Designation: A 304 – 96

An American National Standard

Standard Specification for Carbon and Alloy Steel Bars Subject to End-Quench Hardenability Requirements[1]

This standard is issued under the fixed designation A 304; 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 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 Table 1 and Table 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 the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

A 29/A 29M Specification for Steel Bars, Carbon and Alloy, Hot-Wrought and Cold-Finished, General Requirements for[2]

A 255 Test Method for End-Quench Test for Hardenability of Steel[2]

E 112 Test Methods for Determining Average Grain Size[3]

E 527 Practice for Numbering Metals and Alloys (UNS)[4]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

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 = 5/16 in., heat analysis required, ASTM A 304, 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.

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 which corresponds to the section used by the purchaser.

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

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[2] *Annual Book of ASTM Standards*, Vol 01.05.

[3] *Annual Book of ASTM Standards*, Vol 03.01.

[4] *Annual Book of ASTM Standards*, Vol 01.01.

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*.

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. 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 1⁄16in. from the quenched end can be specified in addition to the other two points as previously described in 4.4.1 to 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 1⁄16 in.), a tolerance of two points Rockwell C (HRC) over any small portion of either curve (except at a distance of 1⁄16in.) 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 one or more of the following primary processes: open-hearth, basic-oxygen, or electric-furnace. The primary melting may incorporate separate degassing or refining and may be followed by secondary melting using electroslag remelting or vacuum arc remelting. Where secondary melting is employed, the heat shall be defined as all of the ingots remelted from a single primary heat.

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 A 29/A 29M, unless otherwise provided for herein.

7. Chemical Composition

7.1 The heat analysis shall conform to the requirements as to chemical composition prescribed in Table 1 and Table 2 for the grade specified by the purchaser.

7.2 When a steel cannot be identified by a standard grade number in accordance with Table 1 and Table 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 A 29/A 29M.

8.2 Hardenability values specified herein 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.

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.

11. Test Methods

11.1 *Grain Size*—Test Methods E 112.

11.2 *End-quench Hardenability*—Test Method A 255.

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 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 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

TABLE 1 Chemical Requirements of Alloy H Steels[A]

NOTE 1— Phosphorus and sulfur in open-hearth steel is 0.035 %, max, and 0.040 %, max respectively. 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 which 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 A 29/A 29M.

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 Designation[A]	Grade Designation	Chemical Composition, %					
		Carbon	Manganese	Silicon	Nickel	Chromium	Molybdenum
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
H 41180	4118 H	0.17–0.23	0.60–1.00	0.15–0.35	...	0.30–0.70	0.08–0.15
H 41300	4130 H	0.27–0.33	0.30–0.70	0.15–0.35	...	0.75–1.20	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	1.55–2.00	0.35–0.65	0.20–0.30
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[C]	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	0.23–0.29	0.40–0.70	0.15–0.35	0.65–1.05	...	0.15–0.25
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[D]	0.37–0.44	0.65–1.10	0.15–0.35	...	0.30–0.70	...
H 50441	50B44 H[D]	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[D]	0.43–0.50	0.65–1.10	0.15–0.35	...	0.13–0.43	...
H 50501	50B50 H[D]	0.47–0.54	0.65–1.10	0.15–0.35	...	0.30–0.70	...
H 50601	50B60 H[D]	0.55–0.65	0.65–1.10	0.15–0.35	...	0.30–0.70	...
H 51200	5120 H	0.17–0.23	0.60–1.00	0.15–0.35	...	0.60–1.00	...
H 51300	5130 H	0.27–0.33	0.60–1.10	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[D]	0.55–0.65	0.65–1.10	0.15–0.35	...	0.60–1.00	...
H 61180	6118 H[E]	0.15–0.21	0.40–0.80	0.15–0.35	...	0.40–0.80	...
H61500	6150 H[F]	0.47–0.54	0.60–1.00	0.15–0.35	...	0.75–1.20	...
H 81451	81B45 H[D]	0.42–0.49	0.70–1.05	0.15–0.35	0.15–0.45	0.30–0.60	0.08–0.15

TABLE 1 *Continued*

UNS Designation[A]	Grade Designation	Chemical Composition, %					
		Carbon	Manganese	Silicon	Nickel	Chromium	Molybdenum
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
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[D]	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[C]	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[D]	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[D]	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[D]	0.27–0.33	0.70–1.05	0.15–0.35	0.25–0.65	0.25–0.55	0.08–0.15

