AS 1444—2007
(Incorporating Amendment No. 1)

AS 1444—2007

Australian Standard®

Wrought alloy steels—Standard, hardenability (H) series and hardened and tempered to designated mechanical properties

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- Australasian Railway Association
- Australian Building Codes Board
- Australian Foundry Institute
- Australian Industry Group
- Bureau of Steel Manufacturers of Australia
- Materials Australia

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Wrought alloy steels—Standard, hardenability (H) series and hardened and tempered to designated mechanical properties

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PREFACE

This Standard was prepared by the Australian members of the Joint Standards Australia/Standards New Zealand MT-001, Iron and Steel, to supersede AS 1444—1996, *Wrought alloy steels—Standard, hardenability (H) series and hardened and tempered to designated mechanical properties.* After consulting with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian rather than an Australian/New Zealand Standard.

This Standard incorporates Amendment No. 1 (February 2008). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

The objective of this Standard is to specify requirements for wrought alloy steels for general engineering purposes supplied in the form of hot-rolled or cold-finished bars for machining, forgings, and bars, blooms, billets and slabs for forgings. Steels may be supplied to chemical composition only (standard series), to chemical composition and subject to end-quench hardenability requirements (H series), to chemical composition and mechanical properties.

The objective of this revision is to update the reference documents and to apply current style.

The alloy designations used in this Standard align with those used in American specifications which have found worldwide acceptance for many years. The alloy designations included in ISO 683-1, *Heat-treatable steels, alloys steels and free-cutting steels,* Part 1: *Direct-hardening unalloyed and low-alloyed wrought steel in form of different black products* and BS 970-3, *Specification for wrought steels for mechanical and allied engineering purposes,* Part 3: *Bright bars for engineering purposes,* are rarely used in Australia and consequently were not acceptable to Committee MT-001 which favours the universally known four-digit system.

The terms 'normative' and 'informative' have been used in this Standard to define the application of the appendix to which they apply. A 'normative' appendix is an integral part of a Standard, whereas an 'informative' appendix is only for information and guidance.

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SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies requirements for wrought alloy steels intended for general engineering purposes and is applicable to hot-rolled or cold-finished bars for machining, blooms, billets and slabs for forgings, and forgings, as follows:

(a) To specified chemical composition only (standard steel series).

(b) To specified chemical composition and end-quench hardenability requirements (H series).

(c) To specified chemical composition and mechanical properties achieved by hardening and tempering.

This Standard does not apply to stainless steels.

NOTES:

1 Advice and recommendations on information to be supplied by the purchaser at the time of enquiry or order are contained in Appendix A.

2 Alternative means for determining compliance with this Standard are given in Appendix B.

1.2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS	
1199	Sampling procedures for inspection by attributes
1199.0	Part 0: Introduction to the ISO 2859 attribute sampling system
1199.1	Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection.
1391	Metallic materials—Tensile testing at ambient temperature
1443	Carbon steels and carbon-manganese steel—Cold-finished bars
1544	Methods for impact tests on metals
1544.1	Part 1: Izod
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1654	ISO system of limits and fits
1654.2	Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts
1733	Methods for the determination of grain size in metals
1770	Steel—Hardenability test by end quench (Jominy test)
1815	Metallic materials—Rockwell hardness test
1815.1	Method 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)

AS
1816 Metallic materials—Brinell hardness test
1816.1 Method 1: Test method (ISO 6506-1:2005, MOD)

1817 Metallic materials—Vickers hardness test
1817.1 Method 1: Test methods (ISO 6507-1:1997, MOD)

2338 Preferred dimensions of wrought metal products

2706 Numerical values—Rounding and interpretation of limiting values

5016 Metallic materials—Conversion of hardness values

AS/NZS
1050 Methods for the analysis of iron and steel (all Methods)
1050.1 Part 1: Sampling iron and steel for chemical analysis

AS/NZS ISO
9001 Quality management systems—Requirements

9004 Quality management systems—Guidelines for performance improvements

HB 18.28 Conformity assessment—Guidance on a third-party certification system for products

ISO
2566 Steel—Conversion of elongation values
2566-1 Part 1: Carbon and low alloy steels

BS
5046 Method for the estimation of equivalent diameters in the heat treatment of steel

1.3 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

1.3.1 Bars

Finished products of solid section which may be rectangular, square, round or hexagonal in cross-section. Bars may be in either the hot-rolled or the cold-finished condition.

1.3.2 Bars in the cold-finished condition

1.3.2.1 *Bright bars*

Bars produced by cold drawing, cold rolling, turning and polishing, or precision grinding, and which have a smooth surface free from scale and harmful imperfections.

1.3.2.2 *Cold-sized bars*

Bars sized by cold drawing or cold rolling to provide closer dimensional tolerances than occur for hot-rolled bars, but which may contain some surface imperfections.

1.3.2.3 *Peeled bars*

Bars which are finished by rough machining.

1.3.3 Bar shapes

1.3.3.1 *Flat bars (flats)*

Bars of rectangular cross-section and having edges of controlled contour.

1.3.3.2 *Hexagonal bars (hexagons)*

Bars of regular hexagonal cross-section supplied in straight lengths or coils.

1.3.3.3 *Round bars (rounds)*

Bars of circular cross-section supplied in straight lengths or coils.

1.3.3.4 *Square bars (squares)*

Bars of square cross-section supplied in straight lengths.

1.3.4 Batch

Finished steel of the same size, produced from the same cast and which has been subjected to the same heat treatment.

1.3.5 Billet

A semi-finished forged, rolled or continuously-cast product intended for processing into finished products by further forging or rolling. The cross-section is usually square or rectangular, with dimensions not greater than 165 mm × 165 mm (or equivalent cross-sectional area), and the width-to-thickness ratio is less than 4:1.

1.3.6 Bloom

A semi-finished forged, rolled or continuously-cast product intended for further rolling or forging. The cross-section is square or rectangular, with dimensions greater than 165 mm × 165 mm (or equivalent cross-sectional area), and the width-to-thickness ratio is less than 4:1.

1.3.7 Limiting ruling section

For any composition of steel, the largest diameter in which certain specified mechanical properties are achieved after a specified heat treatment.

NOTE: For non-circular cross-sections, the equivalent diameter can be determined in accordance with BS 5046.

1.3.8 Out-of-hexagon

The greatest difference between the three dimensions measured at the same cross-section across opposite flats of the hexagon.

1.3.9 Out-of-round

The difference between the maximum and minimum diameters of the bar, measured at the same cross-section.

1.3.10 Out-of-square

The difference between the two dimensions at the same cross-section across opposite flats of the square.

1.3.11 Primary rolled product

Steel product produced in a primary mill by the direct hot-rolling of an ingot or from a continuously cast bloom.

1.3.12 Rod

A semi-finished or finished product of approximately circular cross-section produced in coils.

1.3.13 Slab

A semi-finished forged, rolled or continuously cast product intended for rolling or forging. The cross-section is rectangular, with the thickness greater than 100 mm and the width-to-thickness ratio equal to or greater than 4:1.

1.3.14 Test piece

A prepared piece for testing, made from a test specimen.

1.3.15 Test sample

A portion of material or product, or a group of items selected from a batch by a sampling procedure.

1.3.16 Test specimen

A portion or a single item taken from the test sample for the purpose of applying a particular test.

1.4 DESIGNATION

1.4.1 General

The steel designation shall consist of the following components:

(a) The number of this Australian Standard, i.e. AS 1444.

(b) A series designation in accordance with Clause 1.4.2.

(c) A modification symbol, if applicable, in accordance with Clause 1.4.3.

(d) For steels subject to both composition and end-quench hardenability requirements, the letter 'H' placed after the series designation.

(e) A hyphen and a letter placed after the series designation, if applicable, to indicate tensile strength range, in accordance with Clause 1.4.4.

(f) A letter, if applicable, to indicate surface condition, in accordance with Clause 1.4.5.

(g) Two letters, if applicable, to indicate austenitic grain size in accordance with Clause 1.4.6.

NOTE: The absence of any suffix symbol indicates steel supplied to chemical composition only.

1.4.2 Series designation

The following designations shall be used to identify each series, wherein the first two digits of the number indicate the type of steel and the last two digits indicate the approximate mean of the specified carbon range:

13XX ..... Carbon-manganese steel

33XX ..... Nickel 3.25, Chromium 0.85

40XX ..... Molybdenum 0.25

41XX ..... Chromium 0.95, Molybdenum 0.20

43XX ..... Nickel 1.80, Chromium 0.80, Molybdenum 0.25

46XX ..... Nickel 1.80, Molybdenum 0.25

51XX ..... Chromium 0.80, 0.88 or 0.95

61XX ..... Chromium 0.95, Vanadium 0.20

70XX ..... Chromium 1.60, Molybdenum 0.20, Aluminium 1.00

72XX ..... Chromium 3.00, Molybdenum 0.50

81XX ..... Nickel 0.30, Chromium 0.45

86XX ..... Nickel 0.55, Chromium 0.50, Molybdenum 0.20

87XX ..... Nickel 0.55, Chromium 0.50, Molybdenum 0.25

92XX ..... Silicon 1.40, 1.90 or 2.00, Chromium residual, 0.20 or 0.65

93XX ..... Nickel 4.00, Chromium 1.2, Molybdenum 0.20

99XX ..... Nickel 2.50, Chromium 0.65, Molybdenum 0.55

1.4.3 Modification symbols

Modification symbols may be added to the series designation as follows:

(a) The letter 'X' placed before the series designation to indicate a major deviation in chemical composition of any grade from the corresponding AISI-SAE grade.

NOTE: Information on AISI-SAE grades is given in the relevant steel products manual of The Iron and Steel Society of AIME, 410 Commonwealth Drive, Warrendale, PA 15086, USA.

(b) For boron-treated steels, the letter 'B' is placed between the second and third characters of the four-digit series designation.

Examples of designation: AS 1444/4150, AS 1444/X1320H, AS 1444/86B30H.

1.4.4 Designations for tensile strength ranges of hardened and tempered material

For hardened and tempered materials, the letters R to Z shall be used to designate the tensile strength range in accordance with the following table:

Mechanical property designation	Tensile strength MPa	
R	≥ 700	≤ 850
S	≥ 770	≤ 930
T	≥ 850	≤1 000
U	≥ 930	≤1 080
V	≥1 000	≤1 150
W	≥1 080	≤1 230
X	≥1 150	≤1 300
Y	≥1 230	≤1 380
Z	≥1 550	

NOTE: The equivalent Brinell hardness ranges and advice on the selection of suitable grades of steel capable of meeting these properties, for ruling sections up to 250 mm, are given in Appendix C.

Examples of designation: AS 1444/4140-S, AS 1444/X9931-U.

1.4.5 Surface condition

Where a special condition other than commercial quality is required, it is indicated by either of the following suffix letters:

B: Intermediate surface condition suitable for cold-drawn products, heat-treated products and forgings other than upset or drop-forged products.

F: Surface condition suitable for upsetting, drop-forging and other severe forming applications.

Example of designation: AS 1444/4150 B

1.4.6 Austenitic grain size

The following designations consisting of suffix letters 'CG' or 'FG' indicate the austenitic grain size of the steel as defined in AS 1733:

CG: Coarse

FG: Fine

NOTE: The absence of these suffix letters indicates that the steel may be coarse-grained or fine-grained at the supplier's option.

Examples of designation: AS 1444/4140 FG, AS 1444/4140-T F FG

1.5 CONDITION OF STEEL ON DELIVERY

Steel shall be supplied in one of the following conditions:

(a) *Bars, billet, blooms and slabs for forging*

As-rolled, as-forged or annealed.

(b) *Forgings and hot-rolled bars*

As-rolled, as-forged or heat-treated.

(c) *Cold-finished bars*

Bright, cold-sized or peeled (see AS 1443), optionally heat-treated before cold finishing.

NOTES:

1 Bright bars may be heat treated either before or after any cold work at the option of the manufacturer.

2 Cold-sized bars are subject to some restrictions on grade, size, length and heat-treated condition; this information should be sought from the supplier.

1.6 MATERIALS

1.6.1 Chemical composition

1.6.1.1 *General*

Chemical composition shall be determined by any procedures which are at least as accurate as those given in the AS/NZS 1050 series of Standards.

1.6.1.2 *Cast analysis*

Wherever possible, a chemical analysis of the steel from each cast shall be made to determine the proportions of the specified elements. In cases where it is impracticable to obtain samples from liquid steel, analysis on test samples taken in accordance with the requirements of AS/NZS 1050.1 may be reported as cast analysis.

1.6.1.3 *Residual elements*

For steels complying with this Standard, residual elements are acceptable to the following limits:

(a) Chromium ..... 0.30% maximum.

(b) Copper ..... 0.35% maximum.

(c) Molybdenum ..... 0.10% maximum.

(d) Nickel ..... 0.35% maximum.

NOTE: The amount of residual elements present in the steel may affect subsequent processes, especially those involving cold working, welding and heat treatment.

1.6.1.4 *Product analysis*

For grades of steel specified in Sections 2, 3 and 4 of this Standard, the results of individual determinations carried out on the product shall be within the product analysis tolerance limits specified in Table 1.1. Where several determinations of a single element are carried out on products from any one cast, the spread of individual results shall not extend both above and below the specified range.

1.6.2 Hardness requirements

When required, Brinell hardness shall be determined in accordance with AS 1816.1 using, where possible, a 10 mm diameter ball and a load of 3000 kg.

1.6.3 Tensile test requirements

When required, tensile testing shall be carried out in accordance with AS 1391 (see also Section 4 of this Standard).

1.6.4 Hardenability test requirements

When required, the hardenability test shall be carried out in accordance with AS 1770 (see also Section 3 of this Standard).

1.6.5 Austenitic grain size requirements

When tested in accordance with AS 1733, the austenitic grain size shall be predominantly fine.

