Designation: A304 - 16

Standard Specification for Carbon and Alloy Steel Bars Subject to End-Quench Hardenability Requirements¹

This standard is issued under the fixed designation A304; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

- 1.1 This specification covers hot-worked alloy, carbon, and carbon-boron steels in a variety of compositions and sizes, which may attain specified depth of hardening in the end quench test. These steel compositions are identified by the suffix letter "H" added to the conventional grade number.
- 1.2 This specification provides for analyses other than those listed under Tables 1 and 2. Special hardenability limits are also permissible when approved by the purchaser and manufacturer.
- 1.3 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

2. Referenced Documents

2.1 ASTM Standards:²

A29/A29M Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought

A108 Specification for Steel Bar, Carbon and Alloy, Cold-Finished

A255 Test Methods for Determining Hardenability of Steel E112 Test Methods for Determining Average Grain Size

E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

2.2 Society of Automotive Engineers (SAE) Standard:³ J 1086 Numbering Metals and Alloys

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

¹ This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.15 on Bars.

3.1.1 hardenability—the relative ability of a steel to harden under heat treatment becomes apparent in the degree to which the material hardens when quenched at different cooling rates. It is measured quantitatively, usually by noting the extent or depth of hardening of a standard size and shape test specimen in a standardized quench. In the "end-quench" test the "depth of hardening" is the distance along the specimen from the quenched end to a given hardness.

4. Ordering Information

- 4.1 Orders for material under this specification should include the following information, in proper sequence:
 - 4.1.1 Quantity (weight),
- 4.1.2 Name of material (alloy, carbon, or carbon-boron steel),
 - 4.1.3 Cross-sectional shape,
 - 4.1.4 Size,
 - 4.1.5 Length,
 - 4.1.6 Grade,
 - 4.1.7 End-quenched hardenability (see Section 9),
 - 4.1.8 Report of heat analysis, if desired (see Section 7),
 - 4.1.9 Special straightness, if required,
 - 4.1.10 ASTM designation and date of issue,
 - 4.1.11 End use or special requirements, and
 - 4.1.12 Leaded steel, when required.

Note 1—A typical ordering description is as follows: 10 000 lb, alloy bars, round, 4.0 in. dia by 10 ft, Grade 1340H, J 40/56 = %16 in., heat analysis required, ASTM A304, dated ______, worm gear.

- 4.2 The purchaser shall specify the desired grade, including the suffix letter "H," in accordance with Table 1 or Table 2.
- 4.3 Band limits are shown graphically and as tabulations in Figs. 2-87, inclusive. For specifications purposes, the tabulated values of Rockwell C hardness are used. Values below 20 Rockwell C hardness (20 HRC) are not specified because such values are below the normal range of the C scale. The graphs are shown for convenience in estimating the hardness values obtainable at various locations on the end quench test bar and for various locations in oil or water quenched rounds. The relationship between end-quench distance and bar diameter is approximate and should be used only as a guide.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard' Document Summary page on the ASTM website.

 $^{^3}$ Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, http://www.sae.org.



TABLE 1 Chemical Requirements of Alloy H Steels^A

Note 1—Phosphorus and sulfur in electric-furnace steel (designated by the prefix letter "E") is 0.025 %, max.

Note 2—Small quantities of certain elements are present in alloy steels that are not specified or required. These elements are considered as incidental and may be present to the following maximum amounts: copper, 0.35 %; nickel, 0.25 %; chromium, 0.20 %; molybdenum, 0.06 %.

Note 3—Chemical ranges and limits shown in this table are subject to the permissible variation for product analysis shown in Specification A29/A29M.

Note 4—Standard "H" Steels can be produced with a lead range of 0.15–0.35 %. Such steels are identified by inserting the letter "L" between the second and third numerals of the grade designation, for example, 41L40H. Lead is generally reported as a range of 0.15–0.35 %.

UNS	Grade Designation			Chemical Con	nposition, %		
Designation ^A	Grade Designation	Carbon	Manganese	Silicon	Nickel	Chromium	Molybdenun
H 13300	1330 H	0.27-0.33	1.45-2.05	0.15-0.35			
H 13350	1335 H	0.32-0.38	1.45-2.05	0.15-0.35			
H 13400	1340 H	0.37-0.44	1.45-2.05	0.15-0.35			
H 13450	1345 H	0.42-0.49	1.45-2.05	0.15-0.35			
H 40270	4027 H	0.24-0.30	0.60-1.00	0.15-0.35			0.20-0.30
H 40280	4028 H ^B	0.24-0.30	0.60-1.00	0.15-0.35			0.20-0.30
H 40320	4032 H	0.29-0.35	0.60-1.00	0.15-0.35			0.20-0.30
H 40370	4037 H	0.34-0.41	0.60-1.00	0.15-0.35			0.20-0.30
H 40420	4042 H	0.39-0.46	0.60-1.00	0.15-0.35	***	***	0.20-0.30
H 40470	4047 H	0.44-0.51	0.60-1.00	0.15-0.35			0.20-0.30
11 41100	4440 11	0.17.0.00	0.00 1.00	0.15, 0.05		0.00 0.70	0.00 0.15
H 41180 H 41300	4118 H 4130 H	0.17-0.23 0.27-0.33	0.60-1.00 0.30-0.70	0.15-0.35 0.15-0.35		0.30-0.70 0.75-1.20	0.08-0.15 0.15-0.25
H 41350	4135 H	0.32-0.38	0.60-1.00	0.15-0.35		0.75–1.20	0.15-0.25
H 41370	4137 H	0.34-0.41	0.60-1.00	0.15-0.35		0.75–1.20	0.15-0.25
H 41400	4140 H	0.37-0.44	0.65–1.10	0.15-0.35		0.75–1.20	0.15-0.25
H 41420	4142 H	0.39-0.46	0.65-1.10	0.15-0.35		0.75-1.20	0.15-0.25
H 41450	4145 H	0.42-0.49	0.65-1.10	0.15-0.35		0.75-1.20	0.15-0.25
H 41470	4147 H	0.44-0.51	0.65-1.10	0.15-0.35		0.75-1.20	0.15-0.25
H 41500	4150 H	0.47-0.54	0.65-1.10	0.15-0.35		0.75-1.20	0.15-0.25
H 41610	4161 H	0.55-0.65	0.65-1.10	0.15-0.35		0.65-0.95	0.25-0.35
H 43200	4320 H	0.17-0.23	0.40-0.70	0.15-0.35	1 55 0 00	0.35-0.65	0.20-0.30
					1.55–2.00		
H 43400	4340 H	0.37-0.44	0.55-0.90	0.15-0.35	1.55–2.00	0.65-0.95	0.20-0.30
H 43406	E4340 H	0.37-0.44	0.60-0.95	0.15-0.35	1.55–2.00	0.65–0.95	0.20-0.30
H 44190	4419 H	0.17-0.23	0.35-0.75	0.15-0.35			0.45-0.60
H 46200	4620 H	0.17-0.23	0.35-0.75	0.15-0.35	1.55-2.00		0.20-0.30
H 46210	4621 H	0.17-0.23	0.60-1.00	0.15-0.35	1.55-2.00		0.20-0.30
H 46260	4626 H	0.23-0.29	0.40-0.70	0.15-0.35	0.65-1.05		0.15-0.25
11.47400	474011	0.45, 0.04	0.00.005	0.45.005	0.05.4.05	0.00.000	0.00 0.40
H 47180	4718 H	0.15-0.21	0.60-0.95	0.15-0.35	0.85–1.25	0.30-0.60	0.30-0.40
H 47200	4720 H	0.17-0.23	0.45-0.75	0.15-0.35	0.85–1.25	0.30-0.60	0.15–0.25
H 48150	4815 H	0.12-0.18	0.30-0.70	0.15-0.35	3.20-3.80		0.20-0.30
H 48170	4817 H	0.14-0.20	0.30-0.70	0.15-0.35	3.20-3.80		0.20-0.30
H 48200	4820 H	0.17-0.23	0.40-0.80	0.15-0.35	3.20–3.80		0.20-0.30
H 50401	50B40 H ^C	0.37-0.44	0.65-1.10	0.15-0.35		0.30-0.70	
H 50441	50B44 H ^C	0.42-0.49	0.65-1.10	0.15-0.35		0.30-0.70	
H 50460	5046 H	0.43-0.50	0.65-1.10	0.15-0.35		0.13-0.43	
H 50461	50B46 H ^C	0.43-0.50	0.65-1.10	0.15-0.35		0.13-0.43	
H 50501	50B50 H ^C	0.47-0.54	0.65-1.10	0.15-0.35		0.30-0.70	
H 50601	50B60 H ^C	0.55-0.65	0.65-1.10	0.15-0.35		0.30-0.70	
L 51000	E100 H	0.17.0.00	0.60-1.00	0.15 0.25		0.60 1.00	
H 51200	5120 H	0.17-0.23		0.15-0.35		0.60–1.00	
H 51300	5130 H	0.27-0.33	0.60-1.00	0.15-0.35	•••	0.75–1.20	•••
H 51320	5132 H	0.29-0.35	0.50-0.90	0.15-0.35		0.65–1.10	
H 51350	5135 H	0.32-0.38	0.50-0.90	0.15-0.35	***	0.70-1.15	
H 51400	5140 H	0.37-0.44	0.60-1.00	0.15-0.35		0.60-1.00	
H 51450	5145 H	0.42-0.49	0.60-1.00	0.15-0.35		0.60-1.00	
H 51470	5147 H	0.45-0.52	0.60-1.05	0.15-0.35		0.80-1.25	
H 51500	5150 H	0.47-0.54	0.60-1.00	0.15-0.35		0.60-1.00	
H 51550	5155 H	0.50-0.60	0.60-1.00	0.15-0.35	•••	0.60-1.00	
H 51600	5160 H	0.55-0.65	0.65-1.10	0.15-0.35		0.60-1.00	
H 51601	51B60H ^C	0.55-0.65	0.65–1.10	0.15-0.35		0.60-1.00	
11.044.00	0440.110	0.45.004	0.40.000	0.45.005		0.40.000	
H 61180	6118 H ^D	0.15-0.21	0.40-0.80	0.15-0.35	•••	0.40-0.80	***
H 61500	6150 H ^E	0.47–0.54	0.60-1.00	0.15-0.35		0.75–1.20	
H 81451	81B45 H ^C	0.42-0.49	0.70-1.05	0.15-0.35	0.15-0.45	0.30-0.60	0.08-0.15
H 86170	8617 H	0.14-0.20	0.60-0.95	0.15-0.35	0.35-0.75	0.35-0.65	0.15-0.25

TABLE 1 Continued

UNS	Crada Danismatian			Chemical Cor	nposition, %		
Designation ^A	Grade Designation	Carbon	Manganese	Silicon	Nickel	Chromium	Molybdenum
H 86200	8620 H	0.17-0.23	0.60-0.95	0.15-0.35	0.35-0.75	0.35-0.65	0.15-0.25
H 86220	8622 H	0.19-0.25	0.60-0.95	0.15-0.35	0.35-0.75	0.35-0.65	0.15-0.25
H 86250	8625 H	0.22-0.28	0.60-0.95	0.15-0.35	0.35-0.75	0.35-0.65	0.15-0.25
H 86270	8627 H	0.24-0.30	0.60-0.95	0.15-0.35	0.35-0.75	0.35-0.65	0.15-0.25
H 86300	8630 H	0.27-0.33	0.60-0.95	0.15-0.35	0.35-0.75	0.35-0.65	0.15-0.25
H 86301	86B30 H	0.27-0.33	0.60-0.95	0.15-0.35	0.35-0.75	0.35-0.65	0.15-0.25
H 86370	8637 H	0.34-0.41	0.70-1.05	0.15-0.35	0.35-0.75	0.35-0.65	0.15-0.25
H 86400	8640 H	0.37-0.44	0.70-1.05	0.15-0.35	0.35-0.75	0.35-0.65	0.15-0.25
H 86420	8642 H	0.39-0.46	0.70-1.05	0.15-0.35	0.35-0.75	0.35-0.65	0.15-0.25
H 86450	8645 H	0.42-0.49	0.70-1.05	0.15-0.35	0.35-0.75	0.35-0.65	0.15-0.25
H 86451	86B45 H ^C	0.42-0.49	0.70-1.05	0.15-0.35	0.35-0.75	0.35-0.65	0.15-0.25
H 86500	8650 H	0.47-0.54	0.70-1.05	0.15-0.35	0.35-0.75	0.35-0.65	0.15-0.25
H 86550	8655 H	0.50-0.60	0.70-1.05	0.15-0.35	0.35-0.75	0.35-0.65	0.15-0.25
H 86600	8660 H	0.55-0.65	0.70-1.05	0.15-0.35	0.35-0.75	0.35-0.65	0.15-0.25
H 87200	8720 H	0.17-0.23	0.60-0.95	0.15-0.35	0.35-0.75	0.35-0.65	0.20-0.30
H 87400	8740 H	0.37-0.44	0.70-1.05	0.15-0.35	0.35-0.75	0.35-0.65	0.20-0.30
H 88220	8822 H	0.19-0.25	0.70-1.05	0.15-0.35	0.35-0.75	0.35-0.65	0.30-0.40
H 92600	9260 H	0.55-0.65	0.65-1.10	1.70-2.20			
H 93100	9310 H	0.07-0.13	0.40-0.70	0.15-0.35	2.95–3.55	1.00-1.45	0.08-0.15
H 94151	94B15 H ^C	0.12-0.18	0.70-1.05	0.15-0.35	0.25-0.65	0.25-0.55	0.08-0.15
H 94171	94B17 H ^C	0.14-0.20	0.70-1.05	0.15-0.35	0.25-0.65	0.25-0.55	0.08-0.15
H 94301	94B30 H ^C	0.27-0.33	0.70-1.05	0.15-0.35	0.25-0.65	0.25-0.55	0.08-0.15

A New designations established in accordance with Practice E527 and SAE J 1086, Recommended Practice for Numbering Metals and Alloys (UNS).

TABLE 2 Chemical Requirements of Carbon H-Steels^A

			Che	emical Composition, %		
UNS Designation ^B	Grade Designation	Carbon	Manganese	Phosphorus, max	Sulfur, max	Silicon
H 10380	1038 H	0.34-0.43	0.50-1.00	0.040	0.050	0.15-0.35
H 10450	1045 H	0.42-0.51	0.50-1.00	0.040	0.050	0.15-0.35
H 15220	1522 H	0.17-0.25	1.00-1.50	0.040	0.050	0.15-0.35
H 15240	1524 H	0.18-0.26	1.25-1.75	0.040	0.050	0.15-0.35
H 15260	1526 H	0.21-0.30	1.00-1.50	0.040	0.050	0.15-0.35
H 15410	1541 H	0.35-0.45	1.25-1.75	0.040	0.050	0.15-0.35
H 15211 ^C	15B21 H ^C	0.17-0.24	0.70-1.20	0.040	0.050	0.15-0.35
H 15351 ^C	15B35 H ^C	0.31-0.39	0.70-1.20	0.040	0.050	0.15-0.35
H 15371 ^C	15B37 H ^C	0.30-0.39	1.00-1.50	0.040	0.050	0.15-0.35
H 15411 ^C	15B41 H ^C	0.35-0.45	1.25-1.75	0.040	0.050	0.15-0.35
H 15481 ^C	15B48 H ^C	0.43-0.53	1.00-1.50	0.040	0.050	0.15-0.35
H 15621 ^C	15B62 H ^C	0.54-0.67	1.00-1.50	0.040	0.050	0.40-0.60

^A Standard H Steels can be produced with a lead range of 0.15–0.35 %. Such steels are identified by inserting the letter "L" between the second and third numerals of the grade designation, for example, 15L22 H. Lead is generally reported as a range of 0.15–0.35 %.

- 4.4 Two points from the tabulated values are commonly designated according to one of Methods A, B, C, D, or E, which are defined in the following paragraphs. Those various methods are illustrated graphically in Fig. 1.
- 4.4.1 *Method A*—The minimum and maximum hardness values at any desired distance. This method is illustrated in Fig. 1 as points *A-A* and would be specified as 43 to 54 HRC at J3. Obviously the distance selected would be that distance on the end quench test bar that corresponds to the section used by the purchaser.
- 4.4.2 Method B—The minimum and maximum distances at which any desired hardness value occurs. This method is illustrated in Fig. 1 as points B-B and would be specified as 39 HRC at J4 minimum and J9 maximum. If the desired hardness does not fall on an exact sixteenth position, the minimum distance selected should be the nearest sixteenth position toward the quenched end and the maximum should be the nearest sixteenth position away from the quenched end.
- 4.4.3 *Method C*—Two maximum hardness values at two desired distances, illustrated in Fig. 1 as points *C-C*.

^B Sulfur content range is 0.035 to 0.050 %.

^C These steels can be expected to have a 0.0005 % min boron content.

^D Vanadium content range is 0.10 to 0.15 %.

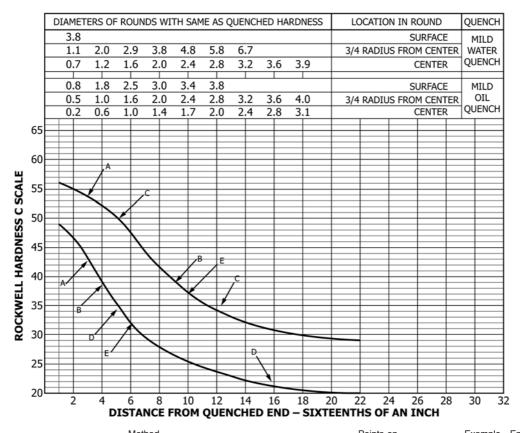
E Minimum vanadium content is 0.15 %.

B New designations established in accordance with Practice E527 and SAE J 1086, Recommended Practice for Numbering Metals and Alloys (UNS).

 $^{^{\}it C}$ These steels can be expected to have 0.0005 % min boron content.



Hardenability Band



	Method	Points on	Example—End Quench
		Charts	Hardenability
Α	Minimum and maximum hardness values at a designated distance	A-A	HRC 43 to 54 at J3
В	A hardness value at minimum and maximum distances	B-B	HRC 39 at J4 minimum and J9 maximum
С	The maximum hardness values at two designated distances	C-C	HRC50 at J5 maximum
			HRC 34 at J12 maximum
D	Two minimum hardness values at two distances	D-D	HRC 35 at J5 minimum
			HRC 21 at J16 minimum
E	Any minimum hardness plus any maximum hardness	E-E	HRC 32 at J6 minimum
			HBC 37 at J10 maximum

FIG. 1 Examples Illustrating Alternative Method of Specifying Hardenability Requirements (tabulated hardness values are used in ordering)

- 4.4.4 *Method D*—Two minimum hardness values at two desired distances, illustrated in Fig. 1 as points *D-D*.
- 4.4.5 *Method E*—Any minimum hardness plus any maximum hardness.
- 4.4.6 When hardenability is specified according to one of the above Methods A to E, the balance of the hardenability band is not applicable.
- 4.5 In cases when it is considered desirable, the maximum and minimum limits at a distance of $\frac{1}{16}$ in. from the quenched end can be specified in addition to the other two points as previously described in 4.4.1 4.4.5, inclusive.
- 4.6 In cases when it is necessary to specify more than two points on the hardenability band (exclusive of the maximum and minimum limits at a distance of ½16 in.), a tolerance of two points Rockwell C (HRC) over any small portion of either curve (except at a distance of ½16 in.) is customary. This tolerance is necessary because curves of individual heats vary

somewhat in shape from the standard band limits and thus deviate slightly at one or more positions in the full length of the curves.

5. Manufacture

- 5.1 *Melting Practice*—The steel shall be made by any commercially accepted process.
- 5.2 Slow Cooling—Immediately after hot working, the bars shall be allowed to cool when necessary to a temperature below the critical range under suitable conditions, to prevent injury by too rapid cooling.

6. General Requirements

6.1 Material furnished under this specification shall conform to the applicable requirements of the current edition of Specification A29/A29M or A108, unless otherwise provided for in this specification.