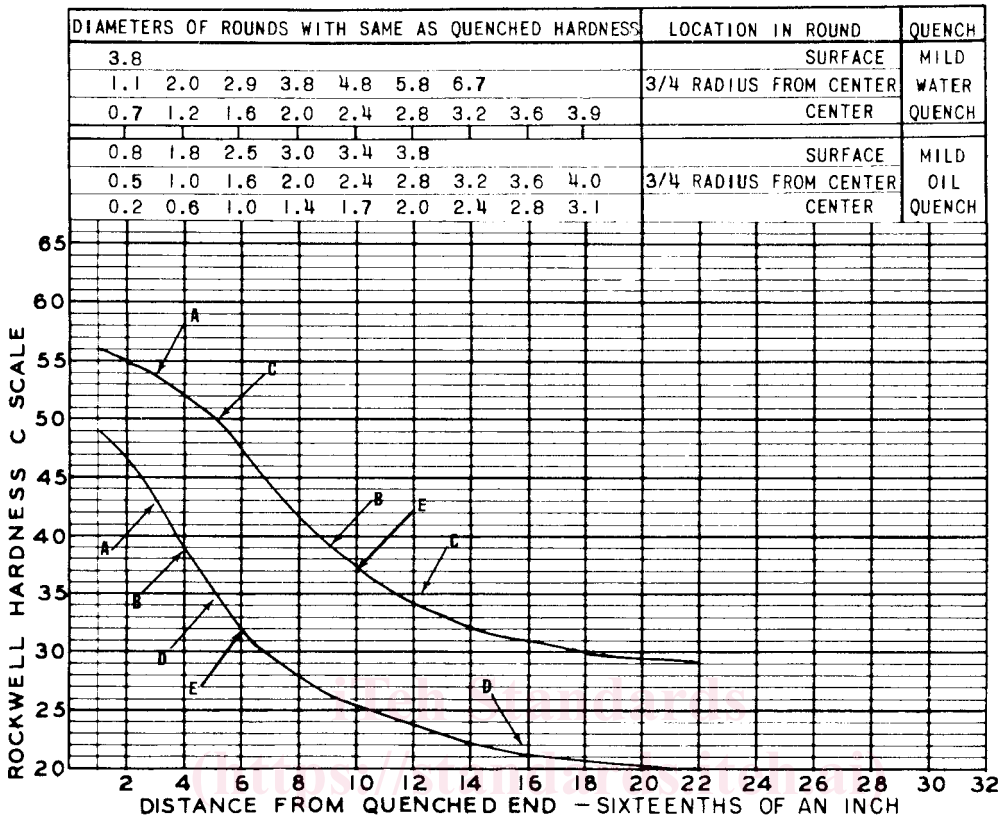
[A] New designations established in accordance with Practice E 527 and SAE J 1086, Recommended Practice for Numbering Metals and Alloys (UNS).
[B] Sulfur content range is 0.035 to 0.050 %.
[C] Electric furnace steel.
[D] These steels can be expected to have a 0.0005 % min boron content.
[E] Vanadium content range is 0.10 to 0.15 %.
[F] Minimum vanadium content is 0.15 %.

TABLE 2 Chemical Requirements of Carbon H-Steels[A]

UNS Designation[B]	Grade Designation	Chemical Composition, %				
		Carbon	Manganese	Phosphorus, max	Sulfur, max	Silicon
H 10380	1038 H	0.34–0.43	0.50–1.00	0.040	0.050	0.15–0.30
H 10450	1045 H	0.42–0.51	0.50–1.00	0.040	0.050	0.15–0.30
H 15220	1522 H	0.17–0.25	1.00–1.50	0.040	0.050	0.15–0.30
H 15240	1524 H	0.18–0.26	1.25–1.75	0.040	0.050	0.15–0.30
H 15260	1026 H	0.21–0.30	1.00–1.50	0.040	0.050	0.15–0.30
H 15410	1541 H	0.35–0.45	1.25–1.75	0.040	0.050	0.15–0.30
H 15211[C]	15B21 H[C]	0.17–0.24	0.70–1.20	0.040	0.050	0.15–0.30
H 15351[C]	15B35 H[C]	0.31–0.39	0.70–1.20	0.040	0.050	0.15–0.30
H 15371[C]	15B37 H[C]	0.30–0.39	1.00–1.50	0.040	0.050	0.15–0.30
H 15411[C]	15B41 H[C]	0.35–0.45	1.25–1.75	0.040	0.050	0.15–0.30
H 15481[C]	15B48 H[C]	0.43–0.53	1.00–1.50	0.040	0.050	0.15–0.30
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 %.
[B] New designations established in accordance with Practice E 527 and SAE J 1086, Recommended Practice for Numbering Metals and Alloys (UNS).
[C] These steels can be expected to have 0.0005 % min boron content.