TABLE 1.1

PRODUCT ANALYSIS TOLERANCES FOR STEELS SUPPLIED TO TABLES 2.1, 3.1 AND 4.1

Element	Limit or maximum of specified range %	Tolerance over maximum limit or under minimum limit %	
		Cross-sectional area, m^2	
		≤0.06	>0.06 ≤0.13
Carbon	≤0.30	0.01	0.02
	>0.30 ≤0.75	0.02	0.03
	>0.75	0.03	0.04
Silicon	≤2.20	0.05	0.06
Manganese	≤0.90	0.03	0.04
	>0.90 ≤2.10	0.04	0.05
Phosphorus	≤0.040	0.005*	0.010*
Sulfur	≤0.060	0.005*	0.010*
	>0.060 ≤0.10	0.010	0.010
Chromium	≤0.90	0.03	0.04
	>0.90 ≤2.10	0.05	0.06
Molybdenum	≤0.20	0.01	0.01
	>0.20 ≤0.40	0.02	0.03
	>0.40	0.03	0.03
Nickel	≤1.00	0.03	0.03
	>1.00 ≤3.00	0.05	0.05
	>3.00	0.07	0.07
Vanadium	≤0.3	0.01	0.01
Aluminium	≥0.80 ≤1.30	0.01	0.10

*Over maximum only.

1.7 FREEDOM FROM DEFECTS

1.7.1 General

The steel shall be free from internal and surface defects which render it unsuitable for its particular application.

If, after acceptance of the steel and provided that it has been properly treated after delivery, subsequent processing reveals that it contains defects found to be detrimental, the steel shall be deemed not to comply with this Standard.

NOTE: Defects referred to in this Clause cannot be completely quantified. Where the presence, size or frequency of any defect is considered to be of concern, arrangements should be made between the purchaser and the manufacturer. This may be achieved by acceptable type samples or methods of test.

1.7.2 Hot-rolled bars

The maximum permissible depth of surface imperfections for commercial, B and F surface conditions is given in Appendix D.

1.7.3 Cold-finished bars

The following requirements apply to cold-finished bars:

(a) *Bright bars (cold-drawn and cold-rolled)*

The maximum permissible depth of surface imperfections shall be in accordance with the requirements for surface condition designation B (see Appendix D).

(b) *Bright bars (turned and polished or precision-ground)*

The surface shall be free from imperfections of hot-rolled origin.

(c) *Cold-sized or peeled bars*

The maximum permissible depth of surface imperfections shall be in accordance with the requirements for surface conditions designated 'Commercial' for cold-sized bars, and F for peeled bars (see Appendix D).

NOTE: Recommended machining allowances for hot-rolled bars and cold-finished bars are given in Appendix E.

1.8 SURFACE DRESSING

1.8.1 Hot-rolled bars

Surface defects may be removed from bars by grinding, chipping, or by other means, provided that the final dimensions meet the tolerance requirements of Clause 5.2 (see Section 5).

1.8.2 Blooms, billets and slabs

1.8.2.1 *General*

Surface defects on blooms, billets and slabs may be removed by rough machining, chipping, grinding, scarfing or other similar processes. The method used and the dimensions remaining after removal of the defects shall not adversely affect the end use of the product.

The amount of steel removed from blooms, billets and slabs that are to be forged shall comply with the requirements of Clause 1.8.2.2

1.8.2.2 *Depth of gouge*

The maximum depth of gouge shall be as follows:

(a) *In blooms, billets and in the edges of slabs*

Not more than 1.5 mm for each 25 mm of dimension, up to a maximum depth of 20 mm, provided that the sum of the depths on two parallel sides at opposite locations does not exceed 1.5 times the maximum depth allowed for one side.

(b) *In the faces of slabs*

Not more than 2.5 mm for each 25 mm of thickness dimension, up to a maximum depth of 20 mm, provided that the sum of the depths in two parallel faces does not exceed 1.5 times the maximum allowed for one face.

1.8.2.3 *Width of gouge*

The width of any gouge present shall be at least four times the depth.

1.9 ROUNDING OF TEST RESULT VALUES

1.9.1 General

With the exception of tensile results, the observed or calculated values shall be rounded to the same number of figures as in the specified values and then compared with the specified values. For example, for specified maximum or minimum values of 2.5, 2.50, 2.500, the observed or calculated value would be rounded respectively to the nearest 0.1, 0.01 and 0.001 (see also AS 2706).

1.9.2 Tensile test results

The determined value of tensile strength shall be rounded to the nearest 10 MPa, and the determined value of 0.2% proof stress shall be rounded to the nearest 5 MPa.

1.10 MARKING

Steel as supplied by the manufacturer shall be legibly and durably marked or tagged (for bundles) to indicate the following:

(a) The name of the manufacturer.

(b) The Batch identification number.

(c) The Grade of steel.

(d) The number of this Standard, i.e. AS 1444.

(e) The nominal size and shape, length and condition, e.g. 25 mm RND 3.0 m BRIGHT BAR HEAT TREATED AND COLD DRAWN.

(f) The identity of the quality plan, if applicable.

(g) The number of pieces, or total mass.

NOTE: Manufacturers making a statement of compliance with this Australian Standard on a product, packaging or promotional material related to that product are advised to ensure that such compliance is capable of being verified.

SECTION 2 STEELS SUPPLIED TO CHEMICAL COMPOSITION ONLY

2.1 SCOPE

This Section specifies chemical composition requirements for those wrought alloy steels of the standard series supplied to specified chemical composition only.

2.2 CHEMICAL COMPOSITION

The reported cast analysis of steel shall comply with the requirements of Table 2.1 for the appropriate grade.

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TABLE 2.1

CHEMICAL COMPOSITION REQUIREMENTS FOR ALLOY STEELS OF THE STANDARD TYPE

Grade AS 1444	Chemical composition (cast analysis), %															
	Carbon		Silicon		Manganese		Phosphorus	Sulfur	Chromium		Molybdenum		Nickel		Vanadium	
	Min.	Max.	Min.	Max.	Min.	Max.	Max.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
X1320	0.18	0.23	0.10	0.35	1.40	1.70	0.040	0.040	—	—	—	—	—	—	—	—
X3312	0.10	0.16	0.10	0.35	0.35	0.60	0.040	0.040	0.70	1.00	—	—	3.00	3.75	—	—
4037	0.35	0.40	0.15	0.35	0.70	0.90	0.035	0.040	—	—	0.20	0.30	—	—	—	—
4130	0.28	0.33	0.10	0.35	0.40	0.60	0.040	0.040	0.80	1.10	0.15	0.25	—	—	—	—
4140	0.38	0.43	0.10	0.35	0.75	1.00	0.040	0.040	0.80	1.10	0.15	0.25	—	—	—	—
4150	0.48	0.53	0.10	0.35	0.75	1.00	0.040	0.040	0.80	1.10	0.15	0.25	—	—	—	—
X4317	0.15	0.20	0.10	0.35	0.40	0.60	0.040	0.040	1.50	1.80	0.25	0.35	1.40	1.70	—	—
X4330	0.28	0.33	0.10	0.35	0.85	1.15	0.040	0.040	0.80	1.10	0.35	0.55	1.10	1.40	—	—
4340	0.38	0.43	0.10	0.35	0.60	0.80	0.040	0.040	0.70	0.90	0.20	0.30	1.65	2.00	—	—
4620	0.17	0.22	0.10	0.35	0.45	0.65	0.040	0.040	—	—	0.20	0.30	1.65	2.00	—	—
5120	0.17	0.22	0.10	0.35	0.70	0.90	0.040	0.040	0.70	0.90	—	—	—	—	—	—
5132	0.30	0.35	0.10	0.35	0.60	0.80	0.040	0.040	0.75	1.00	—	—	—	—	—	—
5140	0.38	0.43	0.10	0.35	0.70	0.90	0.040	0.040	0.70	0.90	—	—	—	—	—	—
5145	0.43	0.48	0.10	0.35	0.70	0.90	0.040	0.040	0.70	0.90	—	—	—	—	—	—
5155	0.50	0.60	0.10	0.35	0.70	1.00	0.050	0.050	0.70	0.90	—	—	—	—	—	—
5160	0.55	0.65	0.10	0.35	0.70	1.00	0.050	0.050	0.70	0.90	—	—	—	—	—	—

(*continued*)

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TABLE 2.1 (*continued*)

Grade AS 1444	Chemical composition (cast analysis), %															
	Carbon		Silicon		Manganese		Phosphorus	Sulfur	Chromium		Molybdenum		Nickel		Vanadium	
	Min.	Max.	Min.	Max.	Min.	Max.	Max.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
6150	0.48	0.53	0.10	0.35	0.70	0.90	0.040	0.040	0.80	1.10	—	—	—	—	0.15	0.25
8115	0.13	0.18	0.10	0.35	0.70	0.90	0.040	0.040	0.30	0.50	0.08	0.15	0.20	0.40	—	—
8617	0.15	0.20	0.10	0.35	0.70	0.90	0.040	0.040	0.40	0.60	0.15	0.25	0.40	0.70	—	—
8620	0.18	0.23	0.10	0.35	0.70	0.90	0.040	0.040	0.40	0.60	0.15	0.25	0.40	0.70	—	—
8660	0.55	0.65	0.10	0.35	0.75	1.00	0.040	0.040	0.40	0.60	0.15	0.25	0.40	0.70	—	—
8740	0.38	0.43	0.10	0.35	0.75	1.00	0.040	0.040	0.40	0.60	0.20	0.30	0.40	0.70	—	—
9255	0.50	0.60	1.60	2.20	0.70	1.05	0.050	0.050	—	—	—	—	—	—	—	—
9260	0.55	0.65	1.80	2.20	0.70	1.00	0.050	0.050	—	—	—	—	—	—	—	—
9261	0.55	0.65	1.80	2.20	0.70	1.00	0.050	0.050	0.10	0.25	—	—	—	—	—	—
X9315	0.12	0.18	0.10	0.35	0.25	0.50	0.040	0.040	1.00	1.40	0.15	0.30	3.90	4.30	—	—
X9931	0.27	0.35	0.10	0.35	0.45	0.70	0.040	0.040	0.50	0.80	0.45	0.65	2.30	2.80	—	—
X9940	0.36	0.44	0.10	0.35	0.45	0.70	0.040	0.040	0.50	0.80	0.45	0.65	2.30	2.80	—	—

SECTION 3 STEELS SUPPLIED TO CHEMICAL COMPOSITION AND HARDENABILITY REQUIREMENTS

3.1 SCOPE

This Section specifies the requirements for chemical composition, and hardenability for wrought alloy steels of the hardenability (H) series supplied to chemical composition and hardenability requirements.

NOTES:

1 The chemical composition ranges for these grades are wider than the ranges for the chemical composition grades (see Section 2), due to hardenability considerations.

2 Restricted hardenability grades may also be specified.

3.2 CHEMICAL COMPOSITION

The reported cast analysis of steel shall conform to the limits given in Table 3.1, for the appropriate grade.

3.3 HARDENABILITY TEST

3.3.1 General

The hardenability test is applicable to steels manufactured to chemical composition and hardenability requirements and shall be carried out in accordance with AS 1770.

3.3.2 Specification of hardenability limits

The hardenability of the steel shall be specified in terms of the tabulated hardness limits for the following distances from the quenched end of the test specimen: 1.5, 3, 5, 9, 13, 20, 25 and 30 mm.

NOTES:

1 No result below 20 HRC need be reported. See AS 1815.1 for the method of conducting the Rockwell hardness test.

2 For convenience in the estimating of hardness values at various locations on the end-quench test bar and for quick comparison of the various grades, hardenability values are also plotted on graphs which are for guidance only.

3 The curves for individual heats may vary in shape from the standard band, and thus may deviate slightly at one or more positions along the full length of the band. A tolerance of two points HRC is therefore permissible over any small portion of the curve, except at the 1.5 mm position.

4 Alternatively, two points may be used to specify hardenability, in several ways, as follows:

(a) The minimum and maximum distances at which any derived hardness value occurs (points A–A′ in Figure 3.1).

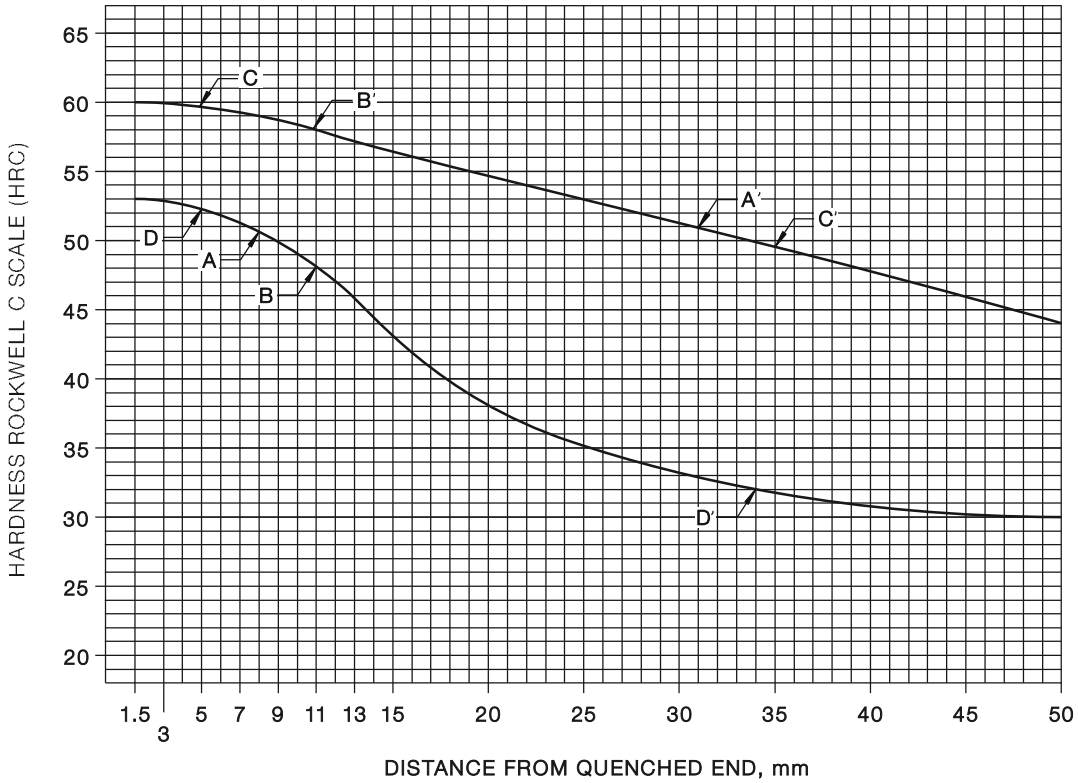
(b) The minimum and maximum hardness at any given distance (points B–B′ in Figure 3.1).

(c) Maximum hardness values at two desired distances (points C–C′ in Figure 3.1).

(d) Minimum hardness values at two desired distances (points D–D′ in Figure 3.1).