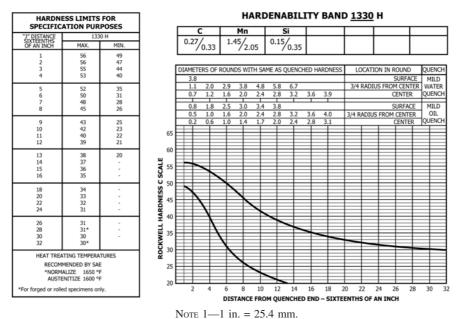


FIG. 2 Limits for Hardenability Band 1330 H

			<u>1335</u> I	BAND	TY	BILI	ENA	KD	HA						SS LIMITS	
						i	S		Mn			С	[SPECIFICA
						, 0.35	0.15/)5	15/2.0	1.4	, 0.38	0.32/		S H MIN.	1335 MAX.	")" DISTANCE SIXTEENTHS OF AN INCH
QUEN	_	IN ROUND	LOCATI	RDNESS	HED HA	UENC	ME AS (TH SA	DS WI	ROUN		DIAMETE 3.8		51 49 47 44	58 57 56 55	1 2 3 4
WATE QUEN MILE OIL	ER ACE	CENTER SURFACE	3/4 RADIU	3.9	3.6	6.7 3.2 3.2	5.8 2.8 3.8 2.8	4.8 2.4 3.4 2.4	3.8 2.0 3.0 2.0	2.9 1.6 2.5 1.6	1.2 1.8 1.0	0.7 0.8 0.5		38 34 31 29	54 52 50 48	5 6 7 8
QUEN		CENTE	3/10/0103	3.1	2.8	2.4	2.0	1.7	1.4	1.0	0.6	0.2	65	27 26 25 24	46 44 42 41	9 10 11 12
											\		60 55 50 50	23 22 22 21	40 39 38 37	13 14 15 16
								\			\setminus		HARDNESS C	20 - - -	35 34 33 32	18 20 22 24
				_	\					\setminus			35 KWELL	:	31 31 30 30	26 28 30 32
							•	\					25 20		TING TEMPERAT MENDED BY SAE ILIZE 1600 °F NITIZE 1550 °F	RECOMM *NORMA
30	28		0 22 ENTHS OF A		16	14	12	10	8	6	4	2		ly.	d specimens on	or forged or rolled

Note-1 in. = 25.4 mm. FIG. 3 Limits for Hardenability Band 1335 H

7. Chemical Composition

- 7.1 The heat analysis shall conform to the requirements as to chemical composition prescribed in Tables 1 and 2 for the grade specified by the purchaser.
- 7.2 When a steel cannot be identified by a standard grade number in accordance with Tables 1 and 2, other compositions may be specified, as agreed upon between the purchaser and the manufacturer. Generally, hardenability bands will not be available for such compositions.
- 7.3 When requested by the manufacturer, and approved by the purchaser, other steels capable of meeting the purchaser's

specified hardenability may be furnished in place of the grade specified by the purchaser.

8. Grain Size Requirements

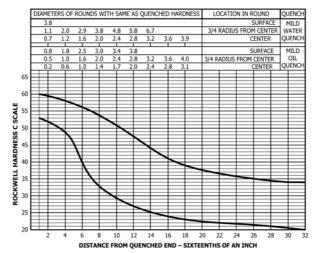
- 8.1 The steel shall conform to the fine austenitic grain size requirement of Specification A29/A29M.
- 8.2 Hardenability values specified in this specification are based on fine-grain steels and are not applicable to coarse-grain material. In case coarse-grain steel is desired, the hardenability values shall be negotiated between the purchaser and the manufacturer.



	ESS LIMITS ATION PUR	
"J" DISTANCE SIXTEENTHS		Ю Н
OF AN INCH	MAX.	MIN.
1	60	53
2	60	52
3	59	51
4	58	49
5	57	46
6	56	40
7	55	35
8	54	33
9	52	31
10	51	29
11	50	28
12	48	27
13	46	26
14	44	25
15	42	25
16	41	24
18	39	23
20	38	23
22	37	22
24	36	22
26	35	21
28	35	21
30	34	20
32	34	20
RECOM *NORM	TING TEMPERA MENDED BY SA ALIZE 1600 ° ENITIZE 1550 °	E F

HARDENABILITY BAND 1340 H

[С	Mn	Si		
	0.37/0.44	1.45/2.05	0.15/0.35		



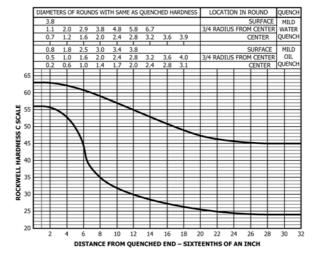
Note-1 in. = 25.4 mm.

FIG. 4 Limits for Hardenability Band 1340 H

SPECIFIC	ESS LIMITS ATION PUR	POSES
"J" DISTANCE	134	5 H
SIXTEENTHS OF AN INCH	MAX.	MIN.
1	63	56
2	63	56
3	62	55
4	61	54
5	61	51
6	60	44
7	60	38
8	59	35
9	58	33
10	57	32
11	56	31
12	55	30
13	54	29
14	53	29
15	52	28
16	51	28
18	49	27
20	48	27
22	47	26
24	46	26
26	45	25
28	45	25
30	45	24
32	45	24
RECOM *NORM	ENITIZE 1550 °	E F

HARDENABILITY BAND 1345 H

ı	С	Mn	Si		
	0.42/0.49	1.45/2.05	0.15/0.35		



Note-1 in. = 25.4 mm.

FIG. 5 Limits for Hardenability Band 1345 H

9. End-Quench Hardenability Requirements

- 9.1 The end-quench hardenability shall conform to the requirements specified on the purchase order.
- 9.2 The hardenability values shall be specified in accordance with the applicable values in Figs. 2-87 inclusive for the grade specified. See Fig. 1 for method of specifying hardenability.
- 9.3 When agreed upon between the purchaser and manufacturer, special hardenability limits may be ordered and shall be reflected on the purchase order.

10. Test Specimens

- 10.1 *Number and Location*—The number and location of test specimens shall be in accordance with the manufacturer's standard practice and shall adequately represent the hardenability of each heat.
- 10.2 *Thermal Treatment*—All forged or rolled hardenability test specimens must be normalized prior to testing. Cast specimens need not be normalized.

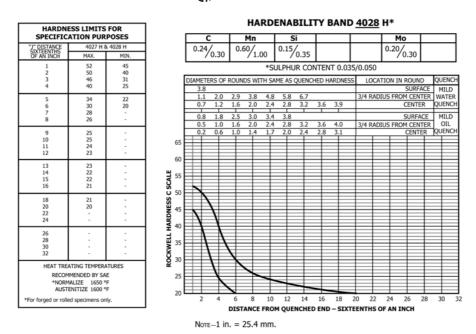


FIG. 6 Limits for Hardenability Band 4027 H and 4028 H

	Мо				i	S		Mn		С					SPECIFICA
	0.20/0.30		\neg	Т	0.35	0.15		.60/	. 0.	29/00	0.2		MIN.	403 MAX.	D" DISTANCE SIXTEENTHS OF AN INCH
QUEN	ION IN ROUND	LOCATI	ARDNESS	IED H				IDS WI	_		DIAME 3.		50 45 36 29	57 54 51 46	1 2 3 4
WATE QUENC	JS FROM CENTER CENTER SURFACE		3.9	3.6	6.7 3.2	5.8 2.8 3.8	4.8 2.4 3.4	3.8 2.0 3.0	2.9 1.6 2.5	1 2.0 7 1.2 8 1.8	1. 0. 1		25 23 22 21	39 34 31 29	5 6 7 8
QUEN	JS FROM CENTER CENTER	3/4 RADIU	3.1	3.6 2.8	2.4	2.8	1.7	1.4	1.6		0.	65	20	28 26 26 25	9 10 11 12
											N	60 55 55	:	24 24 23 23	13 14 15 16
										/	١	RDNESS C		23 22 22 21	18 20 22 24
									\setminus	\setminus		35 KWELL		21 20 - -	26 28 30 32
						Ļ	\					2 5	E F	TING TEMPERA MENDED BY SAI ALIZE 1650 ° NITIZE 1600 °	RECOMM *NORMA

Note-1 in. = 25.4 mm. FIG. 7 Limits for Hardenability Band 4032 H

11. Test Methods

- 11.1 Grain Size—Test Methods E112.
- 11.2 End-Quench Hardenability—Test Method A255.

12. Certification and Reports of Testing

12.1 When the full H-band is specified for alloy steels, the hardenability can be reported by listing hardness values at the following distances from the quenched end of the test specimen: 1 through 16 sixteenths, then 18, 20, 22, 24, 28, and 32 sixteenths of an inch.

12.2 Tables 2-18 in Test Methods A255 are to be used to calculate hardenability from the chemical ideal diameter for the grades shown in 10.1 of Test Methods A255. Hardenability results are to be reported for the first 10 sixteenths (16 mm), then 12, 14, 16, 18, 20, 24, 28, and 32 sixteenths of an inch.

Note 2—The reporting hardenability using the calculated method differs from the procedure shown in 6.4 of Test Methods A255.

12.3 For carbon H-steels, distances from the quenched end may be reported by listing sixteenths or half sixteenths (rather than full sixteenths only as with alloy steels). Units of



	SS LIMITS					- 1	IARI	DENA	BIL	ITY	BAN	D <u>40</u>	<u>37</u> F	1			
	ATION PURE				:	М	n	9	Si				\Box	Mo)		
")" DISTANCE SIXTEENTHS OF AN INCH	MAX.	MIN.		0.34	0.41	0.60	1.00	0.15	0.35				0	0.20/	0.30		
1 2 3 4	59 57 54 51	52 49 42 35		DIAMET	ERS OF	ROUNDS	WITH S	AME AS	QUENC	HED H	ARDNES	S LO	CATIO		OUND	QUE	_
5 6 7 8	45 38 34 32	30 26 23 22		1.1 0.7 0.8	2.0 1.2 1.8	1.6 2 2.5 3	.8 4.3 .0 2.4 .0 3.4	4 2.8 4 3.8	6.7 3.2	3.6	3.9			9	CENTER CENTER SURFACE	QUE!	TER NCI-
9 10 11 12	30 29 28 27	21 20 -	6		0.6		.0 2.		3.2 2.4	3.6	3.1	3/4	RADIUS		CENTER		
13 14 15 16	26 26 26 25	:	SCALE	5	V												
18 20 22 24	25 25 25 24	:	RDNESS C	5	\backslash	\											
26 28 30 32	24 24 23 23	:	ROCKWELL HARDNESS C SCALE	5	\setminus												
RECOMM *NORMA	FING TEMPERAT TENDED BY SAE LIZE 1600 °F NITIZE 1550 °F	URES	2 2	5	ľ			\									
For forged or rolled	d specimens onl	у.	_	2	4	6 DISTAN	8 10		14	16	18				26 28	30	

 $N_{\text{OTE}-1}$ in. = 25.4 mm. FIG. 8 Limits for Hardenability Band 4037 H

	ESS LIMITS ATION PURI					DENABIL	ITY BANI	4042		
"J" DISTANCE	404	2 H		C	Mn	Si	$\overline{}$		Мо	
SIXTEENTHS OF AN INCH	MAX.	MIN.		0.39/	0.60/	0.15		0	.20/	
1	62	55		/ 0.46	/ 1.00	/ 0.35			/ 0.30	
2	60	52								
3	58 55	48 40		3.8	UNDS WITH SAME	AS QUENCHED I	HARDNESS	LOCATI	ON IN ROUND	QUENC
5	50	33		1.1 2.0	2.9 3.8 4.8	3 5.8 6.7		3/4 PAD	SURFAC SIUS FROM CENT	
6	50 45	33 29			1.6 2.0 2.4		3.6 3.9	3/4 KAL	CENTER	
7	39	29					3.0 3.5			_
8	36	26		0.8 1.8	2.5 3.0 3.4		26 40	2/4 2 4 2	SURFAC	
9	34	25		0.5 1.0 0.2 0.6	1.6 2.0 2.4 1.0 1.4 1.7		3.6 4.0 2.8 3.1	3/4 RAD	IUS FROM CENT CENTER	
10	33	24		0.2 0.6	1.0 1.4 1.7	2.0 2.4	2.0 3.1		CENTER	QUENC
11	32	24	65		\rightarrow	\rightarrow	\rightarrow		\vdash	_
12	31	23								
13	30	23	 60		-					
14	30	23	SCALE 55		\perp	\rightarrow				
15	29	22	<u>ප</u> 55	\wedge	-	\rightarrow	+			
16	29	22	U	X 1						
18	28	22	HARDNESS 64 70							
20	28	21	2 45	++	V	\rightarrow	\rightarrow		\vdash	_
22	28	20	& 43		\					
24	27	20	¥ 40	\rightarrow	\rightarrow	\rightarrow	\rightarrow		\vdash	=
26	27	-	∃ **							
28	27	-	₩ 35	1 N		\rightarrow	\rightarrow			
30	26	-	₹ 33	\perp						
32	26	-	35 30 30							
HEAT TREAT	ING TEMPER	ATURES	≥ 30							_
RECOM	MENDED BY S	SAE	25							=
*NORMA	ALIZE 1600	°F		+	1	$\overline{}$			\vdash	=
	NITIZE 1550		20							
or forged or	rolled speci	mens only.	20	2 4	6 8 10	12 14	16 18 2	20 22	24 26 2	30
				DIS	STANCE FROM	4 QUENCHED	END - SIXT	EENTHS C	F AN INCH	
				Note-1 in.		-				

FIG. 9 Limits for Hardenability Band 4042 H

sixteenths rather than thirty-seconds are followed for all steels to avoid misunderstanding. When the full H-band is specified half sixteenths through 8 may be reported, as well as the distances listed in 12.1.

13. Keywords

13.1 alloy steel bars; carbon steel bars; end quench hardenability; steel bars

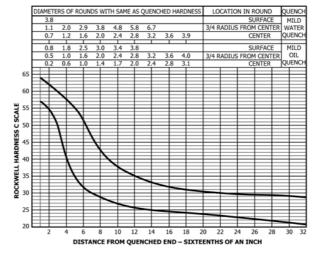


HARDNESS LIMITS FOR SPECIFICATION PURPOSES 64 62 60 58 57 55 50 42 55 52 47 43 35 32 30 28 40 38 37 35 9 10 11 12 28 27 13 14 15 16 34 33 33 32 25 25 25 25 31 30 30 30 24 24 23 23 18 20 22 24 30 29 29 29 26 28 30 32 22 22 21 21 HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1600 °F AUSTENITIZE 1550 °F

*For forged or rolled specimens only

HARDENABILITY BAND 4047 H

	:	Mn	Si		Мо	
0.44	/ 0.51	0.60/1.00	0.15/0.35		0.20/0.30	

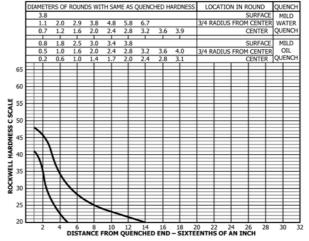


Note-1 in. = 25.4 mm.

FIG. 10 Limits for Hardenability Band 4047 H

HARDENABILITY BAND 4118 H

С	Mn	Si	Cr	Мо	
0.17/0.23	0.60/1.00	0.15/0.35	0.30/0.70	0.08/0.15	



Note-1 in. = 25.4 mm.

FIG. 11 Limits for Hardenability Band 4118 H



HEAT TREATING TEMPERATURES
RECOMMENDED BY SAE
*NORMALIZE 1650 °F
AUSTENITIZE 1600 °F

HARDNESS LIMITS FOR SPECIFICATION PURPOSES

*For forged or rolled specimens only

21 20

HARDENABILITY BAND 4130 H

С	Mn	Si	Cr	Мо	
0.27/0.33	0.30/0.70	0.15/0.35	0.75/1.20	0.15/0.25	

D		RS OF	ROUNE	S WIT	'H SAM	E AS Q	UENCH	IED HA	RDNESS	LOC	CATION				UENCH
F	3.8	2.0	2.9	3.8	4.8	5.8	6.7			2/4 D	ADIUS		URFAC		MILD VATER
_ h	0.7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9	3/4 K	AD103		NTER		UENCH
F	0.8	1.8	2.5	3.0	3.4	3.8						SL	JRFACE		MILD
	0.5	1.0	1.6	2.0	2.4	2.8	3.2	3.6	4.0	3/4 R	ADIUS			ER	OIL
	0.2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1			С	ENTER	q	UENCH
65		-	=	-	-	=	-	-							
60															
55	K														
55 50 SOCKWELL HARDNESS 20 SCALE		\setminus													
45	\mathbb{N}		1												
40		V		•	\blacksquare										
35							•								
30		#	\rightarrow		+	#	#	#							Ħ
25		Ŧ	ŧ	Î	*	+	-								F
20 E	2	4	6	8	10	12	14	16	18	20 2	2 2	4 2	6 2	8	30

Note-1 in. = 25.4 mm.

FIG. 12 Limits for Hardenability Band 4130 H

HARDENABILITY BAND 4135 H

Г	С	Mn	Si	Cr	Мо	
	0.32/0.38	0.60/1.00	0.15/0.35	0.75/1.20	0.15/0.25	

1 2	58 58	51 50																
3	57 56	49		DIAMET	ERS OF	ROUN	DS WIT	'H SAN	1Ε AS Q	UENCH	HED HA	RDNESS	LC	CATI	NI NC	ROUND	QU	JENCH
4	56	48		3.8												SURFA		4ILD
5	56	47	l	1.1	2.0	2.9	3.8	4.8	5.8	6.7			3/4 F	PADIU	S FRO	M CENT		ATER
6 7	55 54	45	l	0.7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9	-			CENT	ER QL	JENCH
8	54 53	42 40		0.8	1.8	2.5	3.0	3.4	3.8							SURFA		4ILD
			ł	0.5	1.0	1.6	2.0	2.4	2.8	3.2	3.6	4.0	3/4 F	PADIU	S FRO	M CENT		OIL
9 10	52 51	38 36	l	0.2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1	-	_	_	CENT	ERIQU	JENCH
11	50	34	65		-	-	_	\pm		-	-							
12	49	33																
13	48	32	60	'				\pm										
14	47	31	3 55		\rightarrow		=	\pm	=		\pm	=						
15 16	46 45	30 30	SCALE SCALE		=	7	$\overline{}$	=	-	-	-							
16	45	30	S 50			_		`										
18	44	29			\rightarrow	\pm			_	\blacksquare								
20 22	42 41	28 27	₩ 45	; 	=	\vee	_	\pm	_	-	_	4						
24	40	27	HARDNESS		_	-		-	_	-	-	\mathbf{r}						
		27				-	\mathbf{X}	\pm							$\overline{}$	_		
26 28	39 38	27 26	#					V										
30	38	26	₩ 35	·	_	_	_	₽	\checkmark	-	_	=			=			=
32	37	26	SOCKWELL 30 30							$\overline{}$								
HEAT TRE	ATING TEMPERA	ATURES	2 30	'===		=		=				$\overline{}$						
RECOM	MENDED BY SA	E	25															
	MALIZE 1600 °		"			_	_	\pm										
	ENITIZE 1550 °		20	Щ	_	_	_	_										
*For forged or rolle	ed specimens or	ily.		2	4	6	8	10	12	14	16						8 3	30 32
						DISIA	ANCE	FROM	ı QUEF	CHEL	CND	SIXTE	CHIH	3 UF	WLI TU	CH		

Note-1 in. = 25.4 mm.

FIG. 13 Limits for Hardenability Band 4135 H



HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1600 °F AUSTENITIZE 1550 °F For forged or rolled specimens only

HARDNESS LIMITS FOR SPECIFICATION PURPOSES MAX. 60 60 59

HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1600 °F AUSTENITIZE 1550 °F *For forged or rolled specimens only

HARDENABILITY BAND 4137 H

-	С	Mn	Si	Cr	Мо	
	0.34/0.41	0.60/1.00	0.15/0.35	0.75/1.20	0.15/0.25	

	DL			S OF	ROUN	DS WI	TH SAN	1E AS (QUENC	HED H	ARDNESS	L	CATI		ROUND		QUEN
	ㄴ	3.8										1			SURFAC		MILE
	⊢	1.1		2.0	2.9	3.8	4.8	5.8	6.7	0.6	2.0	3/4	RADIU		M CENT		WATE
	⊢	0.7	_	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9	+			ENTER		QUEN
	Г	0.8	3	1.8	2.5	3.0	3.4	3.8						9	URFAC	Έ	MILE
		0.5		1.0	1.6	2.0	2.4	2.8	3.2	3.6	4.0	3/4	RADIU		M CENT		OIL
	匚	0.2	2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1	\perp			CENTER	R	QUEN
65	Ħ	=		+	\pm	_	_	_	_	_	_					ŧ	-
		=		+	-	-	-	-	-	-						F	
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35									/	_							
30	\equiv			\pm	\pm	=	=	=	=	\equiv	_	-				E	=
30	Е	=		\equiv	=	=	=	=	=	=							_
25		\equiv		\pm	\pm	=	=									⇇	
-3	Ħ	1			+	=	_	-	-	-							-
20					\equiv												
		2		4	6	8	10	12	14	16	18	20	22	24	26 2	28	30

Note-1 in. = 25.4 mm.