Hardenability Band

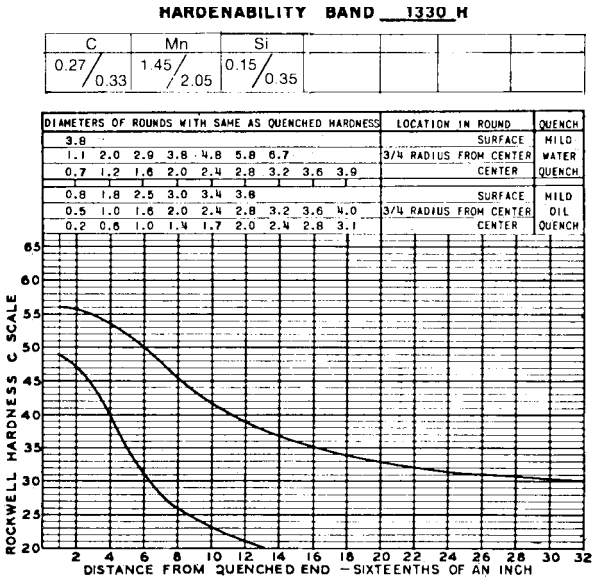


	Method	Points on Charts	Example—End Quench Hardenability
A	Minimum and maximum hardness values at a designated distance	A-A	HRC 43 to 54 at J3
B	A hardness value at minimum and maximum distances	B-B	HRC 39 at J4 minumum and J9 maximum
C	The maximum hardness values at two designated distances	C-C	HRC50 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 HRC 37 at J10 maximum

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

HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	1330 H	
	MAX	MIN
1	56	49
2	56	47
3	55	44
4	53	40
5	52	35
6	50	31
7	48	28
8	45	26
9	43	25
10	42	23
11	40	22
12	39	21
13	38	20
14	37	-
15	36	-
16	35	-
18	34	-
20	33	-
22	32	-
24	31	-
26	31	-
28	31	-
30	30	-
32	30	-

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

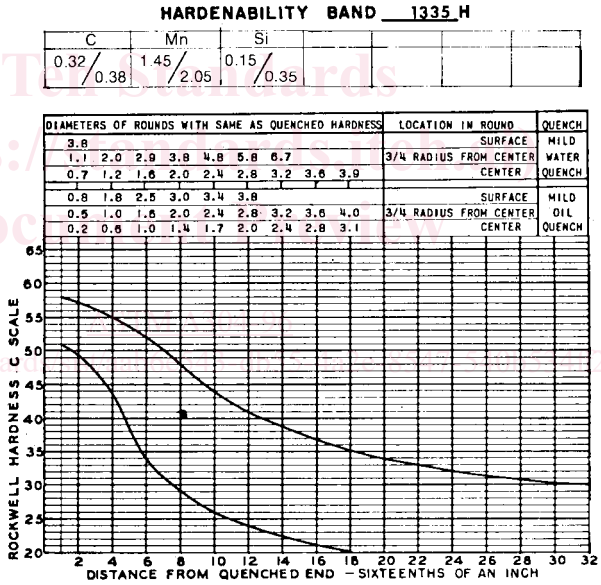


NOTE—1 in. = 25.4 mm.

FIG. 2 Limits for Hardenability Band 1330 H

HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	1335 H	
	MAX	MIN
1	58	51
2	57	49
3	56	47
4	55	44
5	54	38
6	52	34
7	50	31
8	48	29
9	46	27
10	44	26
11	42	25
12	41	24
13	40	23
14	39	22
15	38	22
16	37	21
18	35	20
20	34	-
22	33	-
24	32	-
26	31	-
28	31	-
30	30	-
32	30	-

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



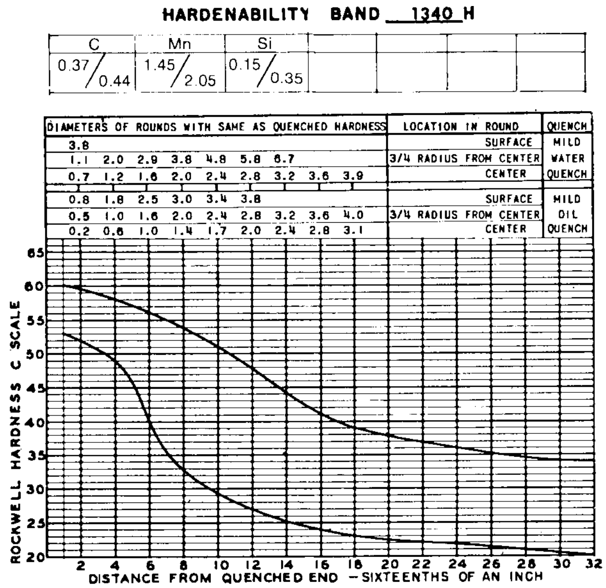
NOTE—1 in. = 25.4 mm.

