F
AUSTENITIZE	1550 °F

*For forged or rolled specimens only

HARDENABILITY BAND SAE 5160 RH

%C	%Mn	%Si	%Ni	%Cr	%Mo	
0.56/0.64	0.75/1.00	0.15/0.35	--	0.70/0.90	--	



HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE MILLIMETERS	HRC	
	MAX.	MIN.
1.5	(65)	(60)
3	65	60
5	65	60
7	65	59
9	63	57
11	62	54
13	60	(49)
15	57	43
20	(52)	38
25	47	36
30	43	34
35	41	32
40	40	31
45	39	30
50	38	29

HEAT TREATING TEMPERATURES

*NORMALIZE	870 °C
AUSTENITIZE	845 °C

*For forged or rolled specimens only

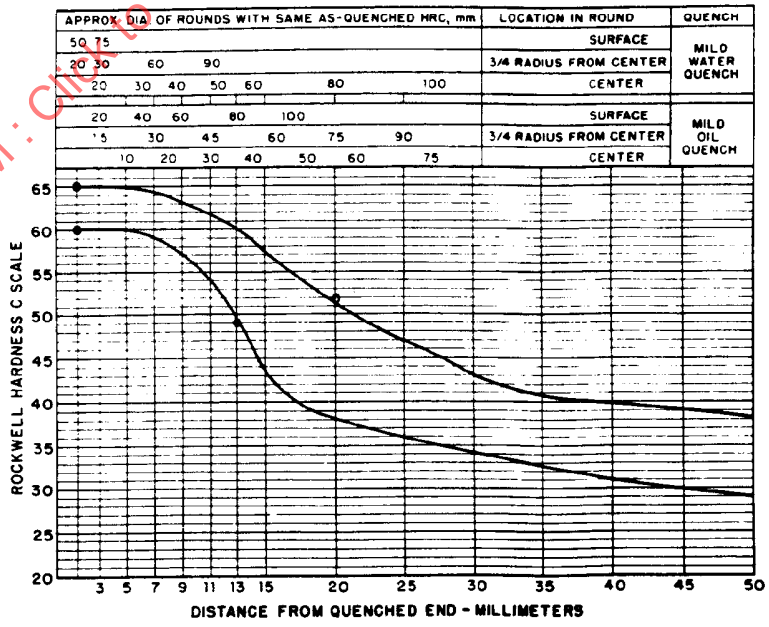


FIGURE 18 - LIMITS FOR HARDENABILITY BAND 5160 RH