FIG. 14 Limits for Hardenability Band 4137 H

HARDENABILITY BAND 4140 H

c	Mn	Si	Cr	Мо	
0.37/0	.44 0.65/1	.10 0.15/0.35	0.75/	0.15/0.25	

1.1 0.7 0.8 0.5 0.2	1.2 1.8 1.0 0.6	2.9 1.6 2.5 1.6 1.0	3.8 2.0 3.0 2.0 1.4	3.4 2.4 1.7	5.8 2.8 3.8 2.8 2.0	3.2 2.4	3.6 2.8	3.9 4.0 3.1		RADIU	S FRO	URF	ER ACE NTER	QUEN
0.8	1.8	2.5	3.0	3.4	3.8	3.2	3.6	4.0	3/4	RADIU	S FRO	URF M CE	ACE NTER	MIL
0.5	1.0	1.6	2.0	2.4	2.8				3/4	RADIU	S FRO	M CE	NTER	OII
0.5	1.0	1.6	2.0	2.4	2.8				3/4	RADIU	S FRO	M CE	NTER	OII
									,,,,					QUEN
	_													
	<u> </u>		•		_									
	<u>+</u>		\		_	_								
-	_			1	4	4	4							
	\			=		\neg	$\overline{}$		_	_	_			
	\blacksquare	$\overline{}$	-								-			_
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	\mp	\pm	#	#	#	#	#	\pm				F	#	+
Ų.		_												30
	2	_											2 4 6 8 10 12 14 16 18 20 22 24 26 DISTANCE FROM QUENCHED END - SIXTEENTHS OF AN INCH	

Note-1 in. = 25.4 mm.

FIG. 15 Limits for Hardenability Band 4140 H



60 60

51 51 50 HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1600 °F AUSTENITIZE 1550 °F *For forged or rolled specimens only.

HARDNESS LIMITS FOR SPECIFICATION PURPOSES

55 55 54 HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1600 °F AUSTENITIZE 1550 °F *For forged or rolled specimens only.

4142 H

")" DISTANCE SIXTEENTHS OF AN INCH

HARDENABILITY BAND 4142 H

С	Mn	Si	Cr	Мо	
0.39/0.46	0.65/	0.15/0.35	0.75/1.20	0.15/0.25	

⊢	0.7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9	\perp			CENT	ER	QUEN
	0.8	1.8	2.5	3.0	3.4	3.8							SURF		MIL
\vdash	0.5	0.6	1.6	2.0	1.7	2.8	3.2 2.4	3.6 2.8	4.0 3.1	3/4	RADIL	JS FR	OM CE CENT		QUEN
65		Ï	Ï	Ť	Ï	Ï	Ť	Ī	Ť			I	Ī	Ì	Έ
60	⊨	+	4		1	1	1							\pm	
55			#			+	+	\downarrow							
		•	\downarrow								Ė	╆	4		
50		#		\rightarrow		#	#		+			ŧ		#	
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55 50 45 40 35		#	#	\mp	#	Ŧ	ightharpoonup	\blacksquare		╞	F	ŧ		#	
								ľ	ightharpoons	+	_				
35														F	
35 30		+	+	=		=	_	-	_						

Note-1 in. = 25.4 mm.

FIG. 16 Limits for Hardenability Band 4142 H

HARDENABILITY BAND 4145 H

С	Mn	Si	Cr	Мо	
0.42/0.49	0.65/1.10	0.15/0.35	0.75/1.20	0.15/0.25	

	DIAMET 3.8		NOUN	DJ 111	iii aru	IL NO	ZOEI1C	ILD II	THE STATE	~ -	oon!	0.41	N ROUN SURF#		QUE M
	1.1	2.0	2.9	3.8	4.8	5.8	6.7			3/4	RADIU	JS FR	OM CEN	ITER	WA
	0.7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9				CENTE	R	QUE
	0.8	1.8	2.5	3.0	3.4	3.8	_	_		+			SURFA	\CE	M
	0.5	1.0	1.6	2.0	2.4	2.8	3.2	3.6	4.0	3/4	RADII	JS FR	OM CEN		1 "
	0.2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1	10/.			CENTE		QUE
65		=					\equiv	=				\equiv		=	\equiv
	-	_					\pm					\pm		\pm	=
60	=		\blacksquare	\rightarrow	-	_	ᆂ	\pm	=	\pm		\pm		\pm	\equiv
	\vdash	_	-	-	-	-	\equiv	$\overline{}$	$\overline{}$	_		+		+	=
55		$\overline{}$						=			\equiv	+	-	+	-
			\rightarrow	$\overline{}$		\pm	\pm					\pm		\pm	⇉
50	\vdash	=	\pm		\rightarrow	$ \leftarrow $	\pm	\pm	=	\pm	=	\pm	=	\pm	\equiv
45		=	-	-	-	_		=	_			-		+	=
45							\rightarrow	_						=	=
40							_	1	◂						=
	=	\pm	\pm	\pm	\pm	\pm	\pm	\pm		┪		\pm		\pm	⇉
35	\vdash	=	_	=	=	\rightarrow	+	=	=	+		+	$\overline{}$	-	
								=							=
	\vdash	\pm	_	_	=	\pm	\pm	\pm				\pm		\pm	=
30	-	=	=	\pm	=	\pm	\pm	=	=	\pm	=	+	=	+	=
	-			_	=		-	=				=		=	\equiv
30 25		=	_	_											
		1													

Note-1 in. = 25.4 mm.

FIG. 17 Limits for Hardenability Band 4145 H



HARDNI	ESS LIMITS	FOR	1	UNS H4:	1470	Harder	nability Ba	nd	SAE/AIS	SI 4147H
SPECIFICA	ATION PUR	POSES		С	Mn	Si		Cr	Mo	
")" DISTANCE SIXTEENTHS OF AN INCH	414 MAX.	7 H MIN.]	.44/.51	.65/1.10	0.15/0.35		.75/1.20	.15/.25	
OF AN INCH			1				•			
2	64 64	57 57								
3 4	64 64	56 56			rounds with sa	me as-quench	ned hardness, ir	nches LOCA	ATION IN ROU	
,				2.4	3 4			3/4 DA	SUR DIUS FROM CE	FACE MILD NTER WATER
5 6	63 63	55 55		0.5 1		2.5 3	3.5 4	3)4 64	CEN	
7	63	55		1	2 3	4			SUR	FACE MILD
8	63	54		0.5 1	1.5 2	2.5 3	3.5 4		DIUS FROM CE	NTER OIL
9	63	54		0.5	1 1.	5 2	2.5 3	3.5	CEN	TER QUENCH
10 11	62 62	53 52	65							=
12	62	51	60							
13	61	49								
14 15	61 60	48 46	₹ 55		_		+			
16	60	45	Š				\perp			=
18	59	42	HARDNESS C SCALE							=
20	59	40	¥ 45							=
22 24	58 57	39 38	ARI							=
26	57	37	<u> </u>					\rightarrow		=
28	57	37	SOCKWELL 32 35				\perp			$\overline{}$
30 32	56 56	37 36	§ ~				\perp			\perp
			2 30				\blacksquare		\rightarrow	\blacksquare
	ATING TEMPE									\blacksquare
*NORN	AALIZE 1600	°F	25							=
AUST	ENITIZE 1550	°F	20							
*For forged or roll	led specimens	only.		2 4	6 8	10 12	14 16 18 CHED END - 5		24 26	28 30 32

FIG. 18 Limits for Hardenability Band 4147 H

			4150	ND	DAI	111	DIL		IKD								ESS LIMITS ATION PUR	
	lo	٨	Cr		\Box		\neg	Si	\perp	Mn		2	-			0 H	415	")" DISTANCE
	0.25	0.15	75/1.20	0.7			35	.15/0	٥١٥	5/1.1	0.6	/ 0.54	0.47			MIN.	MAX.	")" DISTANCE SIXTEENTHS OF AN INCH
QUEN		ON THE DE	LOCATIO	Eec	ADDNE	UED U					: DOLIA		DIAMET			59 59 59	65 65 65	1 2 3
MILE	URFACE		LOCATIO	233	ARDINE	HED H	SOCIAC	IL AS	ITI SAI	ID2 MI	KOUN	ERS O	3.8			58	65	4
		JS FROM	3/4 RADIU	\dashv	3.9	3.6	6.7 3.2	5.8 2.8	4.8 2.4	3.8	2.9	2.0	1.1			58 57	65 65	5 6
MILC	URFACE			=	$\overline{}$			3.8	3.4	3.0	2.5	1.8	0.8			57	65	7
			3/4 RADIU	\rightarrow	4.0	3.6	3.2	2.8	2.4	2.0	1.6	1.0	0.5			56	64	8
QUEN	NTER				3.1	2.8	2.4	2.0	1.7	1.4	1.0	0.6	0.2	65		56 55 54 53	64 64 64 63	9 10 11 12
									ļ	•				60 55	SCALE	51 50 48 47	63 62 62 62	13 14 15 16
				ļ	•	\								50	ROCKWELL HARDNESS C	45 43 41 40	61 60 59 59	18 20 22 24
														40 35	WELL HA	39 38 38	58 58 58	26 28 30
												#		30) GK	38	58	32
														25	e e	AE °F	TING TEMPERA MMENDED BY SA MALIZE 1600 (TENITIZE 1550 (RECOM *NORM
30	6 28	24 2	0 22	20	18	16	14	12	10	8	6	4	2	20				AUST For forged or rolle

Note-1 in. = 25.4 mm.

FIG. 19 Limits for Hardenability Band 4150 H



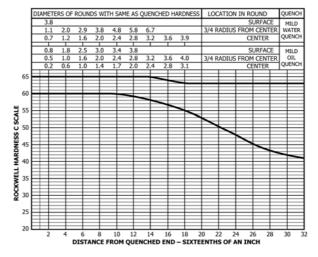
HARDNESS LIMITS FOR SPECIFICATION PURPOSES 3D TESTANCE 4161 H 4161 H 5161 H 51

HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1600 °F AUSTENITIZE 1550 °F

*For forged or rolled specimens only

HARDENABILITY BAND 4161 H

-	С	Mn	Si	Cr	Мо	
	0.55/0.65	0.65/1.10	0.15/0.35	0.65/0.95	0.25/0.35	



Note-1 in. = 25.4 mm.

FIG. 20 Limits for Hardenability Band 4161 H

	ESS LIMITS ATION PUR	
"3" DISTANCE SIXTEENTHS	432	0 H
OF AN INCH	MAX.	MIN.
1 2 3 4	48 47 45 43	41 38 35 32
5 6 7 8	41 38 36 34	29 27 25 23
9 10 11 12	33 31 30 29	22 21 20 20
13 14 15 16	29 27 27 26	:
18 20 22 24	25 25 24 24	
26 28 30 32	24 24 24 24	:
RECON *NORM	ATING TEMPERA IMENDED BY SA IALIZE 1700 ° ENITIZE 1700 ° ed specimens on	E F F

HARDENABILITY BAND 4320 H

С	Mn	Si	Ni	Cr	Мо	
0.17/0.23	0.40/0.70	0.15/0.35	1.55/2.00	0.35/0.65	0.20/0.30	

	DIAMETI 3.8	ERS OF	ROUN	DS WIT	TH SAN	1E AS (QUENC	HED H	ARDNESS	LO	CATIO		URFAC		MILD
	1.1	2.0	2.9	3.8	4.8	5.8	6.7			3/4 F	RADIUS				WATER
-	0.7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9			CI	NTER	Q	UENC
	0.8	1.8	2.5	3.0	3.4	3.8							URFAC		MILD
	0.5	1.0	1.6	2.0	2.4	2.8	3.2	3.6	4.0	3/4 (RADIUS			TER	OIL
F	0.2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1			_ a	NTER		UENC
65			=		=		-								=
60															E
55															⇟
				-			=								⇇
50		-	\pm	-	\pm	-	-	-							₽
45	N														
F		\rightarrow													=
40	N		\vee		\mp										=
35					=		-								₽
"E		V		\setminus											⇇
30		-			\rightarrow		-								⇇
55 50 45 40 35 30			V		-	\blacksquare	_								=
25				V.				\Box							⊨
20 E					*	_									
	2	4	6 DISTA	8	10	12	14	16			2 2			8	30

Note-1 in. = 25.4 mm.

FIG. 21 Limits for Hardenability Band 4320 H

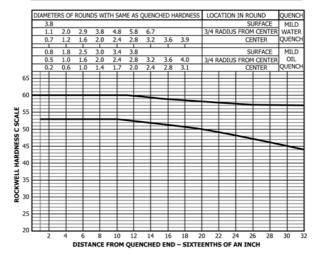


HEAT TREATING TEMPERATURES
RECOMMENDED BY SAE
*NORMALIZE 1600 °F
AUSTENITIZE 1550 °F

*For forged or rolled specimens only

HARDENABILITY BAND E4340 H

[С	Mn	Si	Ni	Cr	Мо	
	0.37/0.44	0.60/0.95	0.15/0.35	1.55/2.00	0.65/0.95	0.20/0.30	



Note-1 in. = 25.4 mm.

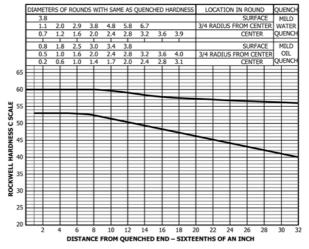
FIG. 22 Limits for Hardenability Band E 4340 H

HARDNESS LIMITS FOR SPECIFICATION PURPOSES "J" DISTANCE SIXTEENTHS OF AN INCH 60 60 53 53 53 60 60 53 53 52 60 59 59 52 51 51 12 14 15 16 58 58 58 49 49 48 20 22 24 57 57 57 46 45 44

22 57 45 24 57 44 26 57 43 28 56 42 30 56 41 32 56 40 HEAT TREATING TEMPERATURES RECOMMENDED BY SAE **NORMALIZE 1600 *F AUSTRAITIZE 1550 *F *For forced or rolled specimens only.

HARDENABILITY BAND 4340 H

I	С	Mn	Si	Ni	Cr	Мо	
	0.37/0.44	0.55/0.90	0.15/0.35	1.55/2.00	0.65/0.95	0.20/0.30	



Note-1 in. = 25.4 mm.

FIG. 23 Limits for Hardenability Band 4340 H



HARDENABILITY BAND 4419 H

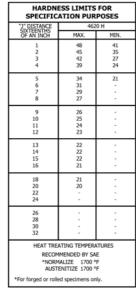
С	Mn	Si		Мо	
0.17/0.23	0.35/0.75	0.15/0.35		0.45/0.60	

	DI			RS O	ROUN	IDS WI	TH SAN	1E AS (QUENC	HED H	ARDNESS	LOC	ATION				QUEN
		3.													URFAC		MIL
	_	1.		2.0	2.9	3.8	4.8	5.8	6.7			3/4 R/	ADIUS			TER	
	_	0.	7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9	_		CE	NTER		QUEN
		0.	8	1.8	2.5	3.0	3.4	3.8						S	URFAC	Έ	MIL
		0.	5	1.0	1.6	2.0	2.4	2.8	3.2	3.6	4.0	3/4 R/	ADIUS	FRON	1 CENT	TER	OII
		0.	2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1			CE	NTER	_	QUEN
65				#	\pm	_	\pm	\pm	\pm	\pm	=		=				+
				+	=	-	\pm	-	\pm	=	=		=				\pm
60	П			#	=		-		-		=						+
	\equiv			#							=						
55	\equiv			#	=	_	\pm	=	\pm	=	=		=				\pm
	П			#	=	_	-	-	-	-							=
50				#													=
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40			_	\blacksquare	=		-			-							=
		V	=	V	=		=	=	\pm	\pm	=						\pm
35	П	١		V	=	_	-	-	-	_	=						-
		_		-													
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			1	#	\rightarrow						=						=
25	П		_	\forall	=	`	_	_	=	=	=	=	=				\pm
	=			╲		-	\blacksquare	_	-	_		=	=				_
20 l		2		4	6	8	10	12	14	16	18 2	0 22	2 24	_	6 2	8	30

Note-1 in. = 25.4 mm.

FIG. 24 Limits for Hardenability Band 4419 H

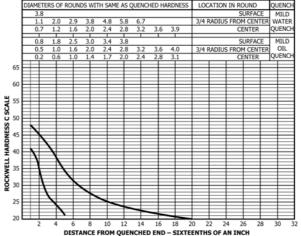
0.17/0.23



HARDNESS LIMITS FOR SPECIFICATION PURPOSES

HEAT TREATING TEMPERATURES

RECOMMENDED BY SAE
*NORMALIZE 1700 °F
AUSTENITIZE 1700 °F
*For forged or rolled specimens only.



Note-1 in. = 25.4 mm.

FIG. 25 Limits for Hardenability Band 4620 H

HARDENABILITY BAND 4621 H

С	Mn	Si	Ni	Мо	
0.17/0.23	0.60/1.00	0.15/0.35	1.55/2.00	0.20/0.30	

0			ROUN	DS WIT	'H SAN	1E AS C	QUENC	HED HA	ARDNES	S	LOCA	TION I				UENC
	3.8									\perp				RFACE		MILD
	1.1	2.0	2.9	3.8	4.8	5.8	6.7			3	3/4 RAD	IUS F				VATE
L	0.7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9	\perp			CEI	NTER	Q	UENC
H	0.8	1.8	2.5	3.0	3.4	3.8		_		+			SU	RFACE	-	MILC
ı	0.5		1.6	2.0	2.4	2.8	3.2	3.6	4.0	13	3/4 RAE	IUS F			ER	OIL
E	0.2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1	\top			CEI	NTER	− Q	UEN
5 E	\blacksquare	=	\pm	\pm	\pm	\pm	\pm	\pm		\mp	\pm	\pm	\equiv			\equiv
E		_	-	+	-	+	-	-	_	+	-	+				=
ΘĒ		=	-	+	-	=	=	-		+	-	\pm		=	_	⊨
E		=			-					#		-	=			⇇
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ωĖ	\pm			\pm		\pm	\pm			≢		=				\pm
~E		=		\pm	+	\pm	\pm	\pm	_	\pm	_	\pm			_	=
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E		_/								#						₣
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E			X							\pm						=
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30 E		\vee	-	\mathbf{x}	-	=	+	-	_	+	-	\pm	=			=
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25	_		V	#	=	*	4			#		_				=
"E	\pm	=	\rightarrow		-	\pm		\blacksquare	$\overline{}$	+	+	_				=
20 E	ш	_	_	\rightarrow	_	\perp		_	\perp	_	\perp	_				
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	3 .	30

Note-1 in. = 25.4 mm.

FIG. 26 Limits for Hardenability Band 4621 H

HARDNESS LIMITS FOR SPECIFICATION PURPOSES

HARDNESS LIMITS FOR SPECIFICATION PURPOSES

22 22 21 21 HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1700 °F AUSTENITIZE 1700 °F *For forged or rolled specimens only

20

SIXTEENTHS	102	
OF AN INCH	MAX.	MIN.
1 2 3 4	51 48 41 33	45 36 29 24
5 6 7 8	29 27 25 24	21 - - -
9 10 11 12	23 22 22 21	
13 14 15 16	21 20 - -	
18 20 22 24		
26 28 30 32		:
RECON *NORM	ATING TEMPE MMENDED BY S MALIZE 1700 ENITIZE 1700	AE °F

*For forged or rolled specimens only.