FIG. 3 Limits for Hardenability Band 1335 H

"J" DISTANCE SIXTEENTHS OF AN INCH	1340 H MAX	1340 H 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

HARDNESS LIMITS FOR SPECIFICATION PURPOSES

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


HARDENABILITY BAND 1340 H
C 0.37/0.44
Mn 1.45/2.05
Si 0.15/0.35
DIAMETERS OF ROUNDS WITH SAME AS QUENCHED HARDNESS
LOCATION IN ROUND
QUENCH
SURFACE
3/4 RADIUS FROM CENTER
CENTER
MILD WATER QUENCH
MILD OIL QUENCH
ROCKWELL HARDNESS C SCALE
DISTANCE FROM QUENCHED END – SIXTEENTHS OF AN INCH

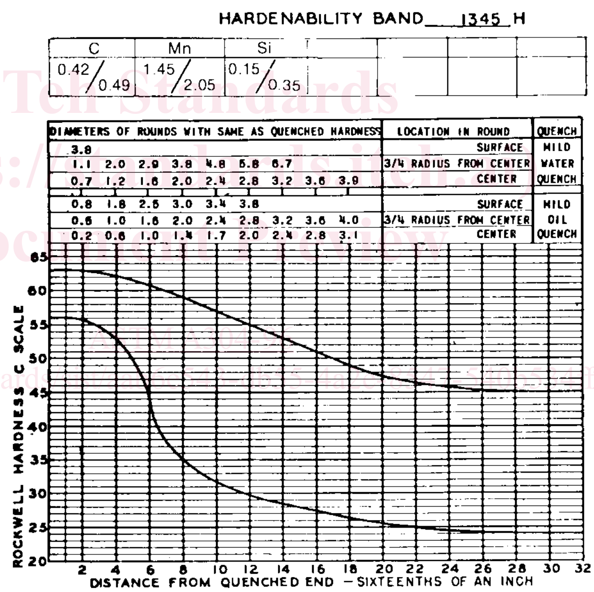
NOTE—1 in. = 25.4 mm.

FIG. 4 Limits for Hardenability Band 1340 H

"J" DISTANCE SIXTEENTHS OF AN INCH	1345 H MAX.	1345 H 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

HARDNESS LIMITS FOR SPECIFICATION PURPOSES

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

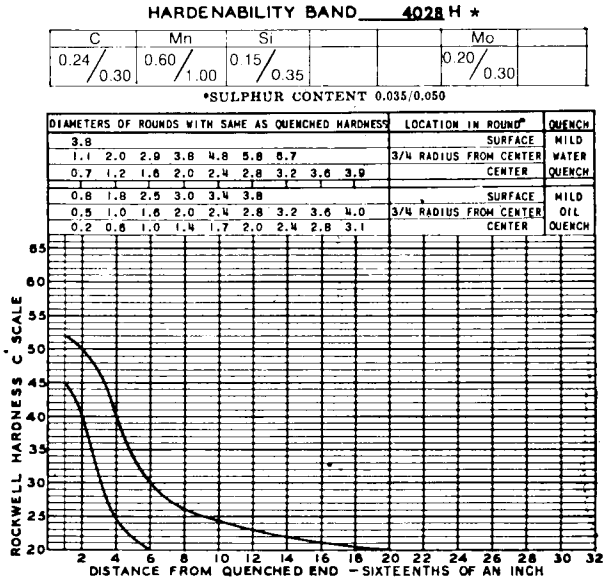

HARDENABILITY BAND 1345 H
C 0.42/0.49
Mn 1.45/2.05
Si 0.15/0.35
DIAMETERS OF ROUNDS WITH SAME AS QUENCHED HARDNESS
LOCATION IN ROUND
QUENCH
SURFACE
3/4 RADIUS FROM CENTER
CENTER
MILD WATER QUENCH
MILD OIL QUENCH
ROCKWELL HARDNESS C SCALE
DISTANCE FROM QUENCHED END – SIXTEENTHS OF AN INCH

NOTE—1 in. = 25.4 mm.