(e) Any minimum hardness plus any maximum hardness.

Where hardenability is specified by one of the ways given in Items (a) to (e), the maximum and minimum hardness values at 1.5 mm may also be specified in addition to the other two points.



HRC values	60 53	60 53	60 52	59 51	59 50	58 48	57 46	57 43	55 38	53 35	52 33	49 33	48 32	– –	– –

FIGURE 3.1 EXAMPLES OF THE USE OF TWO POINTS TO SPECIFY HARDENABILITY LIMITS

3.4 HARDENABILITY REQUIREMENTS

3.4.1 General

The end-quench hardenability of fine-grained steels determined by the method specified in Clause 3.3 shall comply with the hardness limits specified below the graphs in Figures 3.2 to 3.22, as applicable, for the grade concerned.

A1

TABLE 3.1

CHEMICAL COMPOSITION REQUIREMENTS FOR ALLOY STEELS OF THE 'H' TYPE

Grade AS 1444	Chemical composition (cast analysis), %															
	Carbon		Silicon		Manganese		Phosphorus	Sulfur	Chromium		Molybdenum		Nickel		Vanadium	
	Min.	Max.	Min.	Max.	Min.	Max.	Max.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
X1320H	0.17	0.24	0.10	0.35	1.30	1.80	0.040	0.040	—	—	—	—	—	—	—	—
X3312H	0.10	0.16	0.10	0.35	0.35	0.60	0.040	0.040	0.70	1	—	—	3.00	3.75	—	—
4130H	0.27	0.33	0.10	0.35	0.30	0.70	0.040	0.040	0.75	1.20	0.15	0.25	—	—	—	—
4140H	0.37	0.44	0.10	0.35	0.65	1.10	0.040	0.040	0.75	1.20	0.15	0.25	—	—	—	—
4150H	0.47	0.54	0.10	0.35	0.65	1.10	0.040	0.040	0.75	1.20	0.15	0.25	—	—	—	—
X4317H	0.15	0.20	0.10	0.35	0.40	0.60	0.040	0.040	1.50	1.80	0.25	0.35	1.40	1.70	—	—
4340H	0.37	0.44	0.10	0.35	0.55	0.90	0.040	0.040	0.65	0.95	0.20	0.30	1.55	2.00	—	—
4620H	0.17	0.23	0.10	0.35	0.35	0.75	0.040	0.040	—	—	0.20	0.30	1.55	2.00	—	—
5120H	0.17	0.23	0.10	0.35	0.60	1.00	0.040	0.040	0.60	1.00	—	—	—	—	—	—
5132H	0.29	0.35	0.10	0.35	0.50	0.90	0.040	0.040	0.65	1.10	—	—	—	—	—	—
5145H	0.42	0.49	0.10	0.35	0.60	1.00	0.040	0.040	0.60	1.00	—	—	—	—	—	—
6150H	0.47	0.54	0.10	0.35	0.60	1.00	0.040	0.040	0.75	1.20	—	—	—	—	0.15	0.25
8115H	0.12	0.18	0.10	0.35	0.60	0.95	0.040	0.040	0.30	0.55	0.08	0.15	0.20	0.40	—	—
8617H	0.14	0.20	0.10	0.35	0.60	0.95	0.040	0.040	0.35	0.65	0.15	0.25	0.35	0.75	—	—
8620H	0.17	0.23	0.10	0.35	0.60	0.95	0.040	0.040	0.35	0.65	0.15	0.25	0.35	0.75	—	—
86B30H*	0.27	0.33	0.10	0.35	0.60	0.95	0.040	0.040	0.35	0.65	0.15	0.25	0.35	0.75	—	—

(*continued*)

TABLE 3.1 (*continued*)

Grade AS 1444	Chemical composition (cast analysis), %															
	Carbon		Silicon		Manganese		Phosphorus	Sulfur	Chromium		Molybdenum		Nickel		Vanadium	
	Min.	Max.	Min.	Max.	Min.	Max.	Max.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
8660H	0.55	0.65	0.10	0.35	0.70	1.05	0.040	0.040	0.35	0.65	0.15	0.25	0.35	0.75	—	—
8740H	0.37	0.44	0.10	0.35	0.70	1.05	0.040	0.040	0.35	0.65	0.20	0.30	0.35	0.75	—	—
9260H	0.55	0.65	1.70	2.20	0.65	1.10	0.050	0.050	—	—	—	—	—	—	—	—
9261H	0.55	0.65	1.70	2.20	0.65	1.10	0.050	0.050	0.05	0.35	—	—	—	—	—	—
X9315H	0.12	0.18	0.10	0.35	0.25	0.50	0.040	0.040	1.00	1.40	0.15	0.30	3.90	4.30	—	—

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

3.4.2 Grade AS 1444/X1320H

3.4.2.1 *Chemical composition, percent*

	Min.	Max.
C	0.17	0.24
Si	0.10	0.35
Mn	1.30	1.80
P	—	0.040
S	—	0.040

3.4.2.2 *Heat-treatment temperatures*

Normalizing temperature: 900°C.

Austenitizing temperature: 925°C.

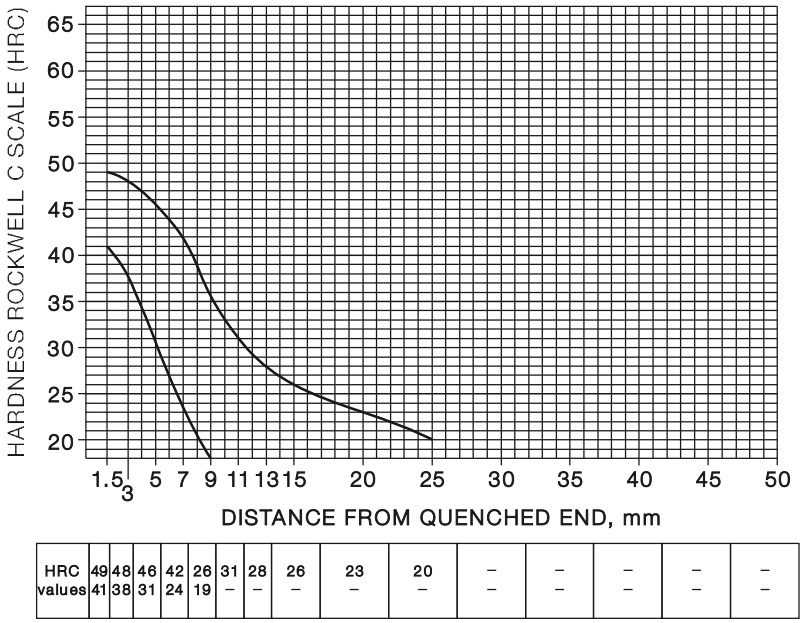


FIGURE 3.2 HARDENABILITY LIMITS FOR GRADE AS 1444/X1320H STEEL

3.4.3 Grade AS 1444/X3312H

3.4.3.1 *Chemical composition, percent*

	Min.	Max.
C	0.10	0.16
Si	0.10	0.35
Mn	0.35	0.60
P	—	0.040
S	—	0.040
Cr	0.70	1.00
Ni	3.00	3.75

3.4.3.2 *Heat-treatment temperatures*

Normalizing temperature: 890°C.

Austenitizing temperature: 830°C.

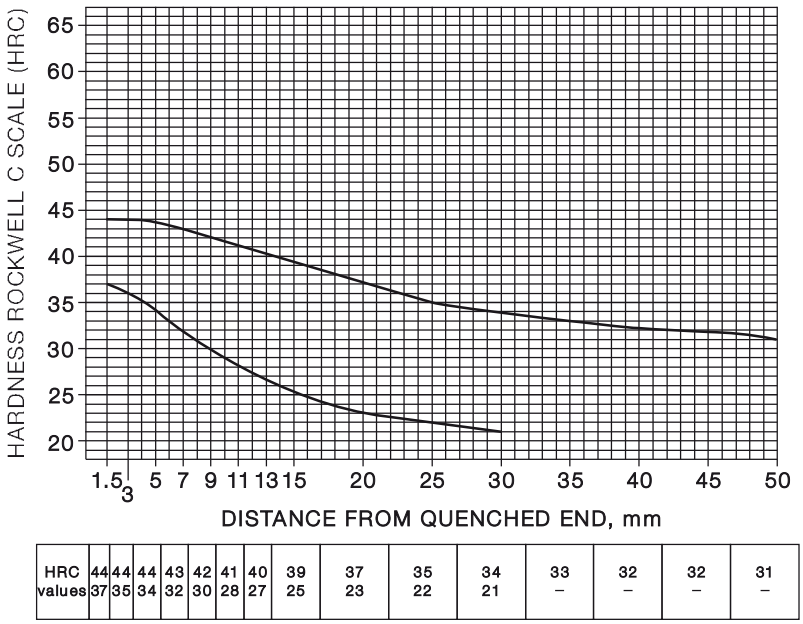


FIGURE 3.3 HARDENABILITY LIMITS FOR GRADE AS 1444/X3312H STEEL

3.4.4 Grade AS 1444/4130H

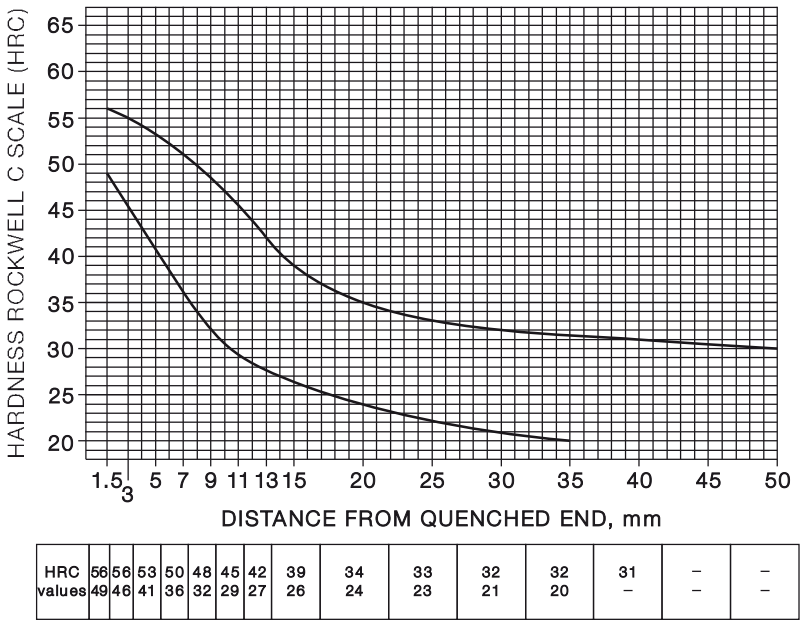
3.4.4.1 *Chemical composition, percent*

	Min.	Max.
C	0.27	0.33
Si	0.10	0.35
Mn	0.30	0.70
P	—	0.040
S	—	0.040
Cr	0.75	1.20
Mo	0.15	0.25

3.4.4.2 *Heat-treatment temperatures*

Normalizing temperature: 900°C.

Austenitizing temperature 870°C.



HRC values	56 49	56 46	53 41	50 36	48 32	45 29	42 27	39 26	34 24	33 23	32 21	32 20	31 –	– –	– –

FIGURE 3.4 HARDENABILITY LIMITS FOR GRADE AS 1444/4130H STEEL

3.4.5 Grade AS 1444/4140H

3.4.5.1 *Chemical composition, percent*

	Min.	Max.
C	0.37	0.44
Si	0.10	0.35
Mn	0.65	1.10
P	—	0.040
S	—	0.040
Cr	0.75	1.20
Mo	0.15	0.25

3.4.5.2 *Heat-treatment temperatures*

Normalizing temperature: 870°C.

Austenitizing temperature: 845°C.

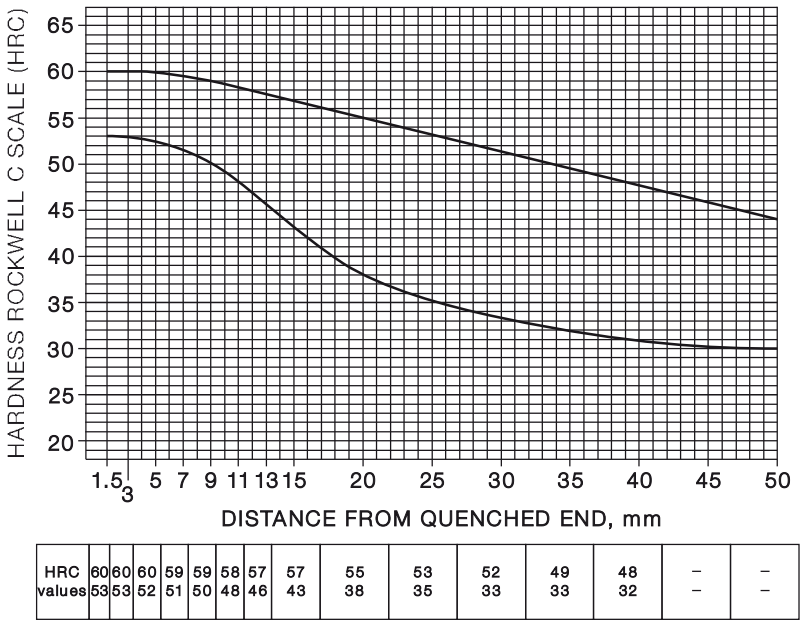


FIGURE 3.5 HARDENABILITY LIMITS FOR GRADE AS 1444/4140H STEEL

3.4.6 Grade AS 1444/4150H

3.4.6.1 *Chemical composition, percent*

	Min.	Max.
C	0.47	0.54
Si	0.10	0.35
Mn	0.65	1.10
P	—	0.040
S	—	0.040
Cr	0.75	1.20
Mo	0.15	0.25

3.4.6.2 *Heat-treatment temperatures*

Normalizing temperature: 870°C.

Austenitizing temperature: 845°C.