HARDENABILITY BAND 4626 H

С	Mn	Si	Ni	Cr	Мо	
.23/	.40/.70	.15/0.35	.65/ 1.05		.15/ .25	

	101		.8	(3 (л к	OUNL)2 WII	п энч	E AS Q	OENCE	IEU NA	RDNESS	┿	CCAI	LOI4 III	SURF		QUE	
	Н		.1	2.0	0	2.9	3.8	4.8	5.8	6.7			3/4	RADI	US FR	OM CE			
	Г	0		1.7		1.6	2.0	2.4	2.8	3.2	3.6	3.9	1-7			CENTE		QUE	
	F	_	Č			7.5	3.0	2.4	3.0		-		+			SURF	LCE.	MIL	=
	⊢	0		1.0		2.5	2.0	3.4 2.4	3.8 2.8	3.2	3.6	4.0	2//	DADI	LIC ED	OM CE		-	
	⊢	0		0.6		1.0	1.4	1.7	2.0	2.4	2.8	3.1	3/4	KADI		CENTE		QUE	
65	Н	Ť	Ē	Ť		Ť	Ť	1	1	1	1	T				T		+	=
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55				#		#	#	#	#	#	#		+		#	#	#	#	Ξ
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	Ħ	1		V		+	+	+	+	\pm	+			=	+	+	\mp	#	Ξ
35	Е		١	V		\mp	\pm	\pm	-	\pm	\pm					+	\mp	\mp	Ξ
30			١	1	$\overline{}$	\pm				\pm	\pm					+	\mp	\mp	Ξ
30	F		-		_		-		-		-						=	=	Ξ
25	Е			V		\mathbf{h}											=	=	Ξ
	Ħ			=	$\overline{}$		\rightarrow	\checkmark		\pm	\pm						\pm	\pm	=
20		_		4	_	بِ			<u> </u>	٠.		10			1	1			=
			2	4		6	8	10 F ROM	12	14	16	18	20	22	24	26	28	30	

Note-1 in. = 25.4 mm.

FIG. 27 Limits for Hardenability Band 4626 H



HEAT TREATING TEMPERATURES

RECOMMENDED BY SAE

*NORMALIZE 1700 °F

AUSTENITIZE 1700 °F

*For forged or rolled specimens only.

HARDENABILITY BAND 4718 H

	С	Mn	Si	Ni	Cr	Мо	
Γ	0.15/0.21	0.60/0.95	0.15/0.35	0.85/1.25	0.30/0.60	0.30/0.40	

	DI	AMETE	RS OF	ROUN	DS WIT	'H SAM	IE AS C	QUENCE	HED HA	RDNESS	LO	CATIC	N IN F	ROUND)	QUENCH
		3.8												URFAC		MILD
		1.1	2.0	2.9	3.8	4.8	5.8	6.7			3/4 8	RADIU:		M CENT	ΓER	
		0.7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9			C	ENTER		QUENCH
	\vdash	0.8	1.8	2.5	3.0	3.4	3.8		_				5	URFAC	F	MILD
	\vdash	0.5	1.0	1.6	2.0	2.4	2.8	3.2	3.6	4.0	3/4	RADILI		M CENT		OIL
	\vdash	0.2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1	37.1.	01010		ENTER	LIV	QUENCH
6	جاء		Ť	Ŧ	<u> </u>	Ť	T	Ť	Ŧ	-						
0.	ľΕ															
6	⋴⋿			#	#		#	+								
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ROCKWELL HARDNESS C SCALE																
DNES 4	5	\uparrow	\checkmark													
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WELL 31	5		V	₽	lacksquare											
2 3	∘≣		₽			\succ	\downarrow									
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20	₀⊨	2	4	6	8	10	12	14	16	18 2	10 2	2 2	4 2	26 2		30 32
		2	-							- SIXTE					O	30 32

Note-1 in. = 25.4 mm.

FIG. 28 Limits for Hardenability Band 4718 H

HARDENABILITY BAND 4720 H

I	С	Mn	Si	Ni	Cr	Мо	
I	0.17/0.23	0.45/0.75	0.15/0.35	0.85/	0.30/0.60	0.15/0.25	

D		ERS OF	ROUN	DS WI	TH SAN	1E AS (QUENC	HED H	ARDNESS	LOCATIO			QUENC
⊢	3.8	2.0	2.0	2.0	4.0	F 0	6.7			2/4 040711		RFACE	MILD
⊢	1.1 0.7	1.2	2.9	2.0	4.8 2.4	5.8	6.7 3.2	3.6	3.9	3/4 RADIU		ITER	WATE
E	U.7	\perp			\perp		3.2	3.0	3.9				`
	0.8	1.8	2.5	3.0	3.4	3.8						RFACE	MILD
L	0.5	1.0	1.6	2.0	2.4	2.8	3.2	3.6	4.0	3/4 RADIU			
H	0.2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1		CEN	ITER	QUENC
65		=			-								
E	#	=			=								
60	#	=	=	=	=	-	-	=	=		=	=	=
E													
55	#	_	=	=	=	-	-	-	_		=	_	_
E		=	=	=	=							=	
50		\equiv			=								
45	\rightarrow		-	-	-	-	-	-				_	
42 E		lacksquare			\equiv								
40		V	_	=	=			=			=		
70 E	1	_\	=	-	-	\pm	-	=				=	=
35	1												
45 40 35 30	#	₩	₩	=	=	-	-	=	=		=	=	=
30		\mathbf{V}	\rightarrow		-	_	_	-				_	
		V		\mathbf{X}		\pm		\pm					
25	-	$-$ \	\rightarrow		$\overline{}$		_	\rightarrow	=		\vdash	=	_
			\setminus			\Box	_	_					
20 E	_	_	_	_	_	_	_				\perp		\rightarrow
	2	4	6	8	10	12	14	16		0 22 ENTHS OF	24 26	28	30

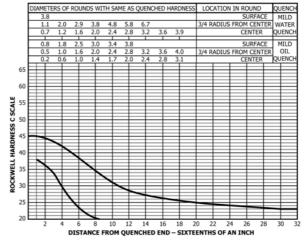
Note-1 in. = 25.4 mm.

FIG. 29 Limits for Hardenability Band 4720 H



HEAT TREATING TEMPERATURES
RECOMMENDED BY SAE
*NORMALIZE 1700 °F
AUSTENITIZE 1550 °F

-	С	Mn	Si	Ni	Мо	
	0.12/0.18	0.30/0.70	0.15/0.35	3.20/3.80	0.20/0.30	



Note-1 in. = 25.4 mm.

FIG. 30 Limits for Hardenability Band 4815 H

| HARDNESS LIMITS FOR SPECIFICATION PURPOSES | 197 DISTANCE SIXTEENTHS | 4817 H | 187 DF | 18

28 25
30 24
32 24

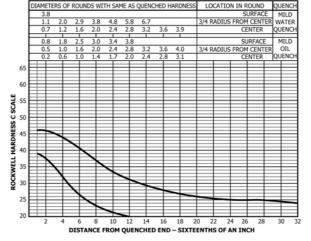
HEAT TREATING TEMPERATURES

RECOMMENDED BY SAE
*NORMALIZE 1700 °F
AUSTENITIZE 1550 °F

*For forged or rolled specimens only

HARDENABILITY BAND <u>4817</u> H

I	С	Mn	Si	Ni	Мо	
I	0.14/0.20	0.30/0.70	0.15/0.35	3.20/3.80	0.20/0.30	



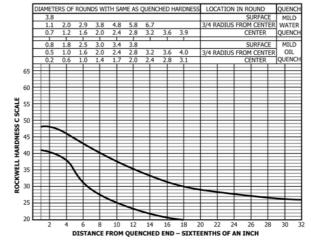
Note-1 in. = 25.4 mm.

FIG. 31 Limits for Hardenability Band 4817 H

HARDNESS LIMITS FOR SPECIFICATION PURPOSES									
")" DISTANCE	482	0 H							
SIXTEENTHS OF AN INCH	MAX.	MIN.							
1	48	41							
2	48	40							
3	47	39							
4	46	38							
5	45	34							
6	43	31							
7	42	29							
8	40	27							
9	39	26							
10	37	25							
11	36	24							
12	35	23							
13	34	22							
14	33	22							
15	32	21							
16	31	21							
18	29	20							
20	28	20							
22	28	-							
24	27	-							
26 28 30 32	27 26 26 25	:							
RECON*NORN	ATING TEMPERATING TEMPERATURE 1700 ° TEMITIZE 1550 ° TEMITIZE 1550 ° TEMITIZE 1550 °	E F							

HARDENABILITY BAND 4820 H

С	Mn	Si	Ni	Мо	
0.17/0.23	0.40/0.80	0.15/0.35	3.20/3.80	0.20/0.30	



Note-1 in. = 25.4 mm.

FIG. 32 Limits for Hardenability Band 4820 H

	HARDNESS LIMITS FOR SPECIFICATION PURPOSES								
"J" DISTANCE SIXTEENTHS	50B	40 H							
OF AN INCH	MAX.	MIN.							
1	60	53							
2	60	53							
3	59	52							
4	59	51							
5	58	50							
6	58	48							
7	57	44							
8	57	39							
9	56	34							
10	55	31							
11	53	29							
12	51	28							
13	49	27							
14	47	26							
15	44	25							
16	41	25							
18	38	23							
20	36	21							
22	35	-							
24	34	-							
26	33	-							
28	32								
30	30	-							
32	29	-							
RECOMME *NORMALI	HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1600 °F AUSTENITIZE 1550 °F								

*For forged or rolled specimens only.

HARDENABILITY BAND 50B40 H

ı	С	Mn	Si	Cr	В
	$0.37/_{0.44}$	0.65/1.10	0.15/0.35	0.30/0.70	*

* Can be expected to have 0.0005 % minimum boron content.

H	JAMETE 3.8									_		5	URFACE	QUENC
- 1-	1.1	2.0	2.9	3.8	4.8	5.8	6.7			3/4	RADIUS		CENTER	
- 1-	0.7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9	, -			ENTER	QUENC
F	0.0	1.8	7.5	2.0	3.4	3.8				+		_	UDEACE	
⊢	0.8	1.0	2.5	3.0	2.4	2.8	3.2	3.6	4.0	2/4	DADTHE		URFACE	MILD
⊢	0.5	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1	3/4	KADIUS		ENTER	QUENC
=	11	1	1.0	- 11	- T	T	1	1	7.2	+				
65	+	=	=		=	=	=	=						_
					=	=		-						
60		_	\blacksquare		=	=	=	=						
- 1		_		`		-		-						
55	+	_	-	-	\rightarrow		-	-	=	=				_
- E		$\overline{}$			\equiv	V								
50	+		=	_	=	-	\Rightarrow	=	=	=			=	_
E			\mathbf{X}				V							
45	+		-		-	-								=
E				V				V						
40	++	_	=	٧	-	+	+	-						=
E	+			-		\pm		\pm	\rightarrow	\pm				
35	+	-	-	_		=	=	-		\mathbf{r}				=
F	+	_	_		\mathbf{V}	=	\pm	_	_	-				
30					_	\pm								\rightarrow
- 1=	+	-	-	-	=	\rightarrow		-	_	-				_
25	+	=	\pm	-	\pm	-	\rightarrow	\blacksquare	-	+			=	_
- E						\pm		-	$\overline{}$					
20 L			\pm		\pm	\pm	\pm	\pm						
	2	4	6	8	10	12	14	16	18	20 2	2 2	4 2	6 28	30

NOTE—1 in. = 25.4 mm.

FIG. 33 Limits for Hardenability Band 50B40 H

HARDENABILITY BAND 50B44 H HARDNESS LIMITS FOR SPECIFICATION PURPOSES 0.30/0.70 0.42/0.49 0.65/1.10 0.15/0.35 63 *Can be expected to have 0.0005 % minimum boron content. 63 62 55 62 SURFACE 2.0 2.9 3.8 4.8 5.8 6.7 3/4 RADIUS FROM CENTER 61 54 52 48 43 OUENC 61 60 60 0.7 0.8 1.2 1.6 2.0 2.4 2.8 1 1 1 1 1 1 1.8 2.5 3.0 3.4 3.8 1.0 1.6 2.0 2.4 2.8 CENTER MILD OIL QUENCE 3/4 RADIUS FROM CENTER 0.5 59 58 57 38 34 31 30 CENTER 10 11 13 14 54 52 29 29 28 27 ROCKWELL HARDNESS C SCALE 15 16 50 48 18 20 22 44 40 38 37 26 24 23 24 21 26 28 36 35 20 30 34 33 HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1600 °F AUSTENITIZE 1550 °F *For forged or rolled specimens only. DISTANCE FROM QUENCHED END – SIXTEENTHS OF AN INCH

Note—1 in. = 25.4 mm.

FIG. 34 Limits for Hardenability Band 50B44 H

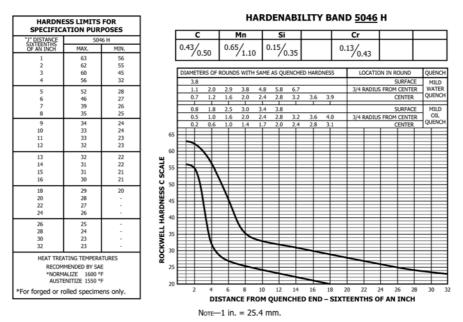


FIG. 35 Limits for Hardenability Band 5046 H



HARDENABILITY BAND 50B46 H HARDNESS LIMITS FOR SPECIFICATION PURPOSES 0.65/1.10 0.13/0.43 0.43/0.50 0.15/0.35 63 62 61 60 56 54 52 50 *Can be expected to have 0.0005 % minimum boron content QUENCH DIAMETERS OF ROUNDS WITH SAME AS QUENCHED HARDNESS LOCATION IN ROUND SURFACE MILD 3/4 RADIUS FROM CENTER WATER 59 58 57 56 41 32 31 30 CENTER QUENCH SURFACE MILD CENTER OIL CENTER QUENCH SURFACE 3/4 RADIUS FROM CENTER 54 51 47 43 9 10 11 12 29 28 27 26 65 13 14 15 16 40 38 37 36 26 25 25 24 ROCKWELL HARDNESS C SCALE 35 34 33 32 18 20 22 24 23 22 21 20 26 28 30 32 31 30 29 28 HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1600 °F AUSTENITIZE 1550 °F 12 14 16 18 20 22 *For forged or rolled specimens only 10 DISTANCE FROM QUENCHED END - SIXTEENTHS OF AN INCH

FIG. 36 Limits for Hardenability Band 50B46 H

Note-1 in. = 25.4 mm.

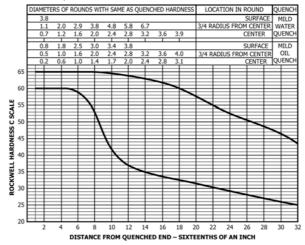
	SS LIMITS			С	Mn	Si	T DA	ND <u>50B50</u> Cr	"	В
	50B5		1	0.47/	0.65/	0.15/	_	0.30/	 	*
DISTANCE EXTEENTHS F AN INCH	MAX.	MIN.	1	0.17/0.54	1.10	0.35	5	0.50/0.70		
1 2	65 65	59 59		*Can be exp	ected to have	e 0.0005 %	minimum	boron content		
3	64	58		DIAMETERS O	F ROUNDS WITH	SAME AS OUE	NCHED HARD!	NESS LOCATI	ON IN ROUND	QUENC
4	64	.57		3.8					SURFACE	MILD
5	63	56	1	1.1 2.0		1.8 5.8 6.			JS FROM CENTER	
6 7	63 62	55 52		0.7 1.2	1.6 2.0	2.4 2.8 3.	.2 3.6 3.9	-	CENTER	QUENC
8	62	47		0.8 1.8		3.4 3.8			SURFACE	MILD
			1	0.5 1.0		2.4 2.8 3.			S FROM CENTER	OIL
9 10	61 60	42 37		0.2 0.6	1.0 1.4	1.7 2.0 2	4 2.8 3.1	<u> </u>	CENTER	QUENC
11	60	35	65		\blacksquare				+	=
12	59	33	60						\vdash	
13	58	32	I							
14 15	57 56	31 30	SCALE 50							
16	54	29	23.		\sim					
			U 50		\rightarrow			\rightarrow		
18 20	50 47	28 27	83		X_				\vdash	
22	44	26	¥ 4!		\rightarrow				-	=
24	41	25	HARDNESS 15		\perp			 	\downarrow	=
26	39	24		'HH						
28	38	22] 35							\rightarrow
30 32	37 36	21 20	₹		\rightarrow				\vdash	=
			SOCKWELL 30		\rightarrow				\vdash	\pm
	TING TEMPERA				\rightarrow		_		\vdash	_
	MENDED BY SAI ALIZE 1600 °I		25	·						
	NITIZE 1550 °		l							٧.
r forged or rolled	d specimens on	ly.	20	2 4	6 8	10 12 1	4 16 18	3 20 22	24 26 28	30
			J					IXTEENTHS OF		
					E-1 in. = 25	•				

FIG. 37 Limits for Hardenability Band 50B50 $\rm H$

SPECIFIC	ESS LIMITS ATION PUR	POSES				
"J" DISTANCE		60 H				
OF AN INCH	MAX.	MIN.				
1 2 3 4		60 60 60				
5	-	60				
6	-	59				
7	-	57				
8	65	53				
9	65	47				
10	64	42				
11	64	39				
12	64	37				
13	63	36				
14	63	35				
15	63	34				
16	62	34				
18	60	33				
20	58	31				
22	55	30				
24	53	29				
26	51	28				
28	49	27				
30	47	26				
32	44	25				
HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1600 °F AUSTENITIZE 1550 °F						

HARDENABILITY BAND <u>50B60</u> H								
С	Mn	Si		Cr		В		
0.55/0.65	0.65/1.10	0.15/0.35		0.30/0.70		*		

*Can be expected to have 0.0005 % minimum boron content.



Note-1 in. = 25.4 mm

FIG. 38 Limits for Hardenability Band 50B60 H

HARDNESS LIMITS FOR SPECIFICATION PURPOSES					HAI	RDENAE	ILITY	BAND	<u>5120</u>	Н	
				С	Mn	Si			Cr		
DISTANCE TEENTHS AN INCH	5120 MAX.	MIN.		0.17/0.23	0.60/1.00	0.15/0.) E	0.	60/1.00		
1 2 3 4	48 46 41 36	40 34 28 23			OF ROUNDS WITH			ARDNESS		ON IN ROUND	
5 6 7 8	33 30 28 27	20 - - -		1.1 2.0 0.7 1.1 0.8 1.0 0.5 1.0	2 1.6 2.0 3 2.5 3.0	2.4 2.8 3.4 3.8	6.7 3.2 3.6 3.2 3.6	3.9		S FROM CENT CENTER SURFAC IS FROM CENT	QUEN
9 10 11 12	25 24 23 22	:	6	0.2 0.			2.4 2.8	3.1	3/4 KADIU	CENTE	Ere or
13 14 15 16	21 21 20	:	SCALE 5	5							
18 20 22 24	:	-	HARDNESS C								
26 28 30 32	:	-	CKWELL								
RECOM *NORM	TING TEMPERAT IMENDED BY SAI IALIZE 1700 ° ENITIZE 1700 °	E F	2 2								

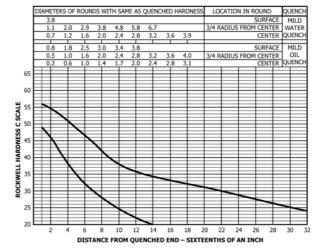
Note-1 in. = 25.4 mm.

FIG. 39 Limits for Hardenability Band 5120 H



	ESS LIMITS ATION PUR	POSES				
")" DISTANCE SIXTEENTHS OF AN INCH	513					
OF AN INCH	MAX.	MIN.				
1 2 3 4	56 55 53 51	49 46 42 39				
5 6 7 8	49 47 45 42	35 32 30 28				
9 10 11 12	40 38 37 36	26 25 23 22				
13 14 15 16	35 34 34 33	21 20 - -				
18 20 22 24	32 31 30 29	:				
26 28 30 32	27 26 25 24	:				
HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1650 °F AUSTENITIZE 1600 °F *For forced or rolled specimens only.						

HARDENABILITY BAND <u>5130</u> H							
С	Mn	Si		Cr			
0.27/0.33	0.60/1.00	0.15/0.35		0.75/			



Note-1 in. = 25.4 mm.

FIG. 40 Limits for Hardenability Band 5130 H

HARDNESS LIMITS FOR							
	ATION PUR						
"J" DISTANCE SIXTEENTHS	513	32 H					
OF AN INCH	MAX.	MIN.					
1	57	50					
2	56	47					
3 4	54 52	43 40					
,	32	40					
5	50	35					
6	48	32					
7 8	45 42	29 27					
•	42	2/					
9	40	25					
10	38	24					
11 12	37 36	23 22					
12	30	22					
13	35	21					
14 15	34 34	20					
16	33						
18	32	-					
20 22	31 30	-					
24	30 29						
24	2.5						
26	28	-					
28	27	-					
30 32	26 25						
	TING TEMPERA						
	MENDED BY SAI	_					
*NORMA							
	NITIZE 1600 °I						
*For forged or rolle	d specimens on	ily.					