FIG. 5 Limits for Hardenability Band 1345 H

HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	4027H & 4028H	
	MAX	MIN
1	52	45
2	50	40
3	46	31
4	40	25
5	34	22
6	30	20
7	28	-
8	26	-
9	25	-
10	25	-
11	24	-
12	23	-
13	23	-
14	22	-
15	22	-
16	21	-
18	21	-
20	20	-
22	-	-
24	-	-
26	-	-
28	-	-
30	-	-
32	-	-

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

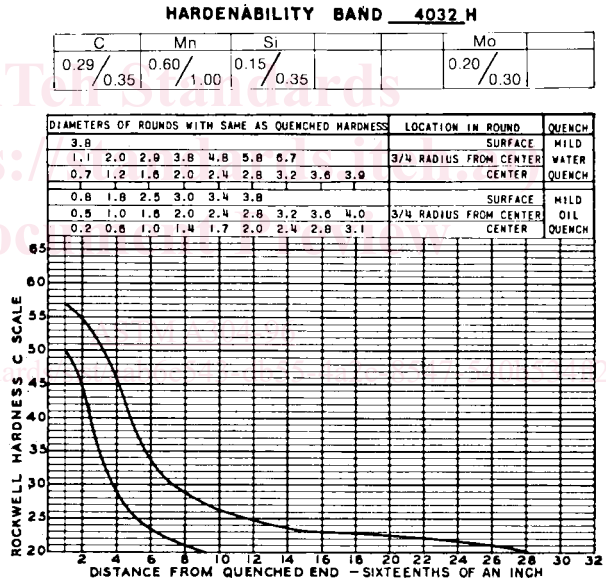


NOTE – 1 in. = 25.4 mm.

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

HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	4032 H	
	MAX	MIN
1	57	50
2	54	45
3	51	36
4	46	29
5	39	25
6	34	23
7	31	22
8	29	21
9	28	20
10	26	-
11	26	-
12	25	-
13	24	-
14	24	-
15	23	-
16	23	-
18	23	-
20	22	-
22	22	-
24	21	-
26	21	-
28	20	-
30	-	-
32	-	-

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



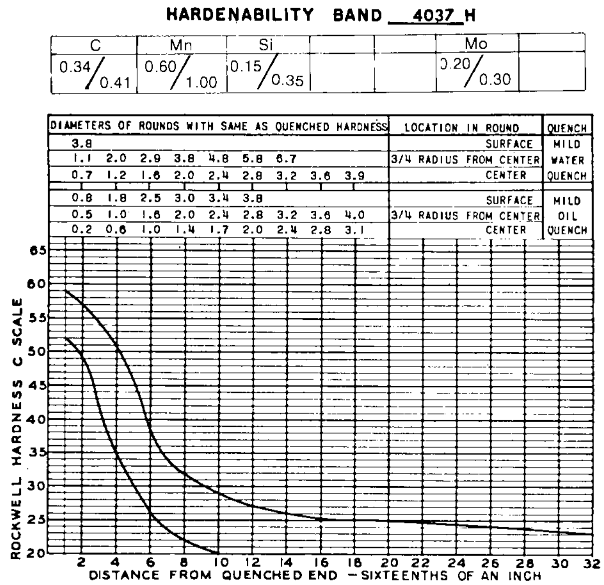
NOTE – 1 in. = 25.4 mm.

FIG. 7 Limits for Hardenability Band 4032 H

"J" DISTANCE SIXTEENTHS OF AN INCH	4037 H MAX	MIN
1	59	52
2	57	49
3	54	42
4	51	35
5	45	30
6	38	26
7	34	23
8	32	22
9	30	21
10	29	20
11	28	-
12	27	-
13	26	-
14	26	-
15	26	-
16	25	-
18	25	-
20	25	-
22	25	-
24	24	-
26	24	-
28	24	-
30	23	-
32	23	-

HARDNESS LIMITS FOR SPECIFICATION PURPOSES

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


HARDENABILITY BAND 4037 H
C 0.34/0.41
Mn 0.60/1.00
Si 0.15/0.35
Mo 0.20/0.30
DIAMETERS OF ROUNDS WITH SAME AS QUENCHED HARDNESS
LOCATION IN ROUND
QUENCH
3.8 SURFACE MILD
1.1 2.0 2.9 3.8 4.8 5.8 6.7 3/4 RADIUS FROM CENTER WATER
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 SURFACE MILD
0.5 1.0 1.6 2.0 2.4 2.8 3.2 3.6 4.0 3/4 RADIUS FROM CENTER OIL
0.2 0.6 1.0 1.4 1.7 2.0 2.4 2.8 3.1 CENTER QUENCH
ROCKWELL HARDNESS C SCALE
DISTANCE FROM QUENCHED END — SIXTEENTHS OF AN INCH