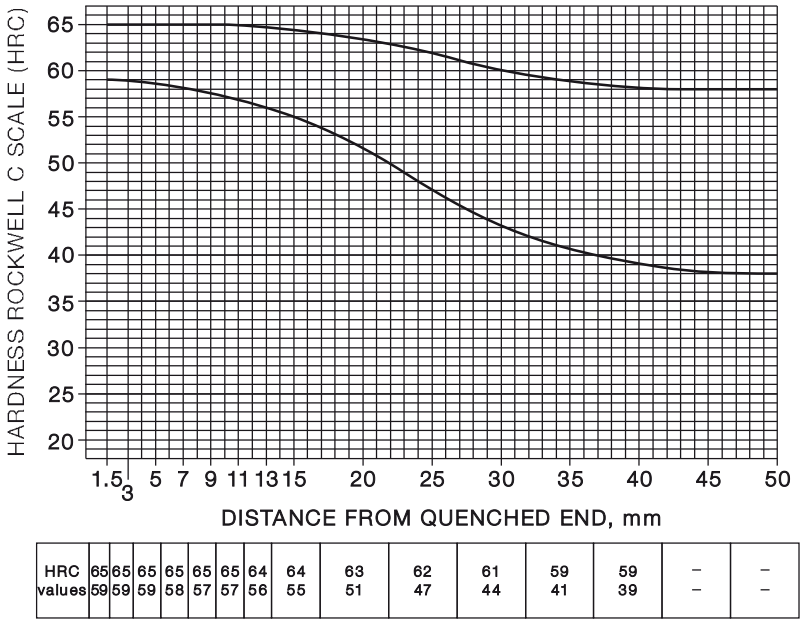


FIGURE 3.6 HARDENABILITY LIMITS FOR GRADE AS 1444/4150H STEEL

3.4.7 Grade AS 1444/X4317H

3.4.7.1 *Chemical composition, percent*

	Min.	Max.
C	0.15	0.20
Si	0.10	0.35
Mn	0.40	0.60
P	—	0.040
S	—	0.040
Cr	1.50	1.80
Mo	0.25	0.35
Ni	1.40	1.70

3.4.7.2 *Heat-treatment temperatures*

Normalizing temperature: 925°C.

Austenitizing temperature: 925°C.

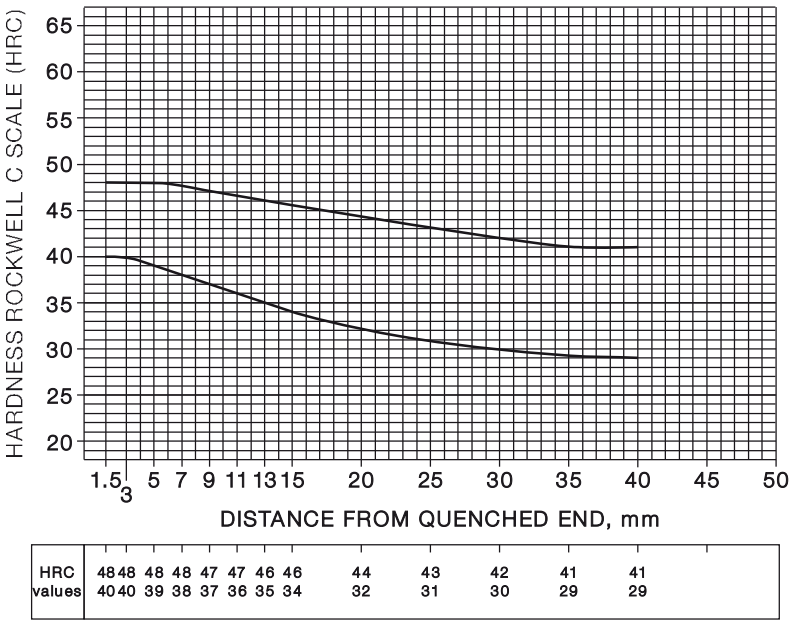


FIGURE 3.7 HARDENABILITY LIMITS FOR GRADE AS 1444/X4317H STEEL

3.4.8 Grade AS 1444/4340H

3.4.8.1 *Chemical composition, percent*

	Min.	Max.
C	0.37	0.44
Si	0.10	0.35
Mn	0.55	0.90
P	—	0.040
S	—	0.040
Cr	0.65	0.95
Mo	0.20	0.30
Ni	1.55	2.00

3.4.8.2 *Heat-treatment temperatures*

Normalizing temperature: 870°C.

Austenitizing temperature: 845°C.

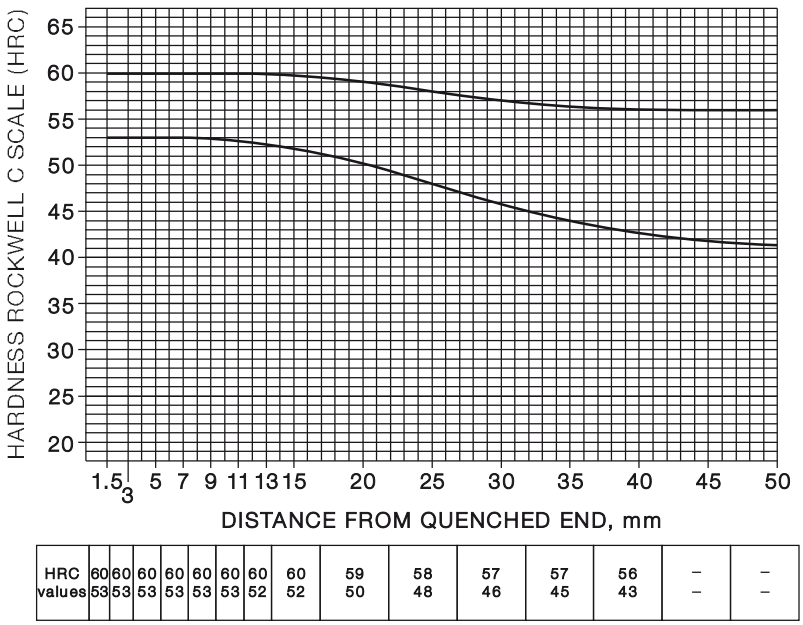


FIGURE 3.8 HARDENABILITY LIMITS FOR GRADE AS 1444/4340H STEEL

3.4.9 Grade AS 1444/4620H

3.4.9.1 *Chemical composition, percent*

	Min.	Max.
C	0.17	0.23
Si	0.10	0.35
Mn	0.35	0.75
P	—	0.040
S	—	0.040
Mo	0.20	0.30
Ni	1.55	2.00

3.4.9.2 *Heat-treatment temperatures*

Normalizing temperature: 925°C.

Austenitizing temperature: 25°C.

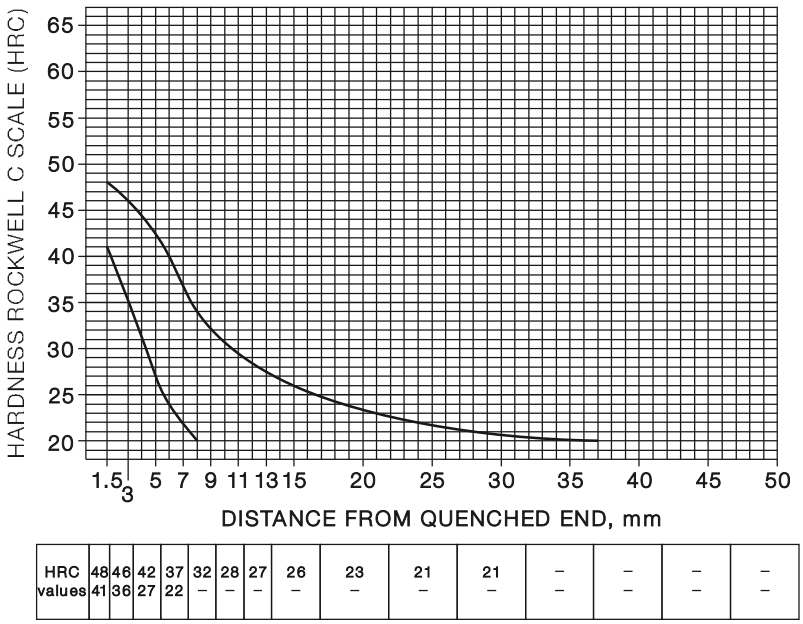


FIGURE 3.9 HARDENABILITY LIMITS FOR GRADE AS 1444/4620H STEEL

3.4.10 Grade AS 1444/5120H

3.4.10.1 *Chemical composition, percent*

	Min.	Max.
C	0.17	0.23
Si	0.10	0.35
Mn	0.60	1.00
P	—	0.040
S	—	0.040
Cr	0.60	1.00

3.4.10.2 *Heat-treatment temperatures*

Normalizing temperature: 925°C.

Austenitizing temperature: 925°C.

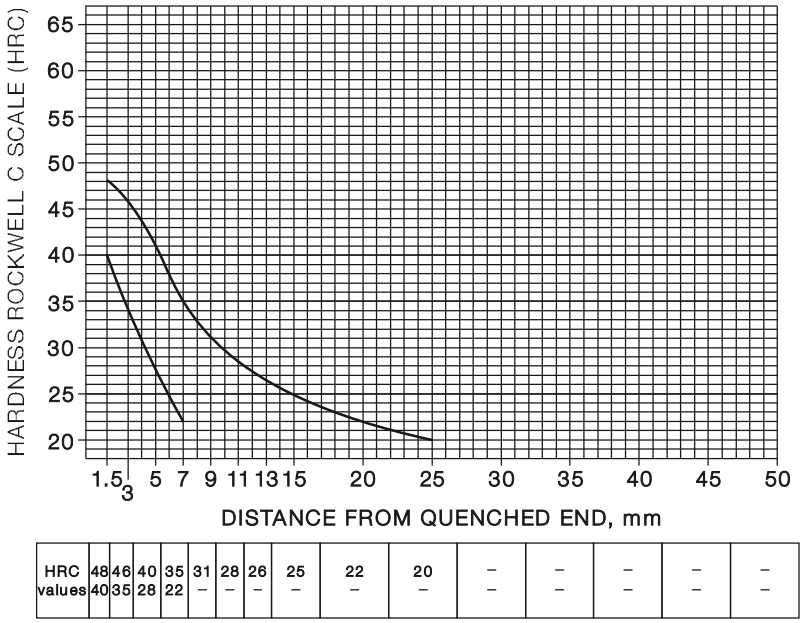


FIGURE 3.10 HARDENABILITY LIMITS FOR GRADE AS 1444/5120H STEEL

3.4.11 Grade AS 1444/5132H

3.4.11.1 *Chemical composition, percent*

	Min.	Max.
C	0.29	0.35
Si	0.10	0.35
Mn	0.50	0.90
P	—	0.040
S	—	0.040
Cr	0.65	1.10

3.4.11.2 *Heat-treatment temperatures*

Normalizing temperature: 900°C.

Austenitizing temperature: 870°C.

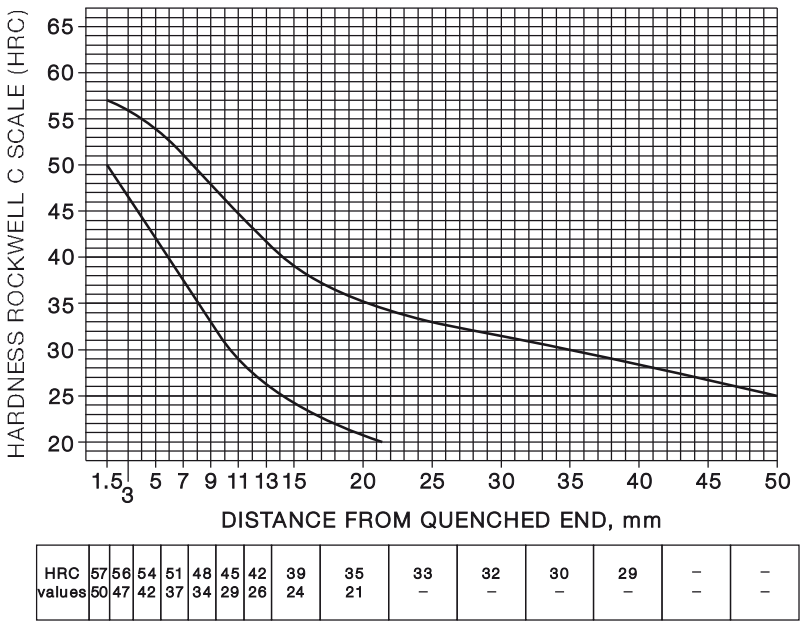


FIGURE 3.11 HARDENABILITY LIMITS FOR GRADE AS 1444/5132H STEEL

3.4.12 Grade AS 1444/5145H

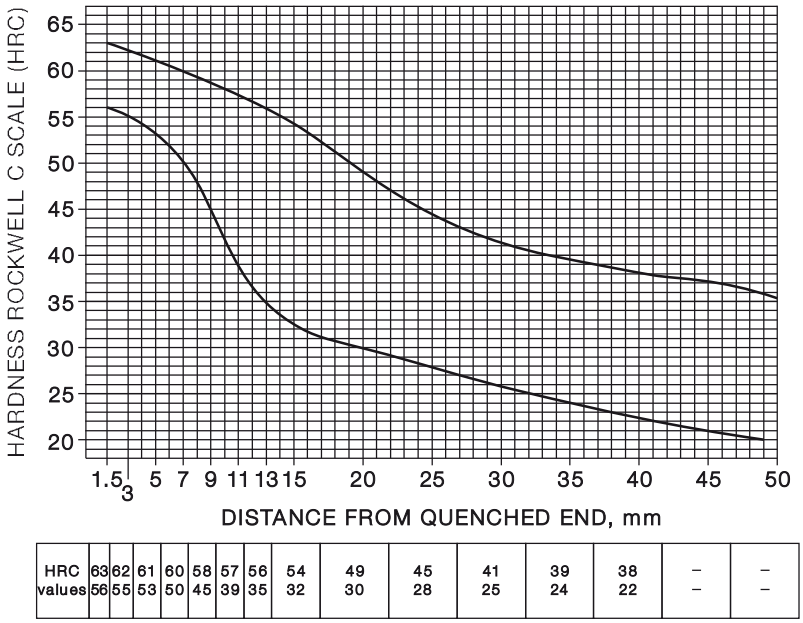
3.4.12.1 *Chemical composition, percent*

	Min.	Max.
C	0.42	0.49
Si	0.10	0.35
Mn	0.60	1.00
P	—	0.040
S	—	0.040
Cr	0.60	1.00

3.4.12.2 *Heat-treatment temperatures*

Normalizing temperature: 870°C.

Austenitizing temperature: 845°C.