HARDENABILITY BAND 5132 H

	Mn	Si		Cr		
.35 0.5	%.90	0.15/0.35		0.65/1.10		
	.35	.35 0.50/0.90	Mn Si .35 0.50/0.90 0.15/0.35	Mn Si 0.50/0.90 0.15/0.35	Mn Si Cr 0.50/0.90 0.15/0.35 0.65/1.10	Mn Si Cr .35 0.50/0.90 0.15/0.35 0.65/1.10

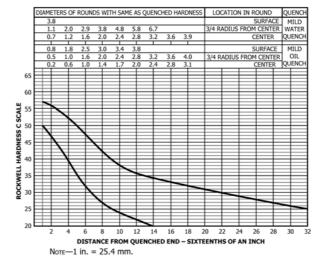


FIG. 41 Limits for Hardenability Band 5132 H



32 32 31 30 HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1650 °F AUSTENITIZE 1600 °F

*NORMALIZE 1600 °F AUSTENITIZE 1550 °F *For forged or rolled specimens only

20

HARDENABILITY BAND 5135 H

С	Mn	Si	Cr	
0.32/0.38	0.50/0.90	0.15/0.35	0.70/	

[DIAMETE	ERS OF	ROUN	DS WIT	TH SAN	1E AS (QUENC	HED H	ARDNES	S	LOCAT	ION I			QUEN	_
ŀ	3.8	2.0	2.9	3.8	4.8	5.8	6.7			3/4	1 PAD	IUS FR		FACE	MILI	
ı	0.7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9		TIOLD	10511			QUEN	
	0.8	1.8	2.5	3.0	3.4	3.8				₩			SUR	FACE	MILI	5
ı	0.5	1.0	1.6	2.0	2.4	2.8	3.2	3.6	4.0	3/4	1 RAD	IUS FR	OM C	NTER	OIL	
- [0.2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1	\perp			CI	NTER	QUEN	(
65		=	\pm	\pm		\pm	\pm	\pm					\pm	\pm		
60																
55		\checkmark				\pm		\pm						_		
3 ~			\checkmark	\pm		\pm	\pm	\pm		\pm	#	\pm		\pm		
50	\sim	\pm	\rightarrow	\pm	\pm	\pm	\pm	\pm		\pm	\pm	\pm	\pm	\pm	\pm	
8		\leftarrow	\pm	\mathbf{X}		\pm	\pm	\pm		\pm	\pm	\pm		\pm		
45	-	V	\pm	+	$\overline{}$	\pm		\pm		\pm		\pm		\pm		
40	-	\rightarrow	_	+	₽	\blacksquare	+	+	_	+	+	+	=	+	+	
, ™		-		=	=		\checkmark			\equiv	=	=	\equiv	=		
35	_	-	V	=	-	-	=	\rightarrow	\downarrow	\blacksquare		-	-	-	-	
 			-			-					\top	+	$\overline{}$	_		
55 50 50 45 45 40 40 35 35 30 30		=	=	\mathbf{X}		#	=	=		=	+	=	=	=	\blacksquare	
٠,,				==	\setminus									-		
25			=			`								=		
20						\pm	\rightarrow	+						\pm		
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	

Note-1 in. = 25.4 mm.

FIG. 42 Limits for Hardenability Band 5135 H

HARDNE: SPECIFICA	SS LIMITS]	HARDENABILITY BANK							5 <u>51</u>	<u>40</u> I	Н						
	5140		4	С		_	Мn	\Box		Si	\perp			Cr					
'J" DISTANCE SIXTEENTHS OF AN INCH	MAX.	MIN.	1	0.37	/ 0.44	0.60	0 1.0	١٥	0.1	5/0.3	5		0	.60/1	.00				
1	60	53	1				, 210			, 0.0.	_			, -	-	_			
3	59 58	52 50	1	DIAMET	ERS OF	ROUN	DS WI	TH S	AME	AS OU	ENC	HED H	ARDNES	s Lo	CATIO	ON IN	ROUNE	- 10	QUEN
4	57	48		3.8													SURFA		MILE
5	56	43	1	1.1	2.0	2.9	3.8	4.8			.7			3/4	RADIU	S FROM			WATE
6 7	54 52	38 35	1	0.7	1.2	1.6	2.0	2.4	4 2	2.8 3	.2	3.6	3.9	+			CENT	ER (QUEN
s I	50	33	1	0.8	1.8	2.5	3.0	3.4	4 3	3.8							SURFA	CE	MILI
_			-	0.5	1.0	1.6	2.0	2.4			.2	3.6	4.0	3/4	RADIU	S FROM			OIL
9	48 46	31 30	1	0.2	0.6	1.0	1.4	1.7	7 2	2.0 2	.4	2.8	3.1	₩	_	_	CENT	ER	QUEN
11	45	29	6	5				=				\pm							
12	43	28	l .			\pm		⇉				\pm							\pm
13	42	27	1 6	° 📂				⇉				\pm							
14	40	27	I w.	, H	_		_	=				=	=	=					+
15 16	39 38	26 25	SCALE	° 🔲		\mathbf{x}		\equiv											
16	30	25	J 85 5	ه ا		= '	$\overline{}$	\equiv				\pm							
18	37	24		°HH	V	-	_					-							-
20	36 35	23 21	§ 4	5	$-\mathbf{\Lambda}$			_	_										
22 24	35	20	ا ۾ ا		⇒'	\leftarrow		=	_	\leftarrow		\pm	=						+
		-+	HARDNESS	۰	-	V		=					=						-
26 28	34 33					λ		=				`	\blacksquare						\pm
30	33		1 3	5	_	-	\leftarrow	=				\pm	$\overline{}$	$\overline{}$					
32	32	-	SOCKWELL				\rightarrow												+
HEAT TREAT	TING TEMPERA	TURES	1 8ૂ₃	۰			=	\rightarrow	◂				=						+
	MENDED BY SAE		Ι,	. 🖽				=		$\overline{}$									\pm

Note-1 in. = 25.4 mm.

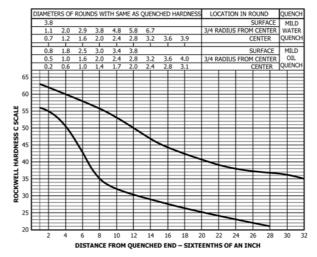
DISTANCE FROM QUENCHED END – SIXTEENTHS OF AN INCH

FIG. 43 Limits for Hardenability Band 5140 H



	ESS LIMITS	
"1" DISTANCE		15 H
SIXTEENTHS OF AN INCH	MAX.	MIN.
1	63	56
2	62	55
3	61	53
4	60	51
5	59	48
6	58	42
7	57	38
8	56	35
9	55	33
10	53	32
11	52	31
12	50	30
13	48	30
14	47	29
15	45	28
16	44	28
18	42	26
20	41	25
22	39	24
24	38	23
26 28 30 32	37 37 36 35	22 21 -
RECOM *NORM	ATING TEMPERATING TEMPERATING TEMPERATURE STATEMENT AND A SECTION OF THE PERATURE STATEMENT OF TEMPERATURE STATEMENT OF T	E F

	HAR	DENABIL	ITY BA	ND <u>5145</u> F	1	
С	Mn	Si		Cr		
0.42/0.49	0.60/1.00	0.15/0.35		0.60/1.00		



Note-1 in. = 25.4 mm.

FIG. 44 Limits for Hardenability Band 5145 H

	ESS LIMITS ATION PUR	
"J" DISTANCE SIXTEENTHS OF AN INCH		7 H
OF AN INCH	MAX.	MIN.
1	64	57
2	64	56
3	63	55
4	62	54
5	62	53
6	61	52
7	61	49
8	60	45
9	60	40
10	59	37
11	59	35
12	58	34
13	58	33
14	57	32
15	57	32
16	56	31
18	55	30
20	54	29
22	53	27
24	52	26
26	51	25
28	50	24
30	49	22
32	48	21
RECOM*NORM	ATING TEMPER/ IMENDED BY SA IALIZE 1600 ° ENITIZE 1550 °	E F

*For forged or rolled specimens only.

	DIA	METE	RS OF	ROUN	DS WI	TH SAM	4E AS	QUENC	HED H	ARDNE	SS	LOCA	TION				QUENC	Ή
	ㄴ	3.8									4				SURFA		MILD	
	⊢	1.1	2.0	2.9	3.8	4.8	5.8	6.7	2.6	2.0	-13	/4 RA[DIUS F				WATE	
	⊢	0.7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9	\pm				ENTE	K	QUENC	
		0.8	1.8	2.5	3.0	3.4	3.8				\perp				URFA		MILD	
	ᆫ	0.5	1.0	1.6	2.0	2.4	2.8	3.2	3.6	4.0	3	/4 RA[DIUS F			ER	OIL	
	⊢	0.2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1	+	_	_	- (CENTE	R	QUENC	씌
65	Ε.	_									#							∃
60			1		+	4												▤
55	Ħ	*	$ \leftarrow $						◝	┿	4							╡
50		ŧ		7									1		_	_	_	▋
45					X													▤
40		ŧ	#		₽`	V		+										╡
45 45 40 35 30		ŧ					\checkmark					1						Ⅎ
30		ŧ								+	4							
25		f	Ŧ	Ŧ	Ŧ		Ŧ	#	Ŧ	F	Ŧ	-			_			
20		2	4	6	8	10	12	14	16	18	20	22	24	2	6 2	28	30	3

Note-1 in. = 25.4 mm.

FIG. 45 Limits for Hardenability Band 5147 H



HARDENABILITY BAND 5150 H

С	Mn	Si	Cr	
0.47/0.54	0.60/1.00	0.15/0.35	0.60/1.00	

	DIA		ERS OF	ROUN	DS WI	TH SAN	ME AS (QUENC	HED H	ARDNESS	LO	CATION IN		_
	⊢	1.1	2.0	2.9	3.8	4.8	5.8	6.7			3/4 D	ADIUS FRO	SURFA	
	⊢	0.7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9	3/4 K	ADIOS FRO	CENTER	
	F	0.8	1.8	2.5	3.0	3.4	3.8						SURFAC	E MILD
	Н	0.5	1.0	1.6	2.0	2.4	2.8	3.2	3.6	4.0	3/4 R	ADIUS FRO		ER OIL
	二	0.2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1	-,		CENTE	R QUENC
65	H	_		\pm	\pm	\pm	=	\pm	\pm					
	\exists		\rightarrow		\pm	\pm	=	\pm	\pm					
60	H	⇟	\pm	1	\checkmark	\pm	=	\pm	\pm					
55		₽	$\overline{}$	=	-	${}^{\prime}$		-	=					
5 22	Ħ	₣					V							
55 50 45 40 35	Ħ	#	-	V		-		V	-					
3	Ħ	#		_\		-		-	\checkmark					
45	Ħ	+		- 1					_	$\overline{}$				
	Ħ	\mp	=	=	V	-			-		$\overline{}$			
40	Ħ	\equiv	=		X	=		=						
35	Ħ		=	=	-	V								
	Ħ					1	◂							
30	Ħ	\pm	-	=	-	#		\rightarrow	+	_				
	Ħ		=											
25	Ħ	#				\pm							$\overline{}$	
20	\equiv	\pm	\pm	\pm		\pm	=	\pm	\pm					
		2	4	6	8	10	12	14	16	18	20 2	22 24	26 2	8 30

Noτε-1 in. = 25.4 mm.

FIG. 46 Limits for Hardenability Band 5150 H

0.50/0.60

LOCATION IN ROUND

SPECIFIC	ATION PUR	POSES
")" DISTANCE SIXTEENTHS	515	5 H
OF AN INCH	MAX.	MIN.
1	-	60
2	65	59
3	64	58
4	64	57
5	63	55
6	63	52
7	62	47
8	62	41
9	61	37
10	60	36
11	59	35
12	57	34
13	55	34
14	52	33
15	51	33
16	49	32
18	47	31
20	45	31
22	44	30
24	43	29
26	42	28
28	41	27
30	41	26
32	40	25
RECOI *NORI	MING TEMPERA MMENDED BY SA MALIZE 1600 TENITIZE 1550	AE ∘F

*For forged or rolled specimens only

HARDNESS LIMITS FOR SPECIFICATION PURPOSES

HEAT TREATING TEMPERATURES

RECOMMENDED BY SAE

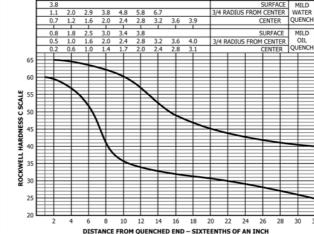
*NORMALIZE 1600 °F

AUSTENITIZE 1550 °F

*For forged or rolled specimens only.

HARDNESS LIMITS FOR

")" DISTANCE SIXTEENTHS OF AN INCH



Nоте—1 in. = 25.4 mm.

FIG. 47 Limits for Hardenability Band 5155 H



HEAT TREATING TEMPERATURES

RECOMMENDED BY SAE
*NORMALIZE 1600 °F
AUSTENITIZE 1550 °F

HARDENABILITY BAND 5160 H

С	Mn	Si	Cr	
0.55/0.65	0.65/1.10	0.15/0.35	0.60/1.00	

DL		RS OF	ROUN	DS WIT	'H SAM	1E AS (QUENC	HED HA	ARDNES	s	LOCA.	TION I			QUE	
\vdash	3.8			2.0						-				RFACE		
\vdash	0.7	2.0	2.9	3.8	4.8 2.4	5.8 2.8	6.7 3.2	2.6	3.9	3/	4 RAD	IUS H		VTER	QUE	
\vdash	0.7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9	+					1	NC
	0.8	1.8	2.5	3.0	3.4	3.8				\perp				RFACE		
\vdash	0.5	1.0	1.6	2.0	2.4	2.8	3.2	3.6	4.0	3,	4 RAD	IUS F			QUE	
\vdash	0.2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1	+	_	_	CE	NTER	QUE	NC
65		-	_		=	=		=		=	=	=	=	=	=	Ξ
		=		\rightarrow	\checkmark	\pm	=	=		\pm	=	\pm	\pm	=	=	=
60	_	$\overline{}$				\checkmark		-			-	\pm	-		=	=
. =			V				$\overline{}$					\pm	=	=	=	=
55	=	=	\rightarrow	=	-	=	₽	\leftarrow	=	+	=	=	=	=	=	=
		=	₽,	lack	=	\pm		X		\pm	=	=	=	=	=	=
50	=	-	=	₩	-	=	_	-	$ \leftarrow$	+	-	=	=	=	=	=
				1					\mathbf{r}	$\overline{}$	_				=	Ξ
45	=	=	=	\rightarrow	-	=	_	-	-	+	\blacksquare	\rightarrow	\rightarrow		=	=
50 45 40				₽,	V I										\rightarrow	-
40		=	=	=	X	=	=	=	=	\pm	=	=	=	=	=	=
=		-			-	\checkmark				-		=	=	=		Ξ
35 30							_	+	ᆂ			\equiv	\equiv	\equiv	=	Ξ
-0 E	=	=	=	-	-	=	_	-	_	\rightarrow	$\overline{}$	=	=	=	=	=
30												\neg	1			Ξ
35	=	=	=	=	-	=	=	=	=	+	=	=	=	-		=
25															=	=
		\pm	\pm		-	\pm	_			\pm		\pm	\pm	=	=	=
20 ⊟																

Note-1 in. = 25.4 mm.

FIG. 48 Limits for Hardenability Band 5160 H

HARDNE	SS LIMITS	FOR	HARDENABILITY BAND 51B60 H														
SPECIFICA	ATION PURI	POSES		[С		Mn			Si			Cr				В
"J" DISTANCE SIXTEENTHS OF AN INCH	51B6 MAX.	0 H MIN.			0.55/0.	65	0.65/1.	10	0.15	0.35		0	0.60/1.	.00		Т	*
1 2	MAX.	60 60	1		Can be						minim	um bor					
3 4	:	60 60		F	DIAMETER 3.8	IS OF R	OUNDS W	/ITH S	AME AS	S QUEN	CHED H	ARDNESS	LO	CATION	IN ROU	ND RFACE	QUENCH MILD
5 6	:	60 59	1				2.9 3.8 1.6 2.0					3.9	3/4 R	ADIUS F	ROM CE CEN		
7 8	:	58 57			0.8	1.0	2.5 3.0 1.6 2.0	2.4	2.8	3.2		4.0	3/4 R	ADIUS F	ROM CE	FACE NTER	MILD OIL
9 10 11 12	- - - 65	54 50 44 41		65	0.2	0.6	1.0 1.4	1.7	2.0	2.4	2.8	3.1			CEN	NTER	QUENCH
13 14 15 16	65 64 64 63	40 39 38 37	CSCALE	55 50				\setminus				Ì		/	ļ		
18 20 22 24	61 59 57 55	36 34 33 31	ARDNESS	45													
26 28 30 32	53 51 49 47	30 28 27 25	ROCKWELL HARDNESS	35								\		ļ			
RECON *NORM	TING TEMPERAT MENDED BY SA MALIZE 1600 ° ENITIZE 1550 °	E F	_ ×	25													\setminus
*For forged or rolle	ed specimens onl	ly.			2	4 D	6 8	10 E FRO					20 2 EENTH			28	30 3

Note-1 in. = 25.4 mm.

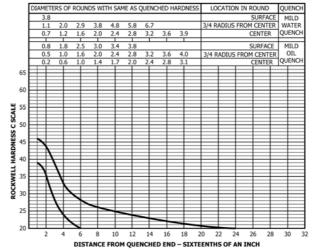
FIG. 49 Limits for Hardenability Band 51B60 H



	ESS LIMITS ATION PUR								
"J" DISTANCE SIXTEENTHS	611	8 H							
OF AN INCH	MAX.	MIN.							
1 2 3 4	46 44 38 33	39 36 28 24							
5 6 7 8	30 28 27 26	22 20 - -							
9 10 11 12	26 25 25 24								
13 14 15 16	24 23 23 22								
18 20 22 24	22 21 21 20								
26									
HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1700 °F AUSTENITIZE 1700 °F *For forged or rolled specimens only.									

HARDENABILITY BAND 6118 H

ı	С	Mn	Si	Cr	V
	0.15/0.21	0.40/0.80	0.15/0.35	0.40/0.80	0.10/0.15



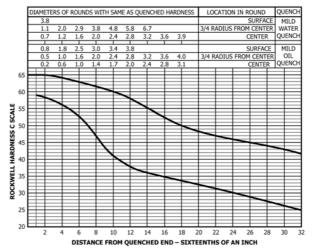
Note-1 in. = 25.4 mm.

FIG. 50 Limits for Hardenability Band 6118 H

	ESS LIMITS ATION PUR	
"J" DISTANCE	615	i0 H
SIXTEENTHS OF AN INCH	MAX.	MIN.
1	65	59
2	65	58
3	64	57
4	64	56
5	63	55
6	63	53
7	62	50
8	61	47
9	61	43
10	60	41
11	59	39
12	58	38
13	57	37
14	55	36
15	54	35
16	52	35
18	50	34
20	48	32
22	47	31
24	46	30
26	45	29
28	44	27
30	43	26
32	42	25
RECOI *NORI	ATING TEMPERA MMENDED BY SI MALIZE 1650 TENITIZE 1600 ed specimens or	AE °F °F

HARDENABILITY BAND 6150 H

С	Mn	Si	Cr	٧
0.47/0.54	0.60/1.00	0.15/0.35	0.75/1.20	0.15 MIN

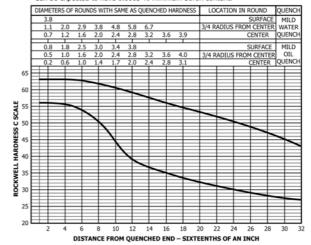


Note-1 in. = 25.4 mm.

FIG. 51 Limits for Hardenability Band 6150 H

HARDN	ESS LIMITS	FOR							
	ATION PUR	POSES							
"J" DISTANCE SIXTEENTHS	81B								
OF AN INCH	MAX.	MIN.							
1	63	56							
2	63	56							
3	63	56							
4	63	56							
5	63	55							
6	63	54							
7	62	53							
8	62	51							
9	61	48							
10	60	44							
11	60	41							
12	59	39							
13	58	38							
14	57	37							
15	57	36							
16	56	35							
18	55	34							
20	53	32							
22	52	31							
24	50	30							
26	49	29							
28	47	28							
30	45	28							
32	43	27							
HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1600 °F AUSTENITIZE 1550 °F *For forged or rolled specimens only.									

*Can be expected to have 0.0005 % minimum boron content.



Note-1 in. = 25.4 mm.