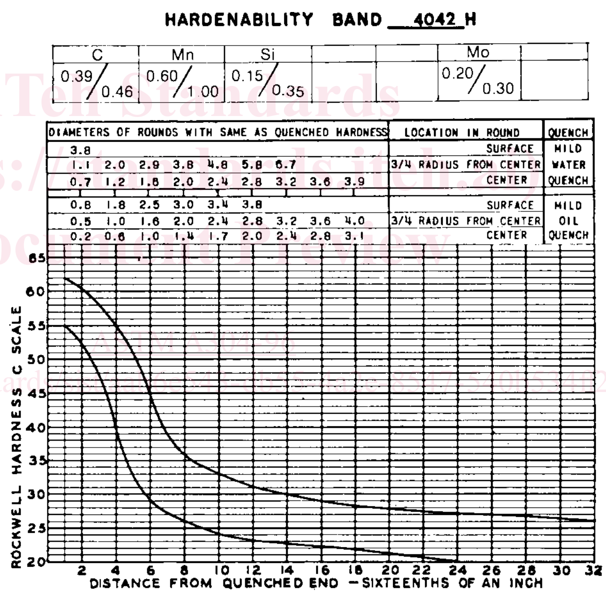
NOTE—1 in. = 25.4 mm.

FIG. 8 Limits for Hardenability Band 4037 H

"J" DISTANCE SIXTEENTHS OF AN INCH	4042 H MAX	MIN
1	62	55
2	60	52
3	58	48
4	55	40
5	50	33
6	45	29
7	39	27
8	36	26
9	34	25
10	33	24
11	32	24
12	31	23
13	30	23
14	30	23
15	29	22
16	29	22
18	28	22
20	28	21
22	28	20
24	27	20
26	27	-
28	27	-
30	26	-
32	26	-

HARDNESS LIMITS FOR SPECIFICATION PURPOSES

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

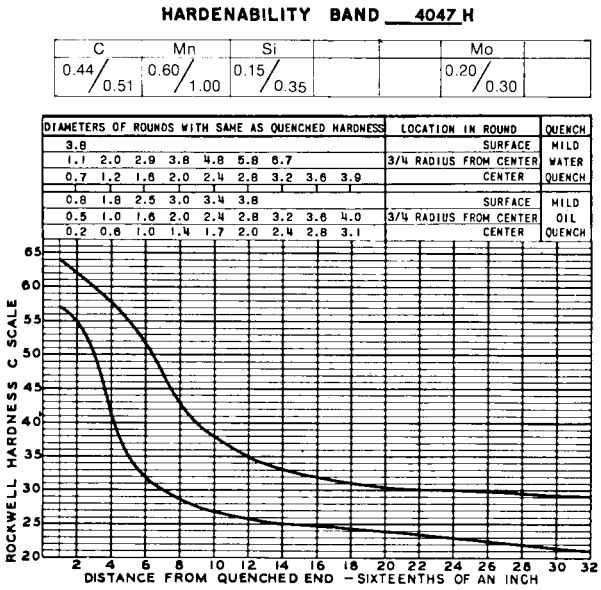

HARDENABILITY BAND 4042 H
C 0.39/0.46
Mn 0.60/1.00
Si 0.15/0.35
Mo 0.20/0.30
DIAMETERS OF ROUNDS WITH SAME AS QUENCHED HARDNESS
LOCATION IN ROUND
QUENCH
3.8 SURFACE MILD
1.1 2.0 2.9 3.8 4.8 5.8 6.7 3/4 RADIUS FROM CENTER WATER
0.7 1.2 1.6 2.0 2.4 2.8 3.2 3.6 3.9 CENTER QUENCH
0.8 1.8 2.5 3.0 3.4 3.8 SURFACE MILD
0.5 1.0 1.6 2.0 2.4 2.8 3.2 3.6 4.0 3/4 RADIUS FROM CENTER OIL
0.2 0.6 1.0 1.4 1.7 2.0 2.4 2.8 3.1 CENTER QUENCH
ROCKWELL HARDNESS C SCALE
DISTANCE FROM QUENCHED END — SIXTEENTHS OF AN INCH

NOTE—1 in. = 25.4 mm.