HRC values	63 56	62 55	61 53	60 50	58 45	57 39	56 35	54 32	49 30	45 28	41 25	39 24	38 22	– –	– –

FIGURE 3.12 HARDENABILITY LIMITS FOR GRADE AS 1444/5145H STEEL

3.4.13 Grade AS 1444/6150H

3.4.13.1 *Chemical composition, percent*

	Min.	Max.
C	0.47	0.54
Si	0.10	0.35
Mn	0.60	1.00
P	—	0.040
S	—	0.040
Cr	0.75	1.20
V	0.15	0.25

3.4.13.2 *Heat-treatment temperatures*

Normalizing temperature: 900°C.

Austenitizing temperature: 870°C.

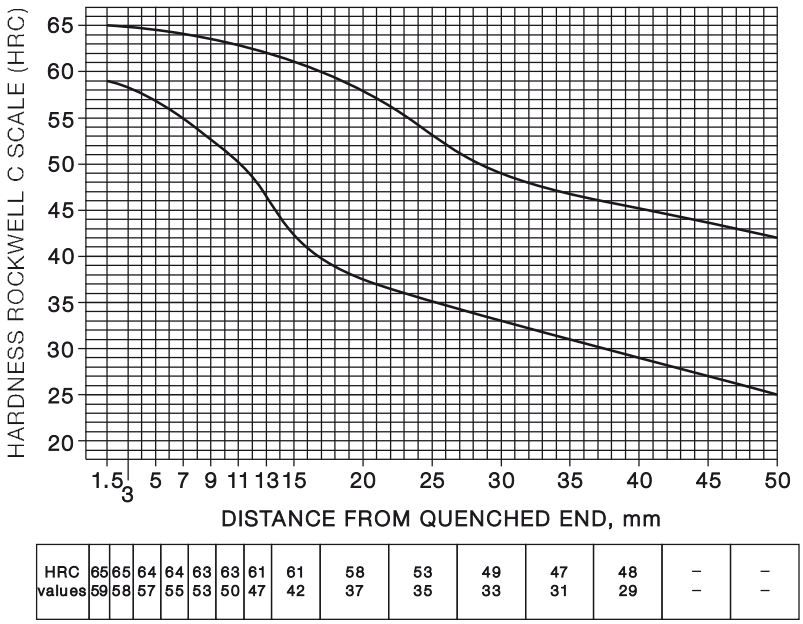


FIGURE 3.13 HARDENABILITY LIMITS FOR GRADE AS 1444/6150H STEEL

3.4.14 Grade AS 1444/8115H

3.4.14.1 *Chemical composition, percent*

	Min.	Max.
C	0.12	0.18
Si	0.10	0.35
Mn	0.60	0.95
P	—	0.040
S	—	0.040
Cr	0.30	0.55
Mo	0.08	0.15
Ni	0.20	0.40

3.4.14.2 *Heat-treatment temperatures*

Normalizing temperature: 925°C.

Austenitizing temperature: 925°C.

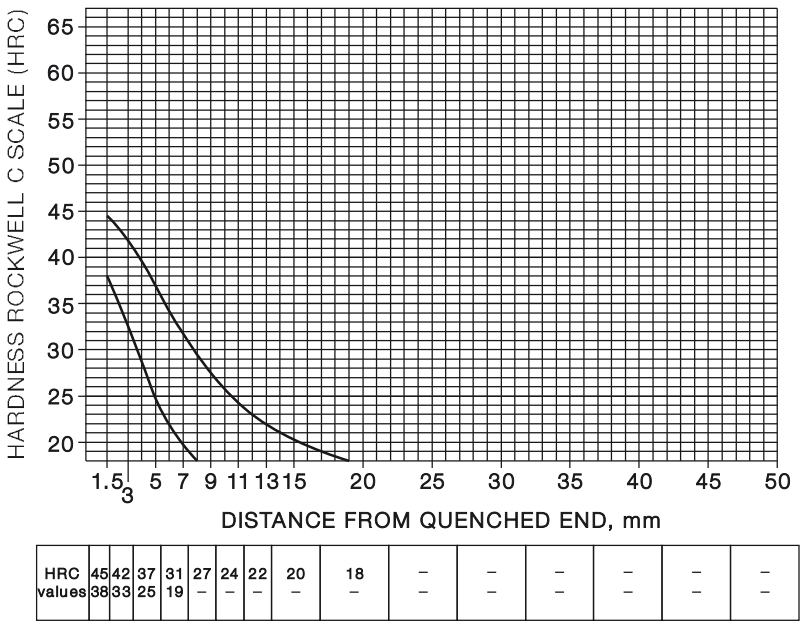


FIGURE 3.14 HARDENABILITY LIMITS FOR GRADE AS 1444/8115H STEEL

3.4.15 Grade AS 1444/8617H

3.4.15.1 *Chemical composition, percent*

	Min.	Max.
C	0.14	0.20
Si	0.10	0.35
Mn	0.60	0.95
P	—	0.040
S	—	0.040
Cr	0.35	0.65
Mo	0.15	0.25
Ni	0.35	0.75

3.4.15.2 *Heat-treatment temperatures*

Normalizing temperature: 925°C.

Austenitizing temperature: 925°C.

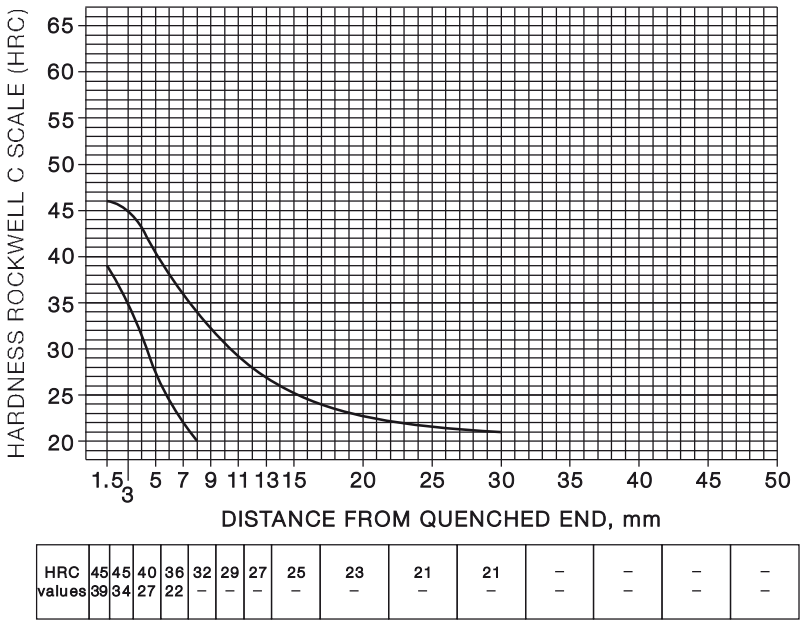


FIGURE 3.15 HARDENABILITY LIMITS FOR GRADE AS 1444/8617H STEEL

3.4.16 Grade AS 1444/8620H

3.4.16.1 *Chemical composition, percent*

	Min.	Max.
C	0.17	0.23
Si	0.10	0.35
Mn	0.60	0.95
P	—	0.040
S	—	0.040
Cr	0.35	0.65
Mo	0.15	0.25
Ni	0.35	0.75

3.4.16.2 *Heat-treatment temperatures*

Normalizing temperature: 925°C.

Austenitizing temperature: 925°C.

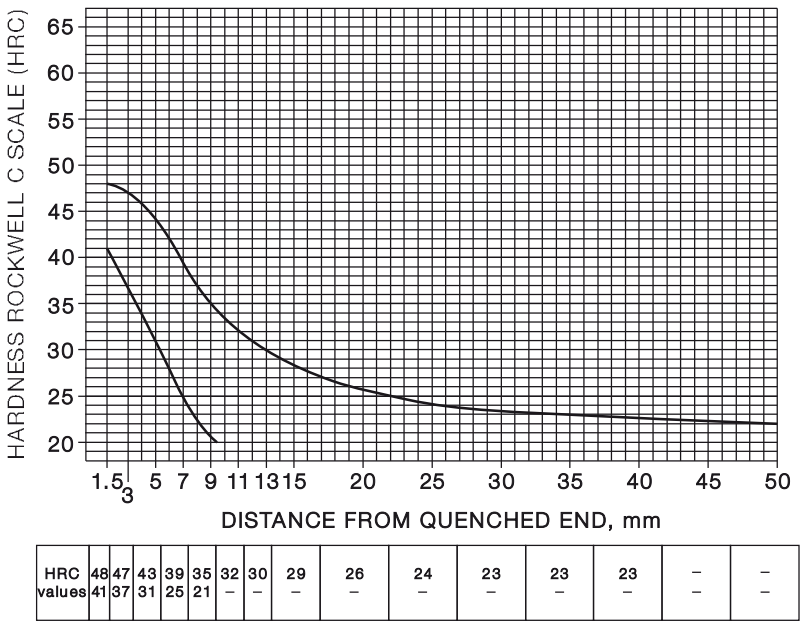


FIGURE 3.16 HARDENABILITY LIMITS FOR GRADE AS 1444/8620H STEEL

3.4.17 Grade AS 1444/86B30H

3.4.17.1 *Chemical composition, percent*

	Min.	Max.
C	0.27	0.33
Si	0.10	0.35
Mn	0.60	0.95
P	—	0.040
S	—	0.040
Cr	0.35	0.65
Mo	0.15	0.25
Ni	0.35	0.75

Can be expected to have 0.0005% minimum boron content.

3.4.17.2 *Heat-treatment temperatures*

Normalizing temperature: 900°C.

Austenitizing temperature: 870°C.

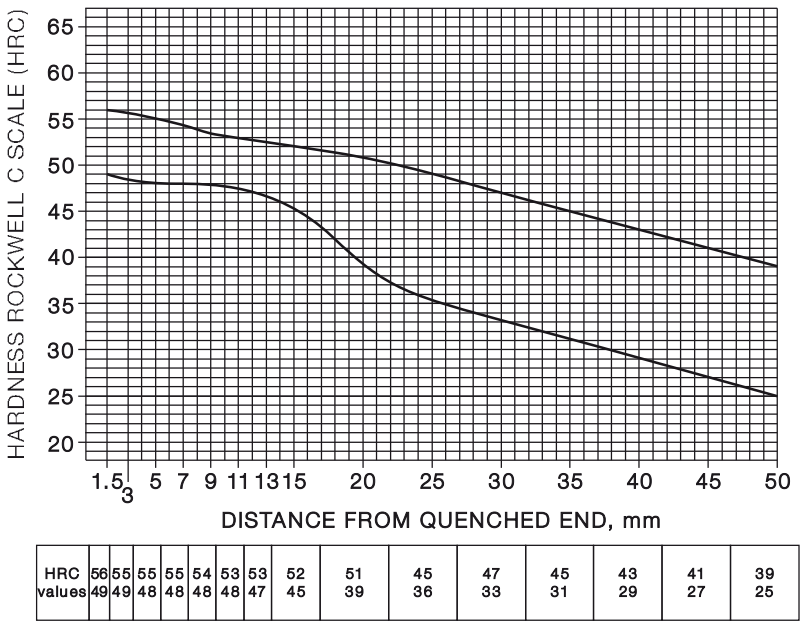


FIGURE 3.17 HARDENABILITY LIMITS FOR GRADE AS 1444/86B30H STEEL

3.4.18 Grade AS 1444/8660H

3.4.18.1 *Chemical composition, percent*

	Min.	Max.
C	0.55	0.65
Si	0.10	0.35
Mn	0.70	1.05
P	—	0.040
S	—	0.040
Cr	0.35	0.65
Mo	0.15	0.25
Ni	0.35	0.75

3.4.18.2 *Heat-treatment temperatures*

Normalizing temperature: 870°C.

Austenitizing temperature: 845°C.

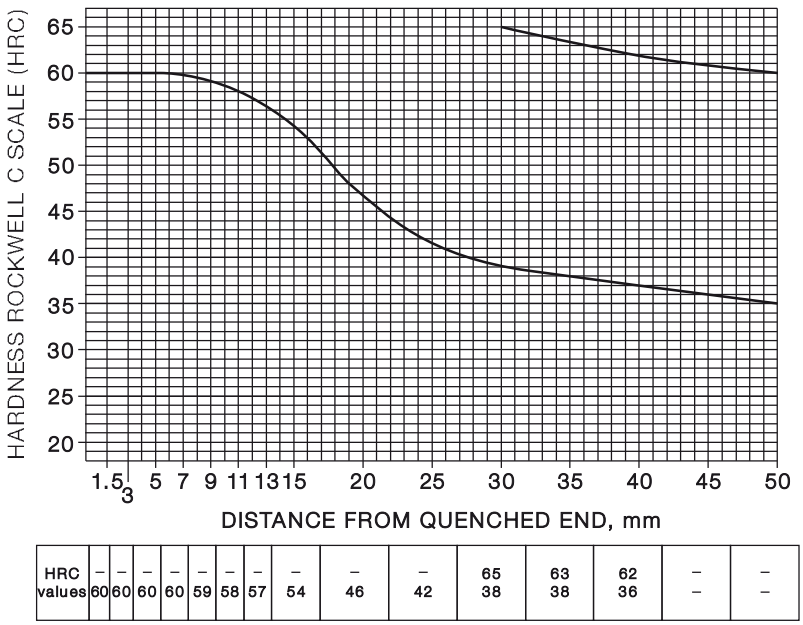


FIGURE 3.18 HARDENABILITY LIMITS FOR GRADE AS 1444/8660H STEEL

3.4.19 Grade AS 1444/8740H

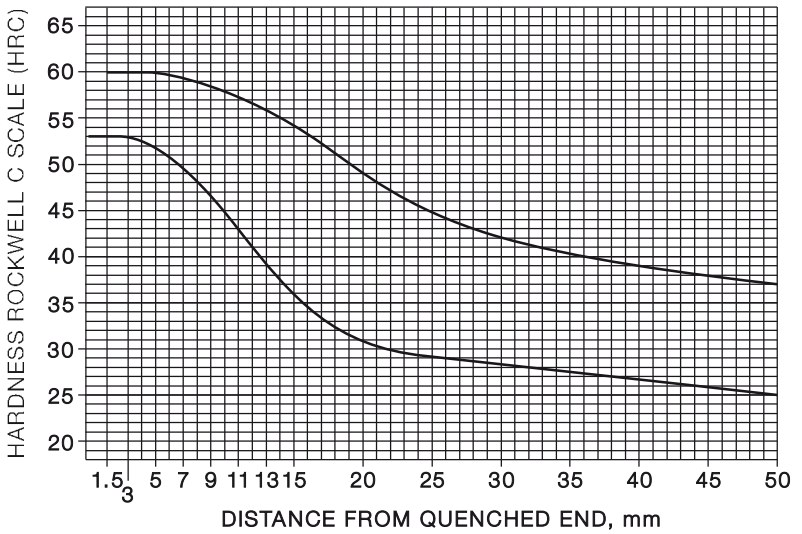
3.4.19.1 *Chemical composition, percent*

	Min.	Max.
C	0.37	0.44
Si	0.10	0.35
Mn	0.70	1.05
P	—	0.040
S	—	0.040
Cr	0.35	0.65
Mo	0.20	0.30
Ni	0.35	0.75

3.4.19.2 *Heat-treatment temperatures*

Normalizing temperature: 870°C.