FIG. 52 Limits for Hardenability Band 81B45 H

	ESS LIMITS FO ATION PURPO				С	_	Mn		Si	LITY		C			10	_
" DISTANCE	861	7 H	1		<u> </u>	10.		_			_		,	_		\vdash
IXTEENTHS IF AN INCH	MAX	MIN	1		0.14	0.6	0.95	0.15	0.35	0.35/	0.75	0.35/	0.65	0.15	0.25	l
1	46	39	l	- 1	/ 0.2	٠,	, 0.55	_ ′	0.55	_ ′	0.75		0.05	_ ′	0.23	_
2	44	33	l													
3	41	27	l	- 1	DIAMETERS	OF RO	UNDS WITH	H SAME	AS QUEN	ICHED HA	ARDNES:	S LC	CATIO	N IN RO	DUND	QU
4	38	24	l	1	3.8									5	URFACE	N
5	34	20	1	ı	1.1 2	0 2.	9 3.8	4.8	5.8 6.7	7		3/4	RADIU	JS FROM	4 CENTE	R W
6	31		l	ı	0.7 1				2.8 3.7	2 3.6	3.9	1 -7			ENTER	Tou
7	28		l	ŀ								_				100
8	27		l	L	0.8 1				3.8			\perp			SURFACE	
			l	I.	0.5 1				2.8 3.2		4.0	3/4	RADI		4 CENTE	
9	26		l	I.	0.2 0	6 1.	0 1.4	1.7	2.0 2.4	4 2.8	3.1				ENTER	QU
10	25		l	65			=	\rightarrow	+	_	_	-	+	-	=	=
11	24		l	-										-		
12	23		l	60												
13	23	-	"	~			=	=	+	=	_	-	=	=	=	
14	22		SCALE	55			=	=	-	=	_	-	=	=	=	=
15	22	-	l &	22										=		
16	21	-	0													
18	21		l 8	50			=	=	+	_	_	-	=	=	=	=
20	20		≌							_				_		
22	20		5	45	\sim											
24			≝		\rightarrow			+	\vdash	=	=	=		=		
	-	-	ROCKWELL HARDNESS	40	\rightarrow			-	+	=	-	-		-	\vdash	
26	-	-	=		/ /	_										
28	-		3	35		\		_	=	_	=	-		-		
30	-	-	≩	- 1	\rightarrow	$\overline{}$			-	_				-		
32	-	-	Ι Σ	30	\rightarrow	_										
HEAT TREAT	TING TEMPERAT	TURES	≥	-	\rightarrow			-	+	\rightarrow	=	_		-		=
	MENDED BY SA		l	25	\rightarrow		\rightarrow			_						
*NORMALI			l	23												
AUSTENI	TIZE 1700	oF.	l			\				_	\perp					
forged or rolled			l	20	2 4	- 6	5 8	10	12 1	4 16	18	20	22	24 2	6 28	3

Note-1 in. = 25.4 mm.

FIG. 53 Limits for Hardenability Band 8617 H



	ESS LIMITS FO											D <u>86</u>	<u>20</u> H				
	ATION PURPO			С		Mn	\Box		Si		Vi	C			lo		
)" DISTANCE SIXTEENTHS OF AN INCH	8620 MAX	MIN		0.17/0	.23	0.60/	.95	0.15	/ _{0.35}	0.35	0.75	0.35/	0.65	0.15	0.25		
1	48	41		_ , ,		, ,			0.55	_ ′	0175		0.05	,	0.25		_
2	47	37															
3	44	32		DIAMETER	RS OF	ROUNDS	WITH	SAME	AS QUE	NCHED	HARDNE	SS LC	CATIO	N IN RO		QU	
4	41	27		3.8											URFACE		ИIL
5	37	23		1.1	2.0				5.8 6.			3/4	RADIL		1 CENTE		/AT
6	34	21		0.7	1.2	1.6 2	2.0	2.4	2.8 3.		3.9			C	ENTER	QU	JEN
7	32			0.8	1.8	2.5 3	3.0		3.8			-		S	URFACE	_ M	ИIL
8	30	-		0.5	1.0				2.8 3.	.2 3.€	4.0	3/4	RADIL		1 CENTE		OIL
9	29			0.2	0.6	1.0 1	1.4	1.7	2.0 2	.4 2.8	3.1			C	ENTER	Πqu	JEN
10	28	- 1	6		\pm												E
11	27	- 1		1	+	_		=		=	_	_	=	=	=		F
12	26		6														Е
13	25	-	SCALE		+	_			-	=	=	_	=	=	\vdash	_	F
14	25	- 1	₹ 5		\pm												Е
15	24	- 1	ທິ		-												
16	24	-	S 5		=												E
18	23	-	SS 3		-												E
20	23	.	Z۵												\vdash		E
22	23	- 1	₽,														E
24	23	-	¥ 4		X										=		E
26	23	-	Ξ,		_						_						E
28	22	- 1	₩ 3			$\overline{}$											E
30	22	- 1	€ 3		\mp	_											E
32	22	-	ROCKWELL HARDNESS			_											E
HEAT TREAT	TING TEMPERATI	URES	8 3		V						=						F
	MENDED BY SAI		2		- 1			_	$\overline{}$								Е
*NORM	MALIZE 1700 °	F			-												E
AUST	ENITIZE 1700 °	F	2		\pm	\											Е
forged or rolled:	enerimens only		2	2	4	6	8	10	12 1	4 16	18	20	22	24 2	6 28	3	0

 $\label{eq:Note-1} \mbox{Note-1 in.} = 25.4 \mbox{ mm}.$ FIG. 54 Limits for Hardenability Band 8620 H

HARDN	ESS LIMITS FO	OR .					Н	ARE	DENA	BI	LITY	BANI	D <u>80</u>	<u>522</u> I	Н				
SPRCIFIC	CATION PURPO	SES		С		М	ln		Si	П	N	i	(Cr	Т	Мо	\Box		
")" DISTANCE SIXTEENTHS	862			0.19/	′	0.60	/	0.1	5/	П	0.35 /	/	0.35	/	0.1	5/	Т		
OF AN INCH	MAX.	MIN.		/	0.25	/	0.95		/ 0.	35	/	0.75	/	0.65	5	/ 0.2	25		
1	50	43						_		_					_				_
2	49	39																	_
3	47	34		DIAMET	ERS O	ROUN	OS WIT	H SAM	ME AS (QUEN	ICHED H	IARDNE	SS	LOCAT	ION IN	ROUN		QUE	NC
4	44	30		3.8												SURFA		MII	
5	40	26		1.1	2.0	2.9	3.8	4.8	5.8	6.7			3/	4 RAD	US FR	OM CEN		WAT	
6	37	24		0.7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9				CENT	ER	QUE	NC
7	34	22		0.8	1.8	2.5	3.0	3.4	3.8	_			=			SURFA	VCE.	MII	_
8	32	20		0.5	1.0	1.6	2.0	2.4	2.8	3.2	3.6	4.0	1 2/	M DAD	HC ED	OM CEN		OI	
9	31			0.3	0.6	1.0	1.4	1.7	2.0	2.4		3.1	3/	4 1040	US FR	CENT		QUE	
10	30	- 1			0.0	1.0	1.7	1./	2.0	-2.7	2.0	3.1	\pm			CENT		QUL	-
11	29		6	5	=	=	_	-	=	=	=	=	=		-	=	+	=	=
12	28	- 1															\pm		Ξ
13	27		щ 6	⁰₩₩	=	=	-	-	=	\Rightarrow	=	=	=	+	-	=	+	-	=
14	26		SCALE	\vdash	=	_	_	-	=	-	_	_	=	+	-	_	+	-	=
15	26		Q 5	5				-		=					\pm		\pm		Ξ
16	25		CS							=							+		Ξ
				0	=	=	_	_	\rightarrow	_	=	_	=	_	-	=	+	_	=
18	25	-	ES														\pm		Ξ
20	24	-	Z 4	5	\mathbf{V}					_		_					\perp		Ξ
22	24	-	₩.	1	\rightarrow	_	_	#	_	=	_	_	=	=	+	_	#	=	=
24	24	-	HARDNESS		⇒,	\leftarrow	_	_	=	=	=	_	=		\pm	_	\pm	_	=
26	24			$^{\circ}$		\mathbf{V}			=	=	=	=	=				+		Ξ
28	24	- 1	₩ 3	.==1	=	\sim	=	=	=	=	_	_	=	=		=	+	=	=
30	24	-	≥ ₃		lacksquare					\equiv				\equiv	\equiv		\pm		Ξ
32	24	-	ROCKWELL	عاداً م	V	_	\rightarrow		-	=	_	-	+	+	+	-	+	=	=
HEAT TOEK	TING TEMPERAT	TIDEC	2 3	"	$\overline{}$			\rightarrow											Ξ
	MMENDED BY SA		_	-	= '	$\overline{}$	_	-	\blacksquare	$\overline{}$		_	\rightarrow		-	_	+	_	=
*NORM			2	THE SECOND	=	N	=	\pm	=	=		_	+	+	_	\blacksquare	-	_	Ξ
	NITIZE 1700					$\overline{}$				=							\pm	=	Ξ
		.	2	0 2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	_
r forged or rolled	specimens only.			2	-	ISTAN	-											30	

 $\label{eq:Note-1} \mbox{Note--1 in.} = 25.4 \mbox{ mm}.$ FIG. 55 Limits for Hardenability Band 8622 H



	ESS LIMITS]		
SPECIFIC	ATION PUR	POSES		С	
)" DISTANCE	862	5 H]	0.22/	0.6

HEAT TREATING TEMPERATURES
RECOMMENDED BY SAE
*NORMALIZE 1650 °F
AUSTENITIZE 1600 °F
*For forged or rolled specimens only.

	HARDENABILITY BAND <u>8625</u> H										
	С	Mn	Si	Ni	Cr	Мо					
0.2	2/0.28	0.60/0.95	0.15/0.35	0.35/0.75	0.35/0.65	0.15/0.25					

[ROUN	OS WI	TH SAN	1E AS (QUENC	HED H	ARDNES:	S I	LOCAT	TION I	 OUND		QUENC
ŀ	3.8	2.0	2.9	3.8	4.8	5.8	6.7			2//	DAD	ILIC E	SURFA CENT		MILD
- 1	0.7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9	3/5	F FOAD.	IUS FI	ENTE		QUENC
ŀ							5.2	510	1	+			URFA		MILD
- 1	0.8	1.8	2.5	2.0	2.4	3.8 2.8	3.2	3.6	4.0	3/4	1 PAD	TIIS F	I CEN		OIL
- 1	0.2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1	13/	TRAD	103 1	CENTE	R	QUENC
65				\equiv	\mp					F	Ŧ	\equiv		E	
	\blacksquare	=	\pm	\pm	\pm	\pm	\pm			+		#			=
60	#	=	=	=	#	=	=	=		ŧ	#	#		E	=
55	\blacksquare	=	+	#	#	+	+	+	-	F	+	#		F	-
	V		=	-	=	-	\equiv			F		=		F	
50			=		\pm	\pm	\pm			E				E	
45		λ	_	_	\pm	\pm	\pm					#			
"	N	=)	\	=	#	=	=	-		#	#	#		E	
40	+		X	-	+	+	+	+		F		+		F	
35		lacksquare												E	
55 50 45 40 35		V		\rightarrow										E	
30	\pm	\rightarrow	\pm	\pm	₽	$\overline{}$				\pm	\pm	\pm		E	
· E	\pm	=	\setminus	=	#		◝	+	_	+	_			E	=
25	#	=		$ \leftarrow $	=	#	#	#		F	#	#		F	=
20 E	Щ	_		#	_							1			
	2	4	6	8	10	12	14	16	18 - SIX 1	20	22	24		28	30

Note-1 in. = 25.4 mm.

FIG. 56 Limits for Hardenability Band 8625 H

	Mo	Cr	Ni	Si	Mn	С	-		SATION PURPO	3" DISTANCE
	0.15/).35/	0.35/	0.15 /	0.60/	0.24/	1	MIN	MAX	SIXTEENTHS OF AN INCH
	0.25	0.65	0.75	/0.35	0.95	0.30	1	47	54	1
								43	52	2
QUE	ION IN ROUND	LOCATI	ICHED HARDNESS	I SAME AS QUEN	F ROUNDS WITH	DIAMETERS C	1 [38	50	3
MIL	SURFACE					3.8	1 [35	48	4
1 WAT	IUS FROM CENTER	3/4 RADI	7	4.8 5.8 6.1	2.9 3.8	1.1 2.0	1 1	32	45	5
QUE	CENTER		2 3.6 3.9	2.4 2.8 3.	1.6 2.0	0.7 1.2	1 1	29	43	6
÷	SURFACE	_					1 1	27	40	7
MIL		2/4 0 4 0 1	2 26 40	3.4 3.8		0.8 1.8	1 1	28	38	s I
01	IUS FROM CENTER	3/4 KADIU		2.4 2.8 3.		0.5 1.0	1 1	24	36	_
QUE	CENTER		4 2.8 3.1	1.7 2.0 2.	1.0 1.4	0.2 0.6	1 1	24	36	9 10
_				+			65	29	34	
							I "	22	32	11 12
=	+	+	\rightarrow	+	\rightarrow	\rightarrow	60			
							I ພ∾[21	31	13
_	+			\vdash			 	21	30	14
=				$\overline{}$			SCALE 25	20	30	15
=				\perp			1 0 1	20	29	16
=	+	+	\rightarrow	+		- X			28	18
							l 🖺	-	28	20
-	+			\vdash	\vee	- N	₹ 45		28	22
=				+		\perp	HARDNESS 45	-	27	24
-	+	+	\rightarrow	+	\rightarrow	\rightarrow			27	26
							= -	-	27	28
=	+	=				\rightarrow	₩ 35	-	27	30
=							≩	-	27	32
1					N		ROCKWELL 30	RES	ITING TEMPERATUR	
							25 20		MALIZE 1650 °F ENITIZE 1600 °F	

NOTE—1 in. = 25.4 mm.

FIG. 57 Limits for Hardenability Band 8627 H



29 29 29 29 HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1650 °F AUSTENITIZE 1600 °F *For forged or rolled specimens only

21 20 20

")" DISTANCE SIXTEENTHS OF AN INCH

*For forged or rolled specimens only.

HARDENABILITY BAND 8630 H

ı	O	Mn	Si	Ni	Cr	Mo	
	0.27/0.33	0.60/0.95	0.15/0.35	0.35/0.75	0.35/0.65	0.15/0.25	

0		RS OF	ROUN	DS WIT	TH SAN	1E AS (QUENC	HED H	ARDNESS	LO	CATION I			QUE	
⊢	3.8		2.0	2.0						2/4 0			URFACE		
⊢	0.7	1.2	2.9	3.8	4.8 2.4	5.8 2.8	6.7 3.2	3.6	3.9	3/4 R	ADIUS FR		NTER	QUE!	
Ŀ	0.7						3.2	3.0	3.9					1	
L	0.8	1.8	2.5	3.0	3.4	3.8							JRFACE	MII	
⊢	0.5	1.0	1.6	2.0	2.4	2.8	3.2	3.6	4.0	3/4 R	ADIUS FR			QUE	
Ŀ	0.2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1				ENTER	QUE	W.
65	-	-	-	-	-	-	=	-	_		\vdash	=	=	=	=
E							=					\equiv		=	Ξ
60	-	=	_	\pm	_		=	_	_			=	=	=	=
E					-		=					=		=	Ξ
55												=		\equiv	Ξ
F	#	\rightarrow	=	+	+	_	=	-	=			=	=	\rightarrow	=
50												=		=	Ξ
45	\perp		λ		_		_					\equiv			Ξ
43 E	₩,		₩,		-		-	-	_			=		_	Ξ
40 F		V		X	-		=							=	Ξ
ΪĒ	+	_	\pm	-	$ \overline{}$		=	_				=	=	=	Ξ
35	-	₩,	\leftarrow	+	♪		-	-	=			=	=	=	=
			V			_	_					=		=	Ξ
30	+	\pm	\rightarrow	\pm	-	_	-	\blacksquare	_			=		_	
F		=	=	\mathbf{X}		-	=	-	_			=	=	\equiv	Ξ
25		=	=		`		=	=	=			=	=	_	Ξ
F		=	_	\pm	+	_	$\overline{}$					=	_	=	=
20 ┗		_			40	42		46	40	20.	2 24		- 20	20	=
	2	4	6	8	10	12	14	16 D END	18	20 2	2 24	26	28	30	

Note-1 in. = 25.4 mm.

FIG. 58 Limits for Hardenability Band 8630 H

HARDENABILITY BAND 86B30 H HARDNESS LIMITS FOR SPECIFICATION PURPOSES Cr С Mn Si Ni Мо .27/.33 .15/.35 .35/.65 .60/.95 .35/.75 .15/.25 MAX. 56 55 55 55 49 49 48 48 *Can be expected to contain 0.0005 to 0.003 per cent boron. DIAMETERS OF ROUNDS WITH SAME AS QUENCHED HARDNESS LOCATION IN ROUND QUENCH SURFACE MILD 48 48 48 47 54 54 53 53 OUENCH CENTER MILD SURFACE 3/4 RADIUS FROM CENTER CENTER QUENCI 52 52 52 51 46 44 42 40 65 11 12 60 13 14 15 16 51 50 50 49 39 38 HARDNESS C SCALE 55 36 35 50 18 20 22 24 48 47 45 44 31 29 28 27 26 25 35 30 30 26 28 30 32 43 41 40 39 HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1650 °F AUSTENITIZE 1600 °F

Note-1 in. = 25.4 mm. FIG. 59 Limits for Hardenability Band 86B30 H

10

12 14

16 18 20

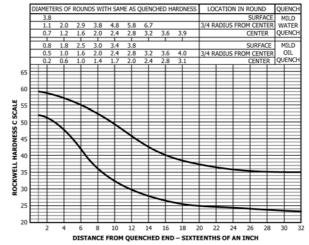
DISTANCE FROM QUENCHED END - SIXTEENTHS OF AN INCH

30

	ESS LIMITS ATION PUR	
"J" DISTANCE SIXTEENTHS		7 H
SIXTEENTHS OF AN INCH	MAX.	MIN.
1	59	52
2	58	51
3	58	50
4	57	48
5	56	45
6	55	42
7	54	39
8	53	36
9	51	34
10	49	32
11	47	31
12	46	30
13	44	29
14	43	28
15	41	27
16	40	26
18	39	25
20	37	25
22	36	24
24	36	24
26	35	24
28	35	24
30	35	23
32	35	23
RECON *NORM	ATTING TEMPERA AMENDED BY SA MALIZE 1600 TENITIZE 1550 and specimens of	AE °F °F

HARDENABILITY BAND 8637 H

С	Mn	Si	Ni	Cr	Мо	
0.34/0.41	0.70/1.05	0.15/0.35	0.35/0.75	0.35/0.65	0.15/0.25	



Note-1 in. = 25.4 mm.

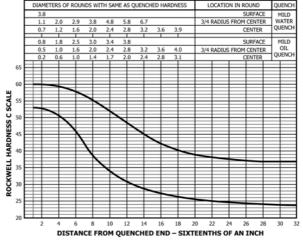
FIG. 60 Limits for Hardenability Band 8637 H

	SS LIMITS ATION PURI				
")" DISTANCE	864	0 H			
SIXTEENTHS OF AN INCH	MAX.	MIN.			
1	60	53			
2	60	53			
3	60	52			
4	59	51			
5	59	49			
6	58	46			
7	57	42			
8	55	39			
9	54	36			
10	52	34			
11	50	32			
12	49	31			
13	47	30			
14	45	29			
15	44	28			
16	42	28			
18	41	26			
20	39	26			
22	38	25			
24	38	25			
26	37	24			
28	37	24			
30	37	24			
32	37	24			
HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1600 °F AUSTENTIZE 1550 °F					

*For forged or rolled specimens only.

HARDENABILITY BAND 8640 H

ı	С	Mn	Si	Ni	Cr	Мо	
ı	0.37/0.44	0.70/1.05	0.15/0.35	0.35/0.75	0.35/0.65	0.15/0.25	



Nоте-1 in. = 25.4 mm.

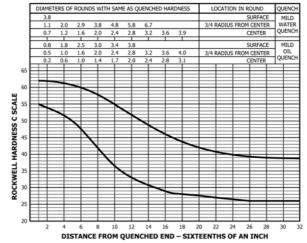
FIG. 61 Limits for Hardenability Band 8640 H



HEAT TREATING TEMPERATURES
RECOMMENDED BY SAE
*NORMALIZE 1600 °F
AUSTENITIZE 1550 °F
*For forged or rolled specimens only.