FIG. 9 Limits for Hardenability Band 4042 H

HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	4047 H	
	MAX	MIN
1	64	57
2	62	55
3	60	50
4	58	42
5	55	35
6	52	32
7	47	30
8	43	28
9	40	28
10	38	27
11	37	26
12	35	26
13	34	25
14	33	25
15	33	25
16	32	25
18	31	24
20	30	24
22	30	23
24	30	23
26	30	22
28	29	22
30	29	21
32	29	21

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

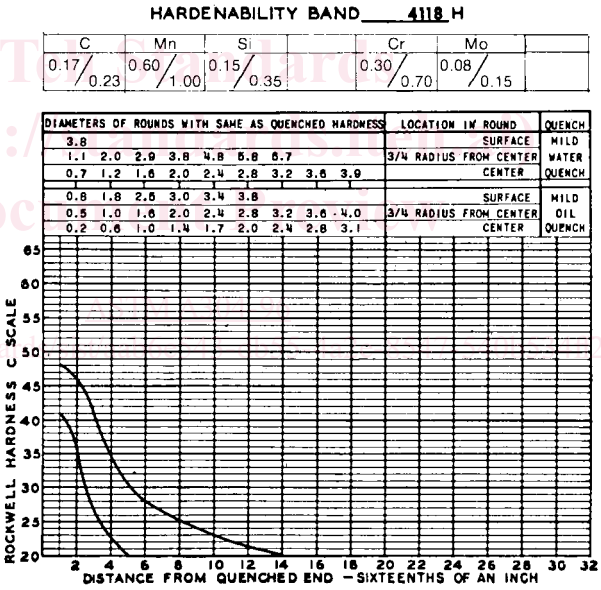


NOTE—1 in. = 25.4 mm.

FIG. 10 Limits for Hardenability Band 4047 H

HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	4118 H	
	MAX	MIN
1	48	41
2	46	38
3	41	27
4	38	23
5	34	20
6	28	-
7	27	-
8	25	-
9	24	-
10	23	-
11	22	-
12	21	-
13	21	-
14	20	-
15	-	-
16	-	-
18	-	-
20	-	-
22	-	-
24	-	-
26	-	-
28	-	-
30	-	-
32	-	-

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

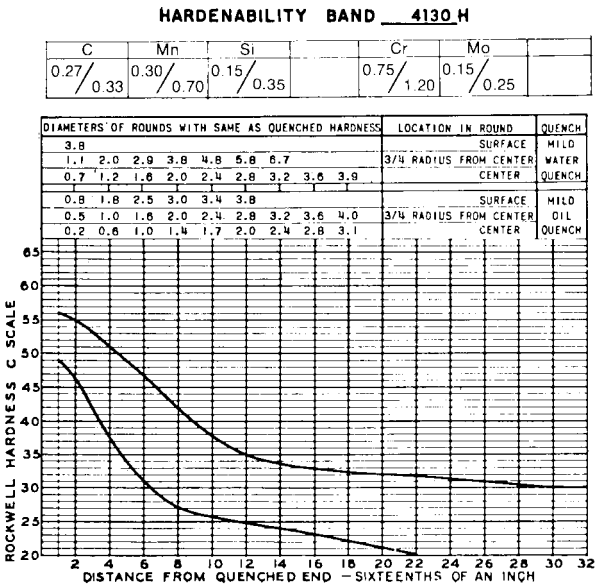


NOTE—1 in. = 25.4 mm.

FIG. 11 Limits for Hardenability Band 4118 H

HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	4130 H	
	MAX	MIN
1	56	49
2	55	48
3	53	42
4	51	38
5	49	34
6	47	31
7	44	29
8	42	27
9	40	26
10	38	26
11	36	25
12	35	25
13	34	24
14	34	24
15	33	23
16	33	23
18	32	22
20	32	21
22	32	20
24	31	-
26	31	-
28	30	-
30	30	-
32	29	-