Austenitizing temperature: 845°C.



HRC values	60 53	60 53	60 52	60 50	58 46	57 43	56 39	54 36	49 31	45 29	42 28	41 27	39 27	– –	– –

FIGURE 3.19 HARDENABILITY LIMITS FOR GRADE AS 1444/8740H STEEL

3.4.20 Grade AS 1444/9260H

3.4.20.1 *Chemical composition, percent*

	Min.	Max.
C	0.55	0.65
Si	1.70	2.20
Mn	0.65	1.10
P	—	0.050
S	—	0.050

3.4.20.2 *Heat-treatment temperatures*

Normalizing temperature: 900°C.

Austenitizing temperature: 870°C.

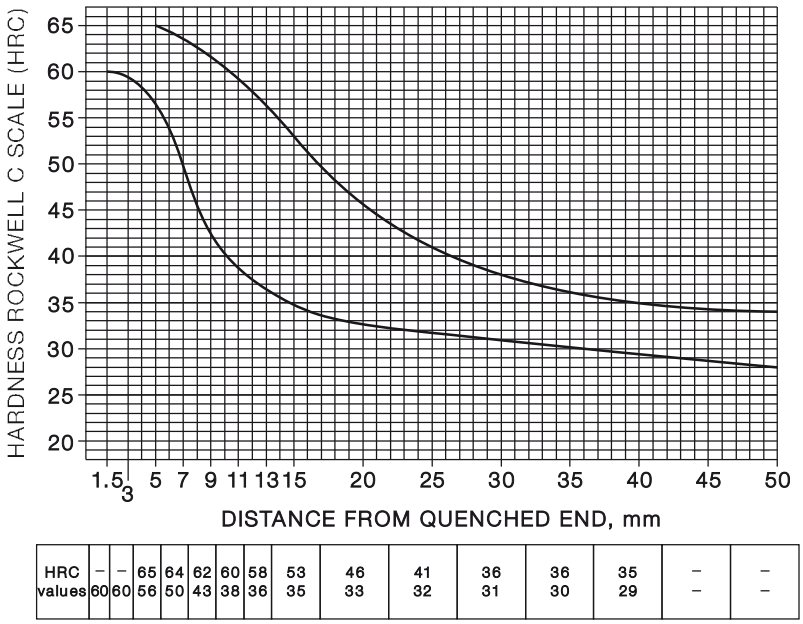


FIGURE 3.20 HARDENABILITY LIMITS FOR GRADE AS 1444/9260H STEEL

3.4.21 Grade AS 1444/9261H

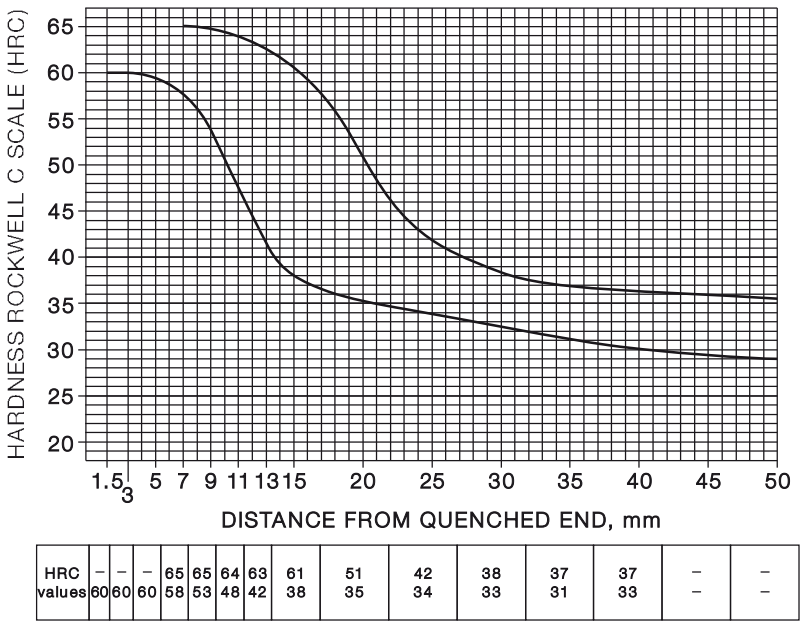
3.4.21.1 *Chemical composition, percent*

	Min.	Max.
C	0.55	0.65
Si	1.70	2.20
Mn	0.65	1.10
P	—	0.050
S	—	0.050
Cr	0.05	0.35

3.4.21.2 *Heat-treatment temperatures*

Normalizing temperature: 900°C.

Austenitizing temperature: 870°C.



HRC values	– 60	– 60	– 60	65 58	65 53	64 48	63 42	61 38	51 35	42 34	38 33	37 31	37 33	– –	– –

FIGURE 3.21 HARDENABILITY LIMITS FOR GRADE AS 1444/9261H STEEL

3.4.22 Grade AS 1444/X9315H

3.4.22.1 *Chemical composition, percent*

	Min.	Max.
C	0.12	0.18
Si	0.10	0.35
Mn	0.25	0.50
P	—	0.040
S	—	0.040
Cr	1.00	1.40
Mo	0.15	0.30
Ni	3.90	4.30

3.4.22.2 *Heat-treatment temperatures*

Normalizing temperature: 930°C.

Austenitizing temperature: 830°C.

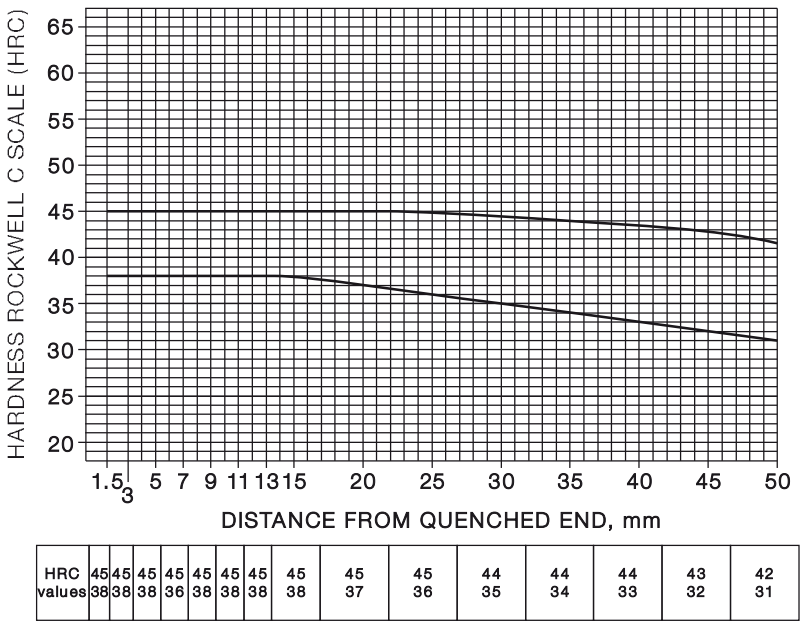


FIGURE 3.22 HARDENABILITY LIMITS FOR GRADE AS 1444/X9315H STEEL

SECTION 4 STEELS SUPPLIED TO CHEMICAL COMPOSITION AND MECHANICAL PROPERTY REQUIREMENTS

4.1 SCOPE

This Section specifies the requirements for chemical composition, heat treatment, mechanical properties and methods for mechanical testing of wrought alloy steels supplied to chemical composition and mechanical property requirements.

4.2 CHEMICAL COMPOSITION

The reported cast analysis of steel shall comply with the requirements of Table 4.1 for the appropriate grade.

4.3 HEAT TREATMENT

4.3.1 Hardening and tempering

The heat treatment of steel to be supplied in the hardened and tempered condition, shall be carried out in a manner to achieve the relevant mechanical property requirements.

NOTES:

1 As a guide, the austenitizing period should be at least 30 min and the tempering period at least 60 min. To avoid quench cracking, it is important to minimize the delay between quenching and the tempering operation.

2 When choosing the quenching agent the influence of other parameters such as shape, dimensions and quenching temperature on properties and crack susceptibility should be taken into account.

4.3.2 Nitriding

Where parts are to be nitrided, the steel shall be hardened and tempered; tempering, or any stress relieving treatment required after rough machining, shall be carried out at a temperature not less than 30°C above the temperature employed for nitriding.

4.4 MECHANICAL PROPERTIES

The mechanical properties of test pieces, prepared and tested in accordance with Clause 4.5 shall meet the following requirements:

(a) *For tensile and hardness tests.*

The results of the tensile and hardness tests shall comply with the relevant requirements of Table 4.2 or Table 4.3.

(b) *For impact tests*

Either Izod or Charpy V-notch tests shall be carried out and, unless otherwise specified by the purchaser, the method of test shall be at the option of the supplier.

The average value of the results obtained for three notches shall comply with the relevant requirements of Table 4.2

No individual value shall be lower than 70% of the minimum average value.

NOTES:

1 The values specified in Table 4.2 apply to test pieces machined in the longitudinal direction. The percentage elongation and Izod impact values obtained from transverse tests will be lower than those values to an extent governed by the size, form and type of steel.

2 It is not possible to convert values from one type of impact test to the other.

4.5 METHODS FOR MECHANICAL TESTING

4.5.1 Form of test sample

For forgings with a ruling section equivalent to a diameter greater than 30 mm, either integral test samples (test samples forming a prolongation on the forgings) or separate test samples shall be provided.

Integral test samples shall not be finally severed from the forgings until final heat treatment has been completed.

Where integral test samples are not required, and for—

(a) small forgings with the ruling section equivalent to a diameter of 30 mm or less; or

(b) parts machined from a bar not finally heat treated,

separate test samples may be provided from the bars or billets from which the forgings or parts are to be made. Test samples shall be forged or machined to the ruling section of the forgings or parts, and shall be heat treated with the finished product they represent.

NOTE: Separate test samples may be additional forgings or parts.

4.5.2 Preparation of test specimens

4.5.2.1 *Bars and billets for forgings, and bars for machining not supplied in the finally heat-treated condition*

Where the ruling section of the bars or billets does not differ appreciably from that of the forgings or parts to be produced, test specimens may be taken directly from a bar or billet, and heat treated in the original size.

Where it is considered that the results of heat treating in the bar or billet size would not be representative of the properties of the forgings or parts to be produced, test samples shall be forged or machined to a diameter equivalent to the ruling section of the forgings or parts at the time of heat treatment.

4.5.2.2 *Bars for machining, supplied in the finally heat-treated condition*

Test specimens shall be cut from the heat-treated bars and shall not be further heat treated or mechanically worked. As an exception, where the specified minimum tensile strength is 1300 MPa or more, test specimens shall be cut from the bars before heat treatment, and shall be separately prepared as specified in Clause 4.5.2.3.

4.5.2.3 *Heat treatment of test specimens*

Where it is necessary to carry out testing on heat-treated test pieces, the heat treatment shall be carried out on either the test sample or the test specimen, except where the minimum tensile strength of the steel is 1300 MPa or more. In this case, the necessary heat treatment shall be carried out on the test specimen after it has been machined to the dimensions of the test piece, plus a grinding allowance, if required.

NOTE: The properties obtained are representative of heat-treated parts having the same ruling section as that of the test specimen and do not represent larger ruling sections.

4.5.3 Preparation of test pieces

4.5.3.1 *General*

Test specimens may be straightened cold before preparation in accordance with this Standard. A test piece which shows defective machining or develops flaws shall be discarded and another test specimen submitted.

4.5.3.2 *Orientation of test pieces*

Test pieces for tensile testing and impact testing shall be prepared with their major axis in the longitudinal direction of the product.

4.5.3.3 *Tensile test pieces*

Tensile test pieces shall be prepared in accordance with AS 1391.

Material of diameter, or width across flats, of 16 mm or less shall be tested in full section. For material of diameter or width across flats greater than 16 mm, either a proportional cylindrical test piece or a non-proportional test piece may be used. Where a proportional test piece is used, the following shall apply:

(a) For test specimen ruling sections up to and including 30 mm, test pieces shall be machined coaxially from the test specimen.

(b) For test specimen ruling sections over 30 mm, the axis of the test piece shall be 12.5 mm from the surface of the test specimen.

4.5.3.4 *Impact test pieces*

Izod impact test pieces with three notches shall be prepared in accordance with AS 1544.1. Alternatively, three Charpy V-notch test pieces shall be prepared in accordance with AS 1544.2.

Test pieces shall be prepared from the following locations within a test specimen:

(a) For test specimen ruling sections up to and including 30 mm, the test piece shall be machined coaxially from the test specimen.

(b) For test specimen ruling sections over 30 mm, the axis of the test piece shall be 12.5 mm from the surface of the test specimen.

4.5.3.5 *Hardness test piece*

The hardness test piece shall be prepared in accordance with AS 1816.1 or AS 1817.1.

4.5.4 Tensile test

The tensile strength, 0.2% proof stress and elongation shall be determined in accordance with AS 1391.

The rate of straining when approaching the yield stress shall conform to the limits of conventional strain rate given in AS 1391.

Elongation results shall be reported on a gauge length of $L_o = 5.65\sqrt{S_o}$, where S_o is the cross-sectional area of the test piece before testing. If required, conversion of results from a non-proportional gauge length shall be in accordance with ISO 2566-1.

4.5.5 Hardness test

Where practicable, hardness testing shall be carried out in accordance with AS 1816.1. Where the size of the section makes a Brinell hardness determination impracticable, Vickers hardness shall be determined in accordance with AS 1817.1.

Hardness conversion, if required, should be in accordance with AS 5016.

4.5.6 Impact test

The Izod or Charpy impact test shall be carried out at ambient temperature in accordance with AS 1544.1 or AS 1544.2 respectively and the average value of the results obtained for three notches determined.