HARDENABILITY BAND 8642 H

С	Mn	Si	Ni	Cr	Мо	
0.39/0.46	0.70/1.05	0.15/0.35	0.35/0.75	0.35/0.65	0.15/0.25	



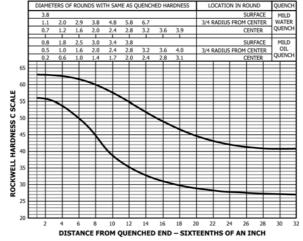
Note-1 in. = 25.4 mm.

FIG. 62 Limits for Hardenability Band 8642 H

HARDNESS LIMITS FOR SPECIFICATION PURPOSES 63 63 63 63 56 56 55 54 52 50 48 45 62 61 61 60 59 58 56 55 41 39 37 35 9 10 11 12 34 33 32 31 13 14 15 16 54 52 51 49 30 29 28 28 18 20 22 24 27 27 27 27 26 28 42 41 41 41 HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1600 °F AUSTENITIZE 1550 °F *For forged or rolled specimens only

HARDENABILITY BAND 8645 H

С	Mn	Si	Ni	Cr	Мо	
0.42/0.49	0.70/1.05	0.15/0.35	0.35/0.75	0.35/0.65	0.15/0.25	



Note-1 in. = 25.4 mm.

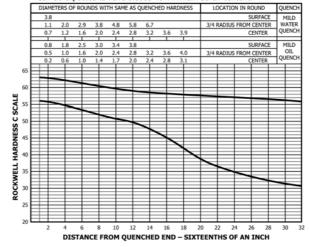
FIG. 63 Limits for Hardenability Band 8645 H

HARDNESS LIMITS FOR SPECIFICATION PURPOSES 63 62 62 54 53 52 52 62 61 61 60 51 51 50 50 60 60 59 59 10 11 12 49 48 46 45 13 14 15 16 59 59 58 58 42 39 37 35 18 20 22 24 58 58 57 57 34 32 32 31 26 28 30 32 HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1600 °F AUSTENITIZE 1550 °F *For forged or rolled specimens only.

HARDENABILITY BAND 86845 H

С	Mn	Si	Ni	Cr	Мо	В
0.42/0.49	0.70/1.05	0.15/0.35	0.35/0.75	0.35/0.65	0.15/0.25	*

*Can be expected to have 0.0005 % minimum boron content.



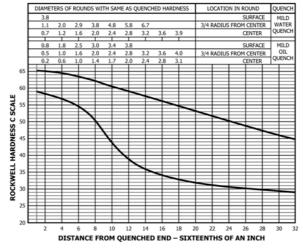
Note-1 in. = 25.4 mm.

FIG. 64 Limits for Hardenability Band 86B45 H

	SS LIMITS ATION PUR				
")" DISTANCE SIXTEENTHS	865				
SIXTEENTHS OF AN INCH	MAX.	MIN.			
1	65	59			
2	65	58			
3	65 64	57 57			
5 6	64 63	56 54			
7	63	59			
8	62	50			
9	61	47			
10	60	44			
11	60	41			
12	59	39			
13	58	37			
14 15	58 57	36 35			
16	56	35			
	55	33			
18 20	53	33 32			
22	52	31			
24	50	31			
26	49	30			
28	47	30			
30 32	46 45	29 29			
32	45	29			
HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1600 °F					
*For forged or rolled specimens only.					

HARDENABILITY BAND 8650 H

[С	Mn	Si	Ni	Cr	Mo	
	0.47/0.54	0.70/1.05	0.15/0.35	0.35/0.75	0.35/0.65	0.15/0.25	



Note-1 in. = 25.4 mm.

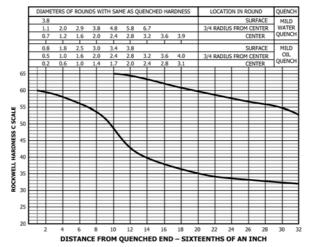
FIG. 65 Limits for Hardenability Band 8650 H



HARDNESS LIMITS FOR SPECIFICATION PURPOSES 60 59 59 58 57 56 55 54 52 49 46 43 9 10 11 12 65 65 64 64 63 63 62 13 14 15 16 41 40 39 38 61 60 59 58 18 20 22 24 37 35 34 34 33 33 32 32 HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1600 °F AUSTENITIZE 1550 °F *For forged or rolled specimens only.

HARDENABILITY BAND 8655 H

	С	Mn	Si	Ni	Cr	Мо	
0.5	%.60	0.70/1.05	0.15/0.35	0.35/0.75	0.35/0.65	0.15/0.25	



Note-1 in. = 25.4 mm.

FIG. 66 Limits for Hardenability Band 8655 H

SPECIFICA "J" DISTANCE					
SIXTEENTHS OF AN INCH	MAX.	MIN.			
	MAX.				
1	-	60			
2	-	60			
3	-	60			
4		60			
5	-	60			
6	-	59			
7	-	58			
8	-	57			
9	-	55			
10	-	53			
11	-	50			
12		47			
13	-	45			
14	-	44			
15	-	43			
16	65	42			
18	64	40			
20	64	39			
22	63	38			
24	62	37			
26	62	36			
28	61	36			
30	60	35			
32	60	35			
HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1600 °F					

*For forged or rolled specimens only

HARDENABILITY BAND 8660 H

[С	Mn	Si	Ni	Cr	Mo	
	0.55/0.65	0.70/1.05	0.15/0.35	0.35/0.75	0.35/0.65	0.15/0.25	

- 1	_									RDNESS	+-	OCATIO		SURFACE	QUENC
- 1		3.8	2.0	2.9	3.8	4.8	5.8	6.7			2/4	DADTHE		SURFACE 4 CENTER	MILD
- 1		0.7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9	3/4	KADIUS		CENTER	QUENC
		0.7	1.2	1.6	2.0	2.4	2.0	3.2	3.0	3.9	+			CENTER	- C
		8.0	1.8	2.5	3.0	3.4	3.8							SURFACE	MILE
		0.5	1.0	1.6	2.0	2.4	2.8	3.2	3.6	4.0	3/4	RADIUS		M CENTER	QUEN
- 1	-	0.2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1	+	_	_	CENTER	QUEIN
65			=						_	_				\blacksquare	
	=	+	_	-	-	_	-	=	_	=			_		=
60	-		$\overline{}$	•											$\overline{}$
			=	_	$\overline{}$	=	\pm	\pm	=	_				=	_
55			-	-	-		-	-	-						_
			=		=	\rightarrow		\pm						+	
50		F	=	=	-	-		-	=					=	_
							X	\pm							
45	-	+	=	-	-	-	٠,	\checkmark	-	=	=			+	=
									$\overline{}$						
40	-	+	-	-	-	_	-	-		$\overline{}$	-			+	_
												\mathbf{r}			
35		\pm	=			=			=						
		F													
30			=												
															=
25			=												
		F	=												==
20	_	2	4	6	8	10	12	14	16	18	20 2	22 2	14	26 28	30

Note-1 in. = 25.4 mm.

FIG. 67 Limits for Hardenability Band 8660 H



HARDNESS LIMITS FOR SPECIFICATION PURPOSES 48 47 45 42

23 23 22 22 HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1700 °F AUSTENITIZE 1700 °F

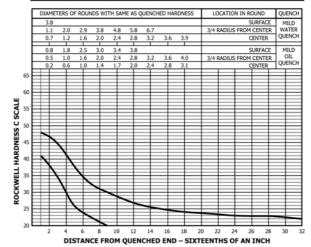
For forged or rolled specimens only

13 14

20

HARDENABILITY BAND 8720 H

С	Mn	Si	Ni	Cr	Мо	
0.17/0.23	0.60/0.95	0.15/0.35	0.35/0.75	0.35/0.65	0.20/0.30	



Note-1 in. = 25.4 mm.

FIG. 68 Limits for Hardenability Band 8720 H

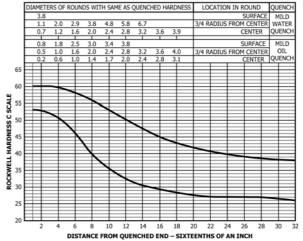
SPECIFIC	HARDNESS LIMITS FOR SPECIFICATION PURPOSES					
")" DISTANCE SIXTEENTHS OF AN INCH	874 MAX.	0 H MIN.				
1	60	53				
2	60	53				
3	60	52				
4	60	51				
5	59	49				
6	58	46				
7	57	43				
8	56	40				
9	55	37				
10	53	35				
11	52	34				
12	50	32				
13	49	31				
14	48	31				
15	46	30				
16	45	29				
18	43	28				
20	42	28				
22	41	27				
24	40	27				

HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1600 °F AUSTENITIZE 1550 °F

* For forged or rolled specimens only

HARDENABILITY BAND 8740 H

С	Mn	Si	Ni	Cr	Мо	
0.37/0.44	0.70/1.05	0.15/0.35	0.35/0.75	0.35/0.65	0.20/0.30	



Note-1 in. = 25.4 mm.

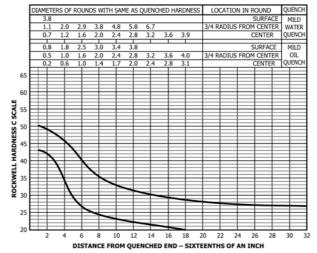
FIG. 69 Limits for Hardenability Band 8740 H



	HARDNESS LIMITS FOR SPECIFICATION PURPOSES					
")" DISTANCE	8822 H					
SIXTEENTHS OF AN INCH	MAX.	MIN.				
1 2 3 4	50 49 48 46	43 42 39 33				
5 6 7 8	43 40 37 35	29 27 25 24				
9 10 11 12	34 33 32 31	24 23 23 22				
13 14 15 16	31 30 30 29	22 22 21 21				
18 20 22 24	29 28 27 27	20 - - -				
26 28 30 32	27 27 27 27 27					
RECON*NORM	ATING TEMPERA IMENDED BY SA IALIZE 1700 ° ENITIZE 1700 ° led specimens o	E F F				

HARDENABILITY BAND 8822 H

С	Mn	Si	Ni	Cr	Мо	
0.19/0.25	0.70/1.05	0.15/0.35	0.35/0.75	0.35/0.65	0.30/0.40	



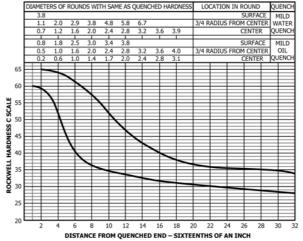
Note-1 in. = 25.4 mm.

FIG. 70 Limits for Hardenability Band 8822 H

	ESS LIMITS ATION PUR	
"J" DISTANCE SIXTEENTHS	926	0 H
OF AN INCH	MAX.	MIN.
1 2 3 4	- 65 64	60 60 57 53
5	63	46
6	62	41
7	60	38
8	58	36
9	55	36
10	52	35
11	49	34
12	47	34
13	45	33
14	43	33
15	42	32
16	40	32
18	38	31
20	37	31
22	36	30
24	36	30
26	35	29
28	35	29
30	35	28
32	34	28
RECOM *NORM	NITIZE 160	SAE D °F D °F

HARDENABILITY BAND 9260 H

С	Mn	Si		
0.55/0.65	0.65/1.10	1.70/2.20		



Noτε-1 in. = 25.4 mm.

FIG. 71 Limits for Hardenability Band 9260 H



	HARDNESS LIMITS FOR SPECIFICATION PURPOSES					
"J" DISTANCE SIXTEENTHS	931	0 H				
OF AN INCH	MAX.	MIN.				
1	43	36				
2	43	35				
3	43	35				
4	42	34				
5	42	32				
6	42	31				
7	42	30				
8	41	29				
9	40	28				
10	40	27				
11	39	27				
12	38	26				
13	37	26				
14	36	26				
15	36	26				
16	35	26				
18 20 22 24	35 35 34 34	26 25 25 25 25				
26	34	25				
28	34	25				
30	33	24				
32	33	24				
	NITIZE 1550	SAE) °F) °F				

HARDENABILITY BAND 9310 H

С	Mn	Si	Ni	Cr	Mo	
0.07/0.13	0.40/0.70	0.15/0.35	2.95/3.55	1.00/1.45	0.08/0.15	

Ī	DIAN	1ETE	RS OF	ROUN	DS WI	TH SAI	ME AS	QUENC	HED H	ARDNESS	LC	CATIO	N IN F	ROUND	Q	UENC
		3.8												SURFAC		MILE
- 1		1.1	2.0	2.9	3.8	4.8	5.8	6.7			3/4 F	RADIUS		CENT		WATE
ŀ	- (0.7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9	₩			ENTER	- 19	UENO
	- (0.8	1.8	2.5	3.0	3.4	3.8						S	URFAC	E	MILE
		0.5	1.0	1.6	2.0	2.4	2.8	3.2	3.6	4.0	3/4 F	RADIUS	FROM	CENT	ER	OIL
	_ (0.2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1				ENTER	2	UEN
65	ŧ	ŧ	\pm	+	\pm	+	\pm	+	+							ŧ
60																
55																F
55 50 45 40 35					1											F
45					#											F
40	Ī		T	1	\Rightarrow	•										F
35	h	_						+	+	-						
30				\setminus	\blacksquare											Π
25						ightharpoons	+	+	+	-						
20 E		2	4	6	8	10	12	14	16	18	20 :	22 7	24 2	26 28		30

Note-1 in. = 25.4 mm.

FIG. 72 Limits for Hardenability Band 9310 H

	ESS LIMITS ATION PUR				
"J" DISTANCE SIXTEENTHS	94B	15 H			
OF AN INCH	MAX.	MIN.			
1 2 3 4	45 45 44 44	38 38 37 36			
5 6 7 8	43 42 40 38	32 28 25 23			
9 10 11 12	36 34 33 31	21 20 - -			
13 14 15 16	30 29 28 27				
18 20 22 24	26 25 24 23				
26 28 30 32	23 22 22 22 22				
	NITIZE 1700	SAE) °F) °F			

HARDENABILITY BAND 94B15 H

I	С	Mn	Si	Ni	Cr	Мо	В
	0.12/0.18	0.70/1.05	0.15/0.35	0.25/0.65	0.25/0.55	0.08/0.15	*

*Can be expected to have 0.0005 % minimum boron content.

3.8 1.1 0.7 0.8 0.5 0.2	2.0 1.2 1.8 1.0	2.9 1.6 1	3.8 2.0 3.0	4.8	5.8	6.7			3/4 R	ADTHE		URFAC		MILD
0.7 0.8 0.5	1.2	1.6 2.5	2.0	2.4					13/4 R					
0.8	1.8	2.5			2.8				5/ 114	4DIU3				VATER
0.5	1.8		3.0			3.2	3.6	3.9	-		C	ENTER	Q	UENC
	1.0			3.4	3.8						S	URFACE		MILD
0.2		1.6	2.0	2.4	2.8	3.2	3.6	4.0	3/4 R	ADIUS		CENTE		OIL
	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1	_	_		ENTER	Q	UENC
	=	-	+		+	=	=	=						=
	#													
_	\blacksquare		\pm		ŧ	\pm								E
		\nearrow	\blacksquare		ŧ	\pm								
	\nearrow			$ \sqrt{}$	ŧ	\pm								
	Ŧ	V	\pm	ŦÌ	\rightarrow	\blacktriangleleft								
		₽						$\overline{}$						
Ļ	Į	Į	Ď	Ų.			1	10						30
	2	2 4								2 4 6 8 10 12 14 16 18 20 2 DISTANCE FROM QUENCHED END - SIXTEENTH				

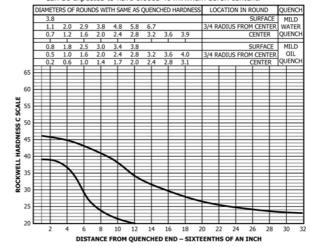
Note-1 in. = 25.4 mm.

FIG. 73 Limits for Hardenability Band 94B15 H

0.14/0.20

	ESS LIMITS ATION PUR					
"J" DISTANCE SIXTEENTHS	94B	17 H				
OF AN INCH	MAX.	MIN.				
1 2 3 4	46 46 45 45	39 39 38 37				
5 6 7 8	44 43 42 41	34 29 26 24				
9 10 11 12	40 38 36 34	23 21 20 -				
13 14 15 16	33 32 31 30					
18 20 22 24	28 27 26 25					
26 28 30 32	24 24 23 23					
RECOM *NORMA	NITIZE 1700	SAE) °F) °F				

*Can be expected to have 0.0005 % minimum boron content.



Nоте-1 in. = 25.4 mm.

FIG. 74 Limits for Hardenability Band 94B17 H

		DOCEC	1				LITY BAN			
J" DISTANCE	ATION PUR 94B		1	C	Mn	Si	Ni	Cr	Mo	<u>B</u>
SIXTEENTHS OF AN INCH	MAX.	MIN.	1	0.27/0.33	0.70/1.05	0.15/0.35	0.25/0.65	0.25/0.55	0.08/0.15	*
1	56	49	1	*Can be	expected to	have 0.00	05 % minim	um boron	content.	
2 3	56 55	49 48	l	DIAMETERS O	F ROUNDS WIT	H SAME AS QU	ENCHED HARDN	ESS LOCAT	TION IN ROUND	QUEN
4	55 55	48 48	l	3.8					SURFACE	MILL
5	54	47	1	1.1 2.0	217 010	110 010 0	.7	3/4 RADI	IUS FROM CENTE	
6	54	46	ı	0.7 1.2	1.6 2.0	2.4 2.8 3	.2 3.6 3.9		CENTER	QUENC
7	53	44	l	0.8 1.8	2.5 3.0	3.4 3.8			SURFACE	
8	53	42	1	0.5 1.0 0.2 0.6	1.6 2.0 1.0 1.4		3.6 4.0 3.4 2.8 3.1	3/4 RADI	US FROM CENTE CENTER	R OIL QUEN
9	52	39	65	0.2 0.6	1.0 1.4	1.7 2.0 2	.4 2.6 3.1		CENTER	Pagerin
10 11	52 51	37 34	65							
12	51	32	60							
13	50	30	1						\perp	
14	49	29	4 55							
15 16	48 46	28 27	8	\Box					\perp	
			ິຊ 50		\rightarrow				\rightarrow	=
18 20	44 42	25 24	₩ 45		\downarrow				+	
22	40	23	2 3							
24	38	23	¥ 40							
26	37	22	ROCKWELL HARDNESS C SCALE							
28	35	21	35 € 35							_
30 32	34 34	21 20	ΙË	\vdash	\rightarrow				\perp	
	TING TEMPER		~ 30	\vdash	\rightarrow				\pm	
	MENDED BY		25							
*NORMA			"					\rightarrow		_
AUSTE	NITIZE 1600	°F	20							$\overline{}$
*For forged or	rolled specim	ens only.	"	2 4	6 8		14 16 18 HED END – SI	20 22	24 26 28	30

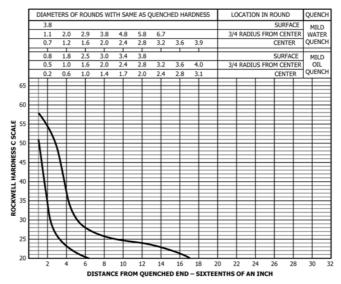
 $\label{eq:Note-1} \mbox{Note-1 in.} = 25.4 \mbox{ mm}.$ FIG. 75 Limits for Hardenability Band 94B30 H



	ESS LIMITS F	
"J" DISTANCE SIXTEENTHS		Н
OF AN INCH	MAX.	MIN.
1 1.5 2 2.5	58 56 55 53	51 42 34 29
3 3.5 4 4.5	49 43 37 33	26 24 23 22
5 5.5 6 6.5	30 29 28 27	22 21 21 20
7 7.5 8 9	27 26 26 25	
10 12 14 16	25 24 23 21	
RECOMME *NORMAL	ITIZE 1550 °F	

HARDENABILITY BAND 1038 H

					•	
С	Mn	Si	Ni	Cr	Мо	
0.34/0.43	0.50/1.00	0.15/0.35				



Note-1 in. = 25.4 mm.