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

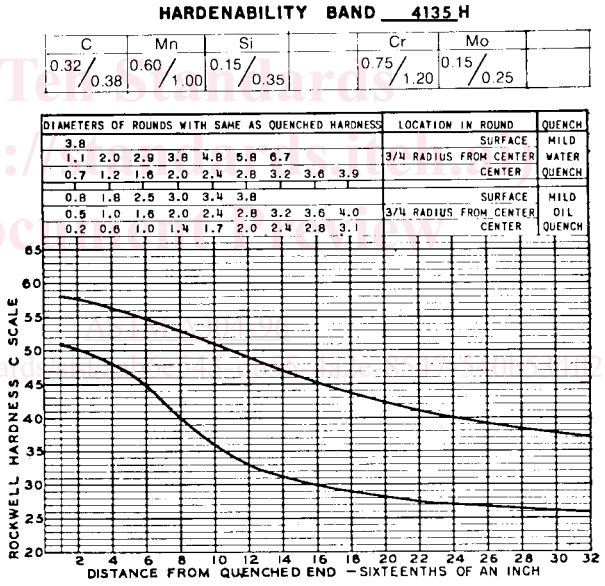


NOTE—1 in. = 25.4 mm.

FIG. 12 Limits for Hardenability Band 4130 H

HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	4135 H	
	MAX	MIN
1	58	51
2	58	50
3	57	49
4	56	48
5	56	47
6	55	45
7	54	42
8	53	40
9	52	38
10	51	36
11	50	34
12	49	33
13	48	32
14	47	31
15	46	30
16	45	30
18	44	29
20	42	28
22	41	27
24	40	27
26	39	27
28	38	26
30	38	26
32	37	26

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

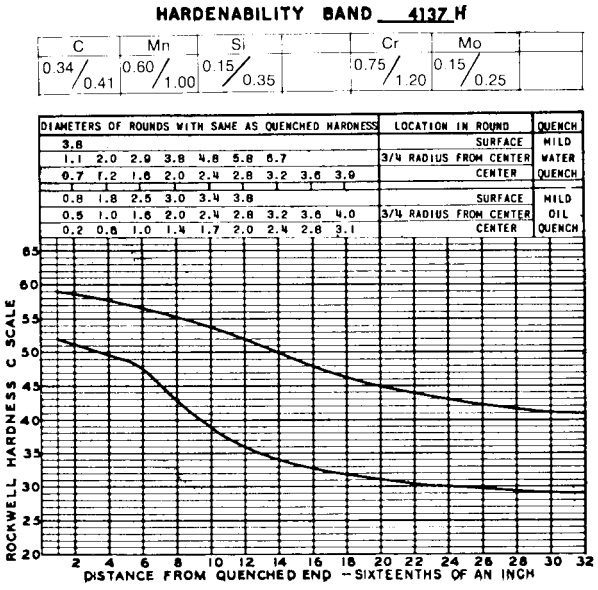


NOTE—1 in. = 25.4 mm.

FIG. 13 Limits for Hardenability Band 4135 H

HARDNESS LIMITS FOR SPECIFICATION PURPOSES		
"J" DISTANCE SIXTEENTHS OF AN INCH	4137 H	
	MAX	MIN
1	59	52
2	59	51
3	58	50
4	58	49
5	57	49
6	57	48
7	56	46
8	55	43
9	55	40
10	54	39
11	53	37
12	52	36
13	51	35
14	50	34
15	49	33
16	48	33
18	46	32
20	45	31
22	44	30
24	43	30
26	42	30
28	42	29
30	41	29
32	41	29

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

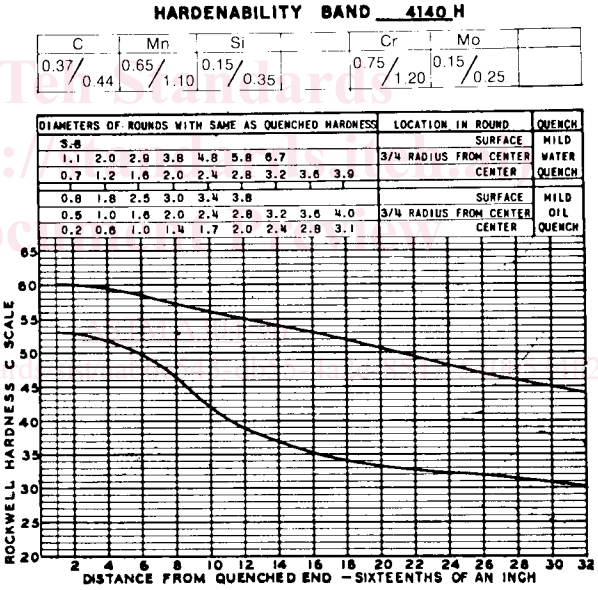


NOTE – 1 in. = 25.4 mm.

FIG. 14 Limits for Hardenability Band 4137 H

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

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



NOTE – 1 in. = 25.4 mm.

FIG. 15 Limits for Hardenability Band 4140 H