4.6 SAMPLING

When mechanical test certificates are required, test samples shall be taken from each batch at the frequency agreed between the purchaser and the supplier.

NOTE: As a guideline, sampling frequencies of one sample for a batch of steel up to 25 t and two samples for a batch of steel exceeding 25 t, are recommended.

TABLE 4.1
CHEMICAL COMPOSITION REQUIREMENTS

Alloy designation	Chemical composition (cast analysis), %															
	Carbon		Silicon		Manganese		Phosphorus*	Sulfur*	Chromium		Molybdenum		Nickel		Aluminium	
	min.	max.	min.	max.	min.	max.	max.	max.	min.	max.	min.	max.	min.	max.	min.	max.
X4036	0.32	0.4	0.1	0.35	1.3	1.7	0.04	0.04	—	—	0.22	0.32	—	—	—	—
4130	0.27	0.33	0.1	0.35	0.3	0.7	0.04	0.04	0.75	1.2	0.15	0.25	—	—	—	—
4140	0.37	0.44	0.1	0.35	0.65	1.1	0.04	0.04	0.75	1.2	0.15	0.3	—	—	—	—
4340	0.37	0.44	0.1	0.35	0.55	0.9	0.04	0.04	0.65	0.95	0.2	0.35	1.55	2	—	—
X7039	0.35	0.43	0.1	0.35	0.4	0.65	0.025	0.025	1.4	1.8	0.15	0.25	—	—	0.9	1.3
X7232	0.28	0.35	0.1	0.35	0.4	0.7	0.04	0.04	2.8	3.3	0.4	0.6	—	—	—	—
X9931	0.27	0.35	0.1	0.35	0.45	0.7	0.04	0.04	0.5	0.8	0.45	0.65	2.3	2.8	—	—
X9940	0.36	0.44	0.1	0.35	0.45	0.7	0.04	0.04	0.5	0.8	0.45	0.65	2.3	2.8	—	—

* Phosphorus 0.025 max., and sulfur 0.025 max., for steels requiring heat treatment to tensile strength designations Y and Z.

TABLE 4.2

MECHANICAL PROPERTY REQUIREMENTS FOR STEELS IN THE HEAT-TREATED CONDITION

Alloy designation AS 1444	Mechanical property designation	Limiting ruling section	Tensile strength MPa		0.20% Proof stress MPa	Elongation on $5.65\sqrt{S_o}$* %	Izod impact J	Charpy impact J	Brinell hardness HB	
		mm	min.	max.	min.	min.	min.	min.	min.	max.
X4036	R	250	700	850	480	15	34	28	201	255
	R	150	700	850	510	17	54	50	201	255
	S	100	770	930	570	15	54	50	223	277
	T	63	850	1 000	665	13	54	50	248	302
	U	30	930	1 080	740	12	47	42	269	331
	V†	20	1 000	1 150	835	12	47	42	293	352
4130	R	150	700	850	510	17	54	50	201	255
	S	100	770	930	570	15	54	50	223	277
	T	63	850	1 000	665	13	54	50	248	302
	U	30	930	1 080	740	12	47	42	269	331
4140‡	R	250	700	850	480	15	34	28	201	255
	S	250	770	930	540	13	27	22	223	277
	S	150	770	930	570	15	54	50	223	277
	T	100	850	1 000	665	13	54	50	248	302
	U	63	930	1 080	740	12	47	42	269	331
	V	30	1 000	1 150	835	12	47	42	293	352
	W†	20	1 080	1 230	925	12	40	35	311	375
4340	T	250	850	1 000	635	13	40	35	248	302
	T	150	850	1 000	665	13	54	50	248	302
	U	100	930	1 080	740	12	47	42	269	331
	V	63	1 000	1 150	835	12	47	42	293	352
	W	30	1 080	1 230	925	11	41	35	311	375
	X§	30	1 150	1 300	1 005	10	34	28	341	401
	Y§	30	1 230	1 380	1 080	10	24	20	363	429
	Z§	30	1 550	—	1 125	5	10	9	444	—
X7039‡	R	150	700	850	510	17	54	—	201	255
	S	100	770	930	570	15	54	—	223	277
	T	63	850	1 000	665	13	47	—	248	302
X7232‡	U	250	930	1 080	740	12	40	35	269	331
	U	150	930	1 080	740	12	47	42	269	331
	V	150	1 000	1 150	835	12	47	42	293	352
	W	100	1 080	1 230	925	11	40	35	311	375

(*continued*)

TABLE 4.2 (*continued*)

Alloy designation AS 1444	Mechanical property designation	Limiting ruling section	Tensile strength MPa		0.20% Proof stress MPa	Elongation on $5.65\sqrt{S_o}$* %	Izod impact J	Charpy impact J	Brinell hardness HB	
		mm	min.	max.	min.	min.	min.	min.	min.	max.
X9931	T	250	850	1 000	635	13	40	35	248	302
	T	150	850	1 000	665	13	54	50	248	302
	U	250	930	1 080	725	12	34	28	269	331
	U	150	930	1 080	740	12	47	42	269	331
	V	150	1 000	1 150	835	12	47	42	293	352
	W	100	1 080	1 230	925	11	40	35	311	375
	X§	63	1 150	1 300	1 005	10	34	28	341	401
	Y§	63	1 230	1 380	1 080	10	34	28	363	429
	Z§	63	1 550	—	1 125	5	10	9	444	—
X9940	U	250	930	1 080	725	12	34	28	269	331
	U	150	930	1 080	740	12	47	42	269	331
	V	250	1 000	1 150	820	12	34	28	293	352
	V	150	1 000	1 150	835	12	47	42	293	352
	W	250	1 080	1 230	910	11	27	22	311	375
	W	150	1 080	1 230	925	11	40	35	311	375
	X§	150	1 150	1 300	1 005	10	34	28	341	401
	Y§	150	1 230	1 380	1 080	10	34	28	363	429
	Z§	100	1 550	—	1 125	7	13	11	444	—

* S_o = original cross-sectional area of test piece.

† The properties may not be attainable by bulk heat treatment, but may be achieved by appropriate heat treatment of die forgings, components or test bars.

‡ Suitable alloys for nitriding.

§ Usually ordered in the annealed condition, for machining and subsequent heat treatment to achieve the specified mechanical properties.

TABLE 4.3

MECHANICAL PROPERTY REQUIREMENTS FOR STEELS HEAT TREATED THEN COLD FINISHED*

Alloy designation AS 1444	Mechanical property designation	Limiting ruling section	Tensile strength MPa		0.2% Proof stress MPa	Elongation on $5.65\sqrt{S_o}$* %	Brinell hardness HB	
		mm	min.	max.	min.	min.	min.	max.
4140	R	63	700	850	525	12	201	255
	S	63	770	930	585	11	223	277
	T	63	850	1 000	680	9	248	302
	U	63	930	1 080	755	9	269	331
	V	63	1 000	1 150	850	9	293	352
4340	T	63	850	1 000	680	9	248	302
	U	63	930	1 080	755	9	269	331
	V	63	1 000	1 150	850	9	293	352

* For mechanical property requirements of cold-finished bars that are not subject to cold work (cold drawing or cold rolling) after heat treatment, see Table 4.2.

SECTION 5 MANUFACTURING TOLERANCES

5.1 SCOPE

This Section specifies dimensional tolerances for hot-rolled and cold-finished bars.

5.2 DIMENSIONAL TOLERANCES FOR HOT-ROLLED BARS

Hot-rolled bars shall be manufactured to the dimensional tolerances specified in the following tables:

(a) Cross-sectional dimension tolerances for round and square bars ..... Table 5.1

(b) Cross-sectional dimension tolerances for hexagonal bars..... Table 5.2

(c) Width tolerances for square-edge and round-edge flat bars..... Table 5.3

(d) Thickness tolerances for square-edge and round-edge flat bars..... Table 5.4

(e) Length tolerances for hot-cut bars..... Table 5.5

(f) Straightness tolerances for bars ..... Table 5.6

5.3 DIMENSIONAL TOLERANCES FOR COLD-FINISHED BARS

Cold-finished bars shall be manufactured to the tolerances specified in the following tables:

(a) Cross-sectional dimension tolerance grades and requirements for round, square, hexagonal and flat bars ..... Tables 5.7 and 5.8

(b) Length tolerances for bars ..... Table 5.9

(c) Straightness tolerances for bars (coils excluded) ..... Table 5.10

NOTES:

1 All straightness measurements are taken at least 50 mm from the end of the product.

2 For critical applications the straightness tolerance should be nominated by the purchaser at the time of order.

TABLE 5.1

CROSS-SECTIONAL DIMENSION TOLERANCES FOR HOT-ROLLED ROUND AND SQUARE BARS

millimetres

Specified size (diameter or thickness)	Permissible variation from specified size	Permissible out-of-round or out-of-square
≤25	+0.25, −0.25	0.40
>25 ≤30	+0.30, −0.30	0.45
>30 ≤40	+0.40, −0.40	0.60
>40 ≤50	+0.50, −0.50	0.75
>50 ≤60	+0.60, −0.60	0.90
>60 ≤70	+0.70, −0.70	1.05
>70 ≤80	+0.80, −0.80	1.20
>80 ≤100*	+0.90, −0.90	1.35
>100 ≤125	+3.20 —	3.20
>125 ≤170	+4.80 —	4.80
>170 ≤215	+6.40 —	6.40

* For material produced as primary rolled product (see Clause 1.3.11), optional dimensional tolerances in the size range >80 ≤100 are +2.45, -0, and the permissible out-of-round or out-of-square is 1.85.

TABLE 5.2

CROSS-SECTIONAL DIMENSION TOLERANCES FOR HOT-ROLLED HEXAGON BARS

millimetres

Specified thickness	Permissible variation from specified thickness	Permissible out-of-hexagon
≤12	+0.20, −0.20	0.30
>12 ≤25	+0.25, −0.25	0.40
>25 ≤40	+0.55, −0.35	0.65
>40 ≤50	+0.80, −0.40	0.90
>50 ≤65	+1.20, −0.40	1.10

TABLE 5.3

WIDTH TOLERANCES FOR SQUARE-EDGE AND ROUND-EDGE HOT-ROLLED FLAT BARS

millimetres

Specified width	Width tolerance
≤25	+0.40, −0.40
>25 ≤50	+0.80, −0.80
>50 ≤100	+1.60, −0.80
>100 ≤150	+2.40, −1.60
>150 ≤200	+3.20, −3.20
>200 ≤300	+3.20, −3.20

TABLE 5.4

THICKNESS TOLERANCES FOR SQUARE-EDGE AND ROUND-EDGE HOT-ROLLED FLAT BARS

millimetres

Specified width	Thickness tolerance (plus or minus)				
	Specified thickness				
	<6	≥6 ≤12	>12 ≤25	>25 ≤50	>50
≤25	0.20	0.20	0.25	—	—
>25 ≤50	0.20	0.30	0.40	0.80	—
>50 ≤100	0.20	0.40	0.50	0.80	1.20
>100 ≤150	0.25	0.40	0.50	0.80	1.60
>150 ≤200	0.25	0.40	0.50	0.80	—
>200 ≤300	—	0.40	0.50	0.80	—

TABLE 5.5

LENGTH TOLERANCES FOR HOT-CUT BARS

Specified length, m	Length tolerance, mm
≤7	+50, −0
>7 ≤12	+75, −0
>12	+100, −0

NOTE: The length tolerance does not apply to primary rolled product.

TABLE 5.6

STRAIGHTNESS TOLERANCES FOR HOT-ROLLED BARS

millimetres

Specified size	Maximum deviation from straight line	
	In any 1.5 m of length	Per metre run
All sizes	6	4

NOTE: These tolerances do not apply to primary rolled product.

TABLE 5.7

TOLERANCE GRADES FOR COLD-FINISHED BARS

Form and condition							
Bright bars						Cold-sized	Peeled
Rounds			Square	Hexagonal	Flat (See Note 4)		
Precision ground	Cold drawn	Turned and polished					
h8	h10	h11	h11	h11	h11	h11	k12

NOTES:

1 Out-of-round, out-of-hexagon, out-of-square in bars have tolerances equal to one half of the tolerance band.

2 The cross-sectional dimensions are measured at a distance of at least 150 mm from the end of the product. In the case of bars in set lengths, testing is carried out at a distance of at least 10 mm from the ends.

3 Cross-sectional dimensions may be checked using instruments such as limit gap gauges, micrometer callipers and three-point measuring devices. Measurement is carried out at room temperature.

4 Width tolerances are generally not applied to flats up to 7 mm thick.

5 The tolerance grades have been derived from AS 1654.2.

TABLE 5.8

CROSS-SECTIONAL DIMENSION TOLERANCES FOR COLD-FINISHED BARS*

millimetres

Specified diameter or cross-sectional dimension	Tolerance grade			
	h8	h10	h11	k12
≤3	+0, –0.014	+0, –0.040	+0, –0.060	+0.100, –0
>3 ≤6	+0, –0.018	+0, –0.048	+0, –0.075	+0.120, –0
>6 ≤10	+0, –0.022	+0, –0.058	+0, –0.090	+0.150, –0
>10 ≤18	+0, –0.027	+0, –0.070	+0, –0.110	+0.180, –0
>18 ≤30	+0, –0.033	+0, –0.084	+0, –0.130	+0.210, –0
>30 ≤50	+0, –0.039	+0, –0.100	+0, –0.160	+0.250, –0
>50 ≤80	+0, –0.046	+0, –0.120	+0, –0.190	+0.300, –0
>80 ≤120	+0, –0.054	+0, –0.140	+0, –0.220	+0.350, –0
>120 ≤180	+0, –0.063	+0, –0.160	+0, –0.250	+0.400, –0
>180 ≤250	+0, –0.072	+0, –0.185	+0, –0.290	+0.460, –0
>250 ≤315	+0, –0.081	+0, –0.210	+0, –0.320	+0.520, –0

* These tolerance values have been derived from AS 1654.2.

TABLE 5.9

LENGTH CATEGORIES AND LENGTH TOLERANCES FOR COLD-FINISHED BARS

Length category	Length		Length details to be specified
	Nominal range m	Tolerance mm	
Mill length*	3.5 to 6.0	±250	Mill length and nominal length
Set length	3 to 7	−0, +50	Set length and nominal length

* For mill length, bars having a total weight of up to 10% of the quantity supplied may be shorter, but not less than 3.0 m.