FIG. 76 Limits for Hardenability Band 1038 H

	ESS LIMITS F ATION PURP	
"J" DISTANCE SIXTEENTHS	ı	1
OF AN INCH	MAX.	MIN.
1 1.5 2 2.5	62 61 59 56	55 52 42 34
3 3.5 4 4.5	52 46 38 34	31 29 28 27
5 5.5 6 6.5	33 32 32 31	26 26 25 25
7 7.5 8 9	31 30 30 29	25 24 24 23
10 12 14 16	29 28 27 26	22 21 20
18 20 22 24	25 23 22 21	:
RECOMME *NORMAL	NG TEMPERATU ENDED BY SAE IZE 1600 °F ITIZE 1550 °F	IRES

*For forged or rolled specimens only.

HARDENABILITY BAND 1045 H

С	Mn	Si	Ni	Cr	Мо	
0.42/0.51	0.50/1.00	0.15/0.35				

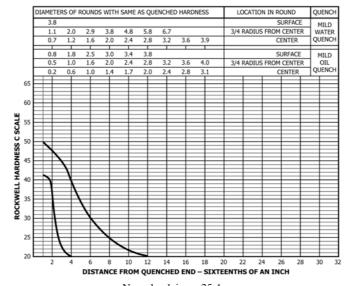
	DIAN	1ETER	S OF R	OUNI	OS WIT	TH SAM	IE AS (QUENCH	IED HA	RDNES	s	LOC	ATION	IN R	OUN	D	QUEN	СH
	3.8													_	SURF		MIL	D
	1.			2.9	3.8	4.8	5.8	6.7			\perp	3/4 R/	ADIUS				WAT	
	0.			1.6	2.0	2.4	2.8	3.2	3.6	3.9	_			-	CENTE	ER	QUEN	CH
	0.0		.8 2	2.5	3.0	3.4	3.8				\neg			5	SURF/	ACE	MIL	$\overline{}$
	0.	5 1		1.6	2.0	2.4	2.8	3.2	3.6	4.0	\neg	3/4 R/	ADIUS	FROM	1 CEN	ITER	OIL	L I
	0.	2 0	.6 1	1.0	1.4	1.7	2.0	2.4	2.8	3.1	\neg			-	CENT	ER	QUEN	CH
6	5 🔲						\equiv			\equiv	\equiv		\equiv			\equiv	\equiv	=
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60							-			=	=		=				\equiv	=
-		$\overline{}$		=	+	+	=	=	=	=	=	=	\Rightarrow		=	+	=	=
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ROCKWELL HARDNESS C SCALE		_									\equiv							=
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X 3	. H	=	1	=	+	_	=	=	=	+	=	=	\Rightarrow		=	+	_	=
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20	2		4	6	8	10	12	14	16	18	20	22	24	2	26	28	30	32
				DIS	TANC	E FRO	M QUI	ENCHE	D END	- SIX			F AN I	NCH				
							-											

Note 1—1 in. = 25.4 mm.

FIG. 77 Limits for Hardenability Band 1045 H

HARDENABILITY BAND 1522 H

С	Mn	Si	Ni	Cr	Мо	
0.17/0.25	1.00/1.50	0.15/0.35				



Note 1—1 in. = 25.4 mm.

FIG. 78 Limits for Hardenability Band 1522 H

	ESS LIMITS F ATION PURP	
"J" DISTANCE SIXTEENTHS		Н
OF AN INCH	MAX.	MIN.
1	51	42
1.5 2	49 48	42 38
2.5	47	34
3	45	29
3.5 4	43 39	25 22
4.5	38	20
5	35	-
5.5 6	34 32	
6.5	30	-
7	29	-
7.5 8	28 27	
9	26	
10	25	-
12 14	23 22	
16	20	-
HEAT TREATIN		JRES
	NDED BY SAE	
*NORMAL AUSTEN	IZE 1650 °F ITIZE 1600 °F	
*For forged or rol	led specimens	only.

HARDENABILITY BAND 1524 H

С	Mn	Si	Ni	Cr	Мо	
0.18/0.26	1.25/1.75	0.15/0.35				

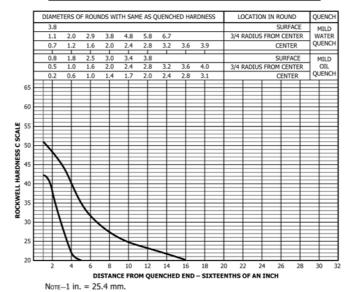


FIG. 79 Limits for Hardenability Band 1524 H



	ESS LIMITS I	
"J" DISTANCE	ATION PURP	H
SIXTEENTHS OF AN INCH	MAX.	MIN.
1 1.5 2 2.5	53 50 49 47	44 42 38 33
3 3.5 4 4.5	46 42 39 37	26 25 21 20
5 5.5 6 6.5	33 31 30 28	
7 7.5 8 9	27 26 26 24	
10 12 14 16	24 23 22 21	
18	20	-
*NORMAL	ENDED BY SAE IZE 1650 °F ITIZE 1600 °F	

HARDENABILITY BAND 1526 H

[С	Mn	Si	Ni	Cr	Мо	
	0.21/0.30	1.00/1.50	0.15/0.35				

		DIAME	TERS O	F ROUN	NDS WI	TH SAM	1E AS Q	UENCH	IED HAI	RDNESS	LOCAT	ON IN	ROUND	QUENCH
		3.8											SURFACE	MILD
		1.1	2.0	2.9	3.8	4.8	5.8	6.7			3/4 RADII	JS FROM	1 CENTER	
		0.7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9		(CENTER	QUENCH
		0.8	1.8	2.5	3.0	3.4	3.8					9	URFACE	MILD
		0.5	1.0	1.6	2.0	2.4	2.8	3.2	3.6	4.0	3/4 RADIU	JS FRON	1 CENTER	
		0.2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1			CENTER	QUENCH
	65	_	\pm	\pm	\pm	=	\pm	\pm	\pm	_			\vdash	
			=	_	=	_	=	=	\pm				\vdash	
	60				\pm				\pm				\vdash	
		-	=	_	\pm	_	=	=	\pm	_			+	
۳	55												=	
ROCKWELL HARDNESS C SCALE		$\overline{}$			\pm								=	
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ES		\rightarrow	\pm		\pm			\pm	\pm					
ă	45		\lor	_	_	_	-	=	=	_			\vdash	=
¥		- N	V											
3	40		$\overline{}$		=	=	\pm	\pm	=				=	
Ň		_ A	_\		-									
Š	35	- 1												
2	30		+	₩	\pm	+	+	+	+	_			\vdash	=
	30			$\overline{}$										
	25		\vdash	=	\checkmark	\pm	\pm	\pm	\pm	=			\vdash	=
	25		V			$^{\prime}$	\blacksquare						=	
	20		X		\pm			\blacksquare	+	_			\perp	
	20.	2	4	6	8	10	12	14	16		20 22		26 28	30 32
				DI	ISTAN	CE FRO	M QUI	ENCHE	D END	- SIXTE	ENTHS OF A	N INCH	1	

Note-1 in. = 25.4 mm.

FIG. 80 Limits for Hardenability Band 1526 H

	ESS LIMITS F ATION PURP	
"J" DISTANCE SIXTEENTHS	ı	1
OF AN INCH	MAX.	MIN.
1 1.5 2 2.5	60 59 59 58	53 52 50 47
3 3.5 4 4.5	57 56 55 53	44 41 38 35
5 5.5 6 6.5	52 50 48 46	32 29 27 26
7 7.5 8 9	44 41 39 35	25 24 23 23
10 12 14 16	33 32 31 30	22 21 20
18 20 22 24	30 29 28 26	-
*NORMAL	ENDED BY SAE	JRES

*For forged or rolled specimens only.

HARDENABILITY BAND <u>1541</u> H

С	Mn	Si	Ni	Cr	Мо	
0.35/0.45	1.25/1.75	0.15/0.35				

L		TERS O	F ROUN	IDS WI	TH SAN	1E AS Q	UENCH	ED HAI	RDNESS		LOCATI			_	QUENCH
F	3.8	2.0	2.9	3.8	4,8	5.8	6.7			-	/4 RADIU		SURFACE	$\overline{}$	MILD WATER
H	0.7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9	1 3	/4 KADIU		ENTER	<u>K</u>	QUENCH
F	0.8	1.8	2.5	3.0	3.4	3.8				+			URFACE	=	MILD
	0.5	1.0	1.6	2.0	2.4	2.8	3.2	3.6	4.0	3	/4 RADIU				OIL
F	0.2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1	\perp		_ (CENTER	\Box	QUENCH
65		-	-		-	-	-	-							
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55 50 45 40 35	λ	ľ	٧				ŧ			ŧ					
45	-		1												
40		٧		X											
35		Λ		=	\checkmark										
30			V					†	_	+	\downarrow				
25				$ \checkmark$											
20 ₺	2	4	6	8	10	12	14	16	18	20	22	24	26 2	8	30 3

Note-1 in. = 25.4 mm.

FIG. 81 Limits for Hardenability Band 1541 H



HARDNESS LIMITS FOR SPECIFICATION PURPOSES

MAX.

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

HARDNESS LIMITS FOR SPECIFICATION PURPOSES
ISTANCE HEENTHS IN INCH MAX. N

-

HEAT TREATING TEMPERATURES
RECOMMENDED BY SAE
*NORMALIZE 1600 °F
AUSTENITIZE 1550 °F
*For forged or rolled specimens only.

MIN

MIN.

")" DISTANCE SIXTEENTHS OF AN INCH

2 2.5

3.5 4.5

5.5 6.5

HARDENABILITY BAND 15B21 H

С	Mn	Si	Ni	Cr	Мо	
0.17/0.24	0.70/1.20	0.15/0.35				

Can be expected to contain 0.0005 to 0.003 per cent boron.

[DIAM	ETERS O	F ROUN	IDS WI	TH SAN	1E AS Q	UENCH	IED HA	RDNESS		LOCA	II NOITA	N ROU	ND.	QUEN	NCH
[3.8						4.0			\perp	211 211		SUR		MIL	
ŀ	1.1 0.7		2.9	2.0	4.8 2.4	5.8 2.8	6.7 3.2	3.6	3.9	+	3/4 RAI	DIUS FR	CENT		QUE	
							3.2	3.0	3.9	+					È	
- 1	0.8		2.5	2.0	3.4 2.4	3.8 2.8	3.2	3.6	4.0	+	3/4 RAI	DILIE ED	SURF		MIL	
ŀ	0.3		1.0	1.4	1.7	2.0	2.4	2.8	3.1	+	3/4 104	D103 FR	CEN		QUE	VCH
65		1		Ť	Ť	1	<u> </u>	1		\pm	-		T		Ή.	
00			_	+	+		_	+		+	_		+	+	-	
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2 30		\rightarrow	\rightarrow	\pm	\pm		\pm	\pm		\pm			\pm	\pm	-	
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25		=		V	-		-	=	-	-	-	-	=	-	-	
		= "		V												
20	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	3
		DIST	TANC	E FR	ом Q	UEN	CHEE	ENI) – SI	XTE	ENT	IS OF	AN	INCH	1	

Note-1 in. = 25.4 mm.

FIG. 82 Limits for Hardenability Band 15B21 H

HARDENABILITY BAND 15B35 H

С	Mn	Si	Ni	Cr	Mo	В
0.31/0.39	0.70/1.20	0.15/0.35				*
Can be expe	ected to cor	tain 0.0005	to 0.003 r	ner cent hor	on.	

	DIAME	TERS O	F ROUN	DS WI	TH SAN	1E AS Q	UENCH	IED HA	RDNESS	LOC	ATION IN	ROUND	QUENC
	3.8											SURFACE	MILD
\vdash	1.1	2.0	2.9	3.8	4.8	5.8	6.7			3/4 R/	ADIUS FRO	OM CENTER	QUENC
F	0.7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9			CENTER	QUEING
F	0.8	1.8	2.5	3.0	3.4	3.8	0.0	2.6	10			SURFACE	MILD
\vdash	0.5	0.6	1.6	2.0	2.4	2.8	3.2 2.4	3.6 2.8	4.0 3.1	3/4 RA	ADIUS FRO	OM CENTER CENTER	QUENC
ےا۔	0.2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1	\vdash	_	CENTER	- Count
5 E					\pm	=							
٦Þ	#	\pm	+	_	+	+	\pm	+	_			+	
ŧΕ													
Έ	#	_		\pm	=	=	=	=	=	\vdash	=	+	_
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•	2	4	6	8	10	12	14	16	18	20 22	24	26 28	30

Nоте-1 in. = 25.4 mm.

FIG. 83 Limits for Hardenability Band 15B35 $\rm H$

HARDNESS LIMITS FOR SPECIFICATION PURPOSES

MAX.

-45

40

33 -29

-27 -25

-23 21 HEAT TREATING TEMPERATURES RECOMMENDED BY SAE *NORMALIZE 1600 °F AUSTENITIZE 1550 °F *For forged or rolled specimens only.

MIN.

-22

21

-20

"J" DISTANCE SIXTEENTHS OF AN INCH

HARDEN	ARTI TT	V RAND	15B37 H

С	Mn	Si	Ni	Cr	Мо	В
0.30/0.39	1.00/1.50	0.15/0.35				*

Can be expected to contain 0.0005 to 0.003 per cent boron.

[DIAME	TERS O	F ROUN	DS WI	TH SAN	1E AS Q	UENCH	IED HA	RDNESS	LOCATI	ON IN RO	UND	QUENCH
[3.8											URFACE	MILD
}	0.7	1.2	2.9	3.8	4.8 2.4	5.8	6.7 3.2	3.6	3.9	3/4 RAD	IUS FROM	CENTER ENTER	WATER QUENCH
							3.2	3.0	3.9				_
ŀ	0.8	1.8	1.6	2.0	3.4 2.4	3.8 2.8	3.2	3.6	4.0	3/4 PAD	S IUS FROM	URFACE	MILD OIL
ŀ	0.2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1	3/4 1040		ENTER	QUENCH
65		\mp	=	=	\mp	=	=	\mp					\equiv
		-	-	-	=	-	-	=					
யு 60		+	-	-	#	+	-	\mp				=	
SCALE 55	\sim			-	-			=					
S		\mathbf{X}		-	-								=
9 50 €	\blacksquare	=	\rightarrow	V	-	-	-	=					
ES.		\vee		_				=					
6 45		$\exists $		-	λ	\pm	-	\pm			=	-	=
HARDNESS 45 40			۱	-	= '	V							
5 40			V			λ							
80CKWELL		=	_\		_	≠`	lack	=			\blacksquare		
₹"		\pm	=1		=	\pm	X	\pm					
830		\pm		V⊨	-	\pm	₽`	\checkmark			\blacksquare		
~		\pm		X					\rightarrow				
25								\pm				$\overline{}$	
20		\pm		\pm	1	+		\pm					
	2	4	6	8	10	12	14	16		20 22 TEENTHS	24 26		30 32

Note-1 in. = 25.4 mm.

FIG. 84 Limits for Hardenability Band 15B37 H

	ESS LIMITS F			-	С	Mn	S		Ni Ni	ND <u>15B</u> Cr	<u>+1 п</u> Пмо	_	\neg
"J" DISTANCE		1	1				+		NI	Cr	MO	+	\dashv
OF AN INCH	MAX.	MIN.	1		0.35/0.45	1.25/1.75	0.15	0.35					
1 2 3 4	60 59 59 58	53 52 52 51		DI	an be expe	cted to con					OCATION IN R		QUEN
5 6 7 8	58 57 57 56	51 50 49 48		(0.7 1.2 1	2.5 3.0	4.8 5. 2.4 2. 3.4 3.	8 3.2 8	3.6 3.9)	RADIUS FROM C	JRFACE	MIL WAT QUEN
9 10 11 12	55 55 54 53	44 37 32 28	65	-			2.4 2. 1.7 2.		3.6 4.0		RADIUS FROM	ENTER	QUEN
13 14 15 16	52 51 50 49	26 25 25 24	C SCALE			\	\						
18 20 22 24	46 42 39 36	23 22 21 21	HARDNESS (
26 28 30 32	34 33 31 31	20 - - -	ROCKWELL H								\		
*NORMAL	ENDED BY SAE IZE 1600 °F ITIZE 1550 °F		25 20				10 12		16 18		2 24 2 THS OF A	6 28	30

FIG. 85 Limits for Hardenability Band 15B41 H

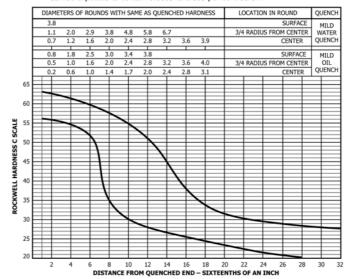
	ESS LIMITS I	
"J" DISTANCE SIXTEENTHS		Н
OF AN INCH	MAX.	MIN.
1	63	56
2	62	56
3	62	55
4	61	54
5	60	53
6	59	52
7	58	42
8	57	34
9	56	31
10	55	30
11	53	29
12	51	28
13	48	27
14	45	27
15	41	26
16	38	26
18	34	25
20	32	24
22	31	23
24	30	22
26	29	21
28	29	20
30	28	-
32	28	-
HEAT TREATIN	IG TEMPERATI ENDED BY SAE	

*NORMALIZE 1600 °F AUSTENITIZE 1550 °F *For forged or rolled specimens only

HARDENABILITY BAND 15848 H

С	Mn	Si	Ni	Cr	Мо	
0.43/0.53	1.00/1.50	0.15/0.35				

Can be expected to contain 0.0005 to 0.003 per cent boron.



Note-1 in. = 25.4 mm.

FIG. 86 Limits for Hardenability Band 15B48 H

	ESS LIMITS I	
"J" DISTANCE SIXTEENTHS		Н
OF AN INCH	MAX.	MIN.
1 2 3 4		60 60 60
5 6 7 8	65 65 64 64	59 58 57 52
9 10 11 12	64 63 63 63	43 39 37 35
13 14 15 16	62 62 61 60	35 34 33 33
18 20 22 24	58 54 48 43	32 31 30 30
26 28 30 32	40 37 35 34	29 28 27 26
*NORMAL	ENDED BY SAE	

*For forged or rolled specimens only.

HARDENABILITY BAND 15B62 H

С	Mn	Si	Ni	Cr	Мо	
0.54/0.67	1.00/1.50	0.40/0.60				

Can be expected to contain to 0.0005 to 0.003 per cent boron.

ŀ	3.8			100 WI	5/4	12 10 Q	OCHOI	20 7100	DNESS	+ -	OCATIO	URFACE	QUEN
ŀ	1.1	2.0	2.9	3.8	4.8	5.8	6,7			3/4	RADIUS	 CENTER	MILE
ŀ	0.7	1.2	1.6	2.0	2.4	2.8	3.2	3.6	3.9	3/1	IVIDIO:	ENTER	QUEN
ŀ	0.8	1.8	2.5	3.0	3.4	3.8	1					URFACE	+
ŀ	0.5	1.0	1.6	2.0	2.4	2.8	3.2	3.6	4.0	3/4	PADTIES	CENTER	MILE
ŀ	0.2	0.6	1.0	1.4	1.7	2.0	2.4	2.8	3.1	3/1	IVIDIO.	ENTER	QUEN
65		Ť		Ť	Ť	Ť	Ť	Ť		+			
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60							\rightarrow	\blacksquare					
~ [-	\rightarrow	\prec	+	+	\pm	+	\Rightarrow	\checkmark	+		\vdash	=
55													_
[-	=	=	_	=	\pm	\pm			$\mathbf{\lambda}$			=
50	-	_	_	-1	_	_	_	_		1			=
ŀ				$\exists 1$						-			=
45	-	+	+	#	\vdash	+	+	+	=	+		\vdash	+
- [V								=
40	-	+	=	+	λ	=	+	\pm	_	+			=
- [\setminus	
35	\rightarrow	+	+	+	=	\rightarrow	\pm	\pm	_	+			\rightarrow
- 1	\rightarrow	\pm	_	_	_	_	_	$\overline{}$		+			=
30	-				=				$\overline{}$	-			
- 1	-	=	+	+	=	=	+	+	=	+			
25					\pm	=	\pm						
- 1	-	\pm	\pm	\pm	\pm	\pm	\pm		-				
20 L					10	12	14	16	18	20 2	2 2	26 28	30

Note-1 in. = 25.4 mm.

FIG. 87 Limits for Hardenability Band 15B62 H

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A304 - 11) that may impact the use of this standard. (Approved Dec. 1, 2016.)

(1) In Table 1, deleted first sentence of Note 1 and added "H" to 4626 in Grade Designation column.

(4) Added new section 4.4.6.

(3) Deleted second sentence of 4.4.5.

(2) Added 2.2 for referenced document SAE Standard J 1086.

(5) Revised language in 5.1.

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