TABLE 5.10

STRAIGHTNESS TOLERANCES FOR COLD-FINISHED BARS FOR COMMERCIAL APPLICATIONS*

millimetres

Section	Steel type	Maximum permissible deviation from straight line
Rounds	Grades with <0.25% carbon	1 in 1000
	Grades with ≥0.25% carbon, alloys and all heat-treated grades	1 in 500
Squares and hexagons	All grades	1 in 375
Flats	All grades	1 in 375

* See Clause 5.3(c) Note 2 for straightness critical applications.

APPENDIX A

PURCHASING GUIDELINES

(Informative)

A1 GENERAL

Australian Standards are intended to include the technical requirements for relevant products, but do not purport to comprise all the necessary provisions of a contract. This Appendix contains advice and recommendations on the information to be supplied by the purchaser at the time of enquiry or order.

A2 INFORMATION TO BE SUPPLIED BY THE PURCHASER

The purchaser should supply the following information at the time of enquiry and order, after making due reference to the explanation, advice and recommendations contained in this Appendix:

(a) Quantity and delivery instructions (mass, dates, schedules, packaging and delivery point).

(b) Dimensions of steel, e.g. section, length category (if applicable), mass per unit length, bundle mass.

NOTE: Attention is drawn to the desirability of specifying cross-sectional dimensions in terms of AS 2338. It should be noted that sizes not listed in AS 2338 are not necessarily precluded for ordering purposes.

(c) Designation of grade (see Clause 1.4).

NOTE: If a grade of steel having restricted hardenability is required, the extent of restriction should be specified, e.g. upper, lower or middle third.

(d) The surface condition designation (see Clause 1.4.5).

(e) Whether austenite grain size testing is required (see Clause 1.6.5).

(f) Defects allowable (see Clause 1.7.1).

(g) Condition of steel on delivery (see Clause 1.5).

(h) Whether maximum hardness values are required.

NOTE: Where subsequent processing requires that a maximum hardness be specified, the value to be used should be subject to agreement between the purchaser and the supplier. The values given in Table A1 may be used as the basis for negotiation.

(i) Whether tolerances are required for billets or blooms.

(j) For bright bars, requirements for length and straightness tolerances (see Clause 5.3(b) and (c)).

(k) Whether a test certificate or certificate of compliance is required.

(l) Whether a non-destructive testing examination is required and, if so, the test method to be used and the acceptance criteria.

(m) Whether it is the intention of the purchaser to inspect the steel at the manufacturer's works.

(n) Any information concerning processing or end use that the purchaser considers would assist the manufacturer, e.g. electroplating, grinding and heat treatment.

(o) Any special requirements such as steel making techniques or cleanliness.

(p) Reference to this Australian Standard, i.e. AS 1444.

TABLE A1

MAXIMUM BRINELL HARDNESS

Grade AS 1444	Bars and billets for forging	Forgings and bars for machining		
		Normalized	Annealed	Normalized and tempered
X1320	207	207	—	—
X3312	255	—	255	223
4130	217	—	197	—
X4036	—	—	217	—
4140	235	—	217	—
4150	255	—	235	—
X4317	255	—	229	—
4340	277	—	248	—
4620	207	207	—	—
5120	207	207	—	—
5132	217	217	—	—
5145	235	—	229	—
6150	248	—	229	—
X7039	248	—	235	—
X7232	248	—	248	—
8115	207	207	—	—
8617	207	207	—	—
8620	207	207	—	—
86B30	235	—	217	—
8660	255	—	235	—
8740	235	—	217	—
9260	262	—	248	—
9261	262	—	248	—
X9315	277	—	277	255
X9931	255	—	255	—
X9940	255	—	255	—

APPENDIX B

MEANS FOR DEMONSTRATING COMPLIANCE WITH THIS STANDARD

(Informative)

B1 SCOPE

This Appendix sets out the following different means by which compliance with this Standard can be demonstrated by the manufacturer or supplier:

(a) Evaluation by means of statistical sampling.

(b) The use of a product certification scheme.

(c) Assurance using the acceptability of the supplier's quality system.

(d) Other such means proposed by the manufacturer or supplier and acceptable to the customer.

B2 STATISTICAL SAMPLING

Statistical sampling is a procedure which enables decisions to be made about the quality of batches of items after inspecting or testing only a portion of those items. This procedure will only be valid if the sampling plan has been determined on a statistical basis and the following requirements are met:

(a) The sample needs to be drawn randomly from a population of product of known history. The history needs to enable verification that the product was made from known materials at essentially the same time, by essentially the same processes and under essentially the same system of control.

(b) For each different situation, a suitable sampling plan needs to be defined. A sampling plan for one manufacturer of given capability and product throughput may not be relevant to another manufacturer producing the same items.

In order for statistical sampling to be meaningful to the customer, the manufacturer or supplier needs to demonstrate how the above conditions have been satisfied. Sampling and the establishment of a sampling plan should be carried out in accordance with AS 1199.1, guidance to which is given in AS 1199.0.

B3 PRODUCT CERTIFICATION

The purpose of product certification is to provide independent assurance of the claim by the manufacturer that products comply with the stated Standard.

The certification scheme should meet the criteria described in HB 18.28 in that, as well as full type testing from independently sampled production and subsequent verification of conformance, it requires the manufacturer to maintain effective quality planning to control production.

The certification scheme serves to indicate that the products consistently conform to the requirements of the Standard.

B4 SUPPLIER'S QUALITY MANAGEMENT SYSTEM

Where the manufacturer or supplier can demonstrate an audited and registered quality management system complying with the requirements of the appropriate or stipulated Australian or international Standard for a supplier's quality management system or systems, this may provide the necessary confidence that the specified requirements will be met. The quality assurance requirements need to be agreed between the customer and supplier and should include a quality or inspection and test plan to ensure product conformity.

Information on establishing a quality management system is set out in AS/NZS ISO 9001 and AS/NZS ISO 9004.

B5 OTHER MEANS OF ASSESSMENT

If the above methods are considered inappropriate, determination of compliance with the requirements of this Standard may be assessed from the results of testing coupled with the manufacturer's guarantee of product conformance.

Irrespective of acceptable quality levels (AQLs) or test frequencies, the responsibility remains with the manufacturer or supplier to supply products that conform to the full requirements of the Standard.

APPENDIX C

GUIDE TO THE SELECTION OF STEELS BASED ON HEAT TREATMENT, MECHANICAL PROPERTIES AND RULING SECTION

(Informative)

C1 SCOPE

This Appendix provides guidelines on the selection of steels based on tensile strength and ruling section for various heat treatment conditions.

C2 RULING SECTION

In selecting a grade of steel, one of the most important considerations is that its composition should allow the desired mechanical properties to be developed throughout its cross-section by heat treatment. Table C1 lists grades of steel which should be capable of through hardening at various ruling sections to achieve the mechanical property ranges specified in this Standard.

TABLE C1

RELATIONSHIP BETWEEN MECHANICAL PROPERTIES, RULING SECTION AND STEEL GRADE

Mechanical property designation	Tensile strength range MPa	Brinell hardness range HB	Steel grade selection guide for ruling section ranges					
			≤20 mm	>20 mm ≤30 mm	>30 mm ≤63 mm	>63 mm ≤100 mm	>100 mm ≤150 mm	>150 mm ≤250 mm
R	≥700 ≤850	≥201 ≤255	X4036	X4036	X4036	X4036	X4036	X4036
			4130	4130	4130	4130	4130	—
			4140	4140	4140	4140	4140	4140
			X7039	X7039	X7039	X7039	X7039	—
S	≥770 ≤930	≥223 ≤277	X4036	X4036	X4036	X4036	—	—
			4130	4130	4130	4130	—	—
			4140	4140	4140	4140	4140	4140
			X7039	X7039	X7039	X7039	—	—
T	≥850 ≤1000	≥248 ≤302	X4036	X4036	X4036	—	—	—
			4130	4130	4130	—	—	—
			4140	4140	4140	4140	—	—
			4340	4340	4340	4340	4340	4340
			X7039	X7039	X7039	—	—	—
			X9931	X9931	X9931	X9931	X9931	X9931

(*continued*)

TABLE C2 (*continued*)

Mechanical property designation	Tensile strength range MPa	Brinell hardness range HB	Steel grade selection guide for ruling section ranges					
			≤20 mm	>20 mm ≤30 mm	>30 mm ≤63 mm	>63 mm ≤100 mm	>100 mm ≤150 mm	>150 mm ≤250 mm
U	≥930 ≤1080	≥269 ≤331	X4036	X4036	—	—	—	—
			4130	4130	—	—	—	—
			4140	4140	4140	—	—	—
			4340	4340	4340	4340	—	—
			X7232	X7232	X7232	X7232	X7232	X7232
			X9931	X9931	X9931	X9931	X9931	X9931
			X9940	X9940	X9940	X9940	X9940	X9940
V	≥1000 ≤1150	≥293 ≤352	X4036	—	—	—	—	—
			4140	4140	—	—	—	—
			4340	4340	4340	—	—	—
			X7232	X7232	X7232	X7232	X7232	—
			X9931	X9931	X9931	X9931	—	—
			X9940	X9940	X9940	X9940	X9940	X9940
W	≥1080 ≤1230	≥311 ≤375	4140	—	—	—	—	—
			4340	4340	—	—	—	—
			X7232	X7232	X7232	—	—	—
			X9931	X9931	X9931	—	—	—
			X9940	X9940	X9940	X9940	X9940	X9940
X	≥1150 ≤1300	≥341 ≤401	4340	4340	—	—	—	—
			X9931	X9931	X9931	—	—	—
			X9940	X9940	X9940	X9940	X9940	—
Y	≥1230 ≤1380	≥363 ≤429	X9931	X9931	X9931	—	—	—
			4340	4340	—	—	—	—
			X9940	X9940	X9940	X9940	X9940	—
Z	≥1550	≥444	4340	4340	—	—	—	—
			X9931	X9931	X9931	—	—	—
			X9940	X9940	X9940	X9940	—	—

APPENDIX D

REQUIREMENTS FOR MAXIMUM SURFACE IMPERFECTION DEPTH

(Normative)

This Appendix contains Table D1, which specifies the maximum permitted depth of surface imperfections for a commercial quality surface condition and for surface condition designations B and F (see Clause 1.7).

TABLE D1

MAXIMUM SURFACE IMPERFECTION DEPTH FOR COMMERCIAL AND FOR B AND F SURFACE CONDITION DESIGNATIONS

millimetres

Diameter*		Thickness of flats	Maximum depth		
Rods	Rounds		Commercial	B	F
	—	3	0.40	0.20	0.10
—	—	5	0.40	0.20	0.10
—	—	—	0.40	0.20	0.10
5.5	—	6	0.40	0.20	0.10
—	—	—	0.40	0.21	0.11
6.5	—	—	0.40	0.21	0.11
7.0	—	—	0.40	0.22	0.12
7.5	—	8	0.40	0.22	0.12
8.0	—	—	0.40	0.23	0.13
9.0	10	10	0.40	0.23	0.13
10.0	—	—	0.45	0.24	0.14
11.2	12	12	0.48	0.25	0.15
—	—	—	0.50	0.25	0.15
12.5	14	—	0.56	0.26	0.16
—	16	16	0.64	0.27	0.17
—	18	—	0.72	0.29	0.19
—	20	20	0.80	0.30	0.20
—	22	—	0.88	0.33	0.21
—	24	—	0.96	0.36	0.22
—	—	25	1.00	0.37	0.22
—	27	—	1.08	0.42	0.23
—	30	—	1.20	0.45	0.24
—	—	32	1.28	0.48	0.24
—	33	—	1.32	0.49	0.25
—	36	—	1.44	0.54	0.26
—	39	—	1.56	0.59	0.27
—	—	40	1.60	0.60	0.27

(*continued*)

TABLE D1 (*continued*)

millimetres

Diameter*		Thickness of flats	Maximum depth		
Rods	Rounds		Commercial	B	F
—	42	—	1.60	0.63	0.28
—	45	—	1.60	0.68	0.29
—	48	—	1.60	0.72	0.29
—	50	50	1.60	0.75	0.30
—	56	—	1.60	0.84	0.32
—	60	—	1.60	0.90	0.34
—	65	—	1.60	0.98	0.35
—	70	—	1.60	1.05	0.37
—	75	—	1.60	1.13	0.38
—	80	—	1.60	1.20	0.40
—	90	—	1.60	1.20	0.40
—	100	—	1.60	1.20	0.40
—	110	—	3.0	1.35	0.45
—	120	—	3.0	1.45	0.45
—	130	—	3.0	1.60	0.50
—	140	—	3.0	1.70	0.55
—	150	—	4.0	1.80	0.55
—	160	—	4.0	1.90	0.60
—	170	—	4.0	2.00	0.65
—	180	—	4.0	2.10	0.70
—	190	—	4.0	2.20	0.70
—	200	—	5.0	2.30	0.75
—	215	—	5.0	2.40	0.80

* Diameter of hot-rolled bar.

NOTE: The requirement for maximum imperfection depth in squares and hexagons of a nominal size is the same as for rounds of the same nominal diameter (e.g. a square section with faces 24 mm × 24 mm corresponds to a 24 mm dia. round section).

APPENDIX E

RECOMMENDED MINIMUM MACHINING ALLOWANCES

(Informative)

This Appendix contains Table E1, which gives recommended minimum machining allowances for hot-rolled bars. For cold-finished bars, the recommended minimum machining allowance is also determined by using Table E1; the rolled size being that of the original hot-rolled bar.

TABLE E1

RECOMMENDED MINIMUM MACHINING ALLOWANCES FOR HOT-ROLLED BARS

millimetres

Rolled size*		Minimum allowance for machining (on nominal diameter)	
		Commercial condition	B or F condition
	≤16	3.0	0.80
>16	≤22	3.0	1.10
>22	≤24	3.0	1.15
>24	≤27	4.0	1.25
>27	≤30	4.0	1.40
>30	≤36	5.0	1.50
>36	≤39	5.0	1.70
>39	≤50	5.0	2.10
>50	≤65	5.0	2.60
>65	≤75	10.0	3.60
>75	≤130	13.0	6.40
>130	≤215	—	9.50

* Size of hot-rolled bar

AMENDMENT CONTROL SHEET

AS 1444—2007

Amendment No. 1 (2008)

CORRECTION

SUMMARY: This Amendment applies to the Tables 2.1 and 3.1.

Published on 27 February 2008.

NOTES

NOTES

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