

Australian Standard[®]

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



This Australian Standard® was prepared by Committee MT-001, Iron and Steel. It was approved on behalf of the Council of Standards Australia on 23 August 2007. This Standard was published on 26 October 2007.

The following are represented on Committee MT-001:

- 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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STANDARDS AUSTRALIA

RECONFIRMATION

OF

AS 1444—2007

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

RECONFIRMATION NOTICE

Technical Committee MT-001 has reviewed the content of this publication and in accordance with Standards Australia procedures for reconfirmation, it has been determined that the publication is still valid and does not require change.

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Australian Building Codes Board
Australian Steel Association
Australian Steel Institute
Bureau of Steel Manufacturers of Australia
Employers and Manufacturers Association
Materials Australia
New Zealand Heavy Engineering Research Association
Society of Automotive Engineers- Australasia

NOTES

Australian Standard[®]

**Wrought alloy steels—Standard,
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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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STANDARDS AUSTRALIA

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

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
- 1544.2 Part 2: Charpy V-notch
- 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 0.35

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	$\leq 1\ 000$
U	≥ 930	$\leq 1\ 080$
V	$\geq 1\ 000$	$\leq 1\ 150$
W	$\geq 1\ 080$	$\leq 1\ 230$
X	$\geq 1\ 150$	$\leq 1\ 300$
Y	$\geq 1\ 230$	$\leq 1\ 380$
Z	$\geq 1\ 550$	

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.

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)

A1

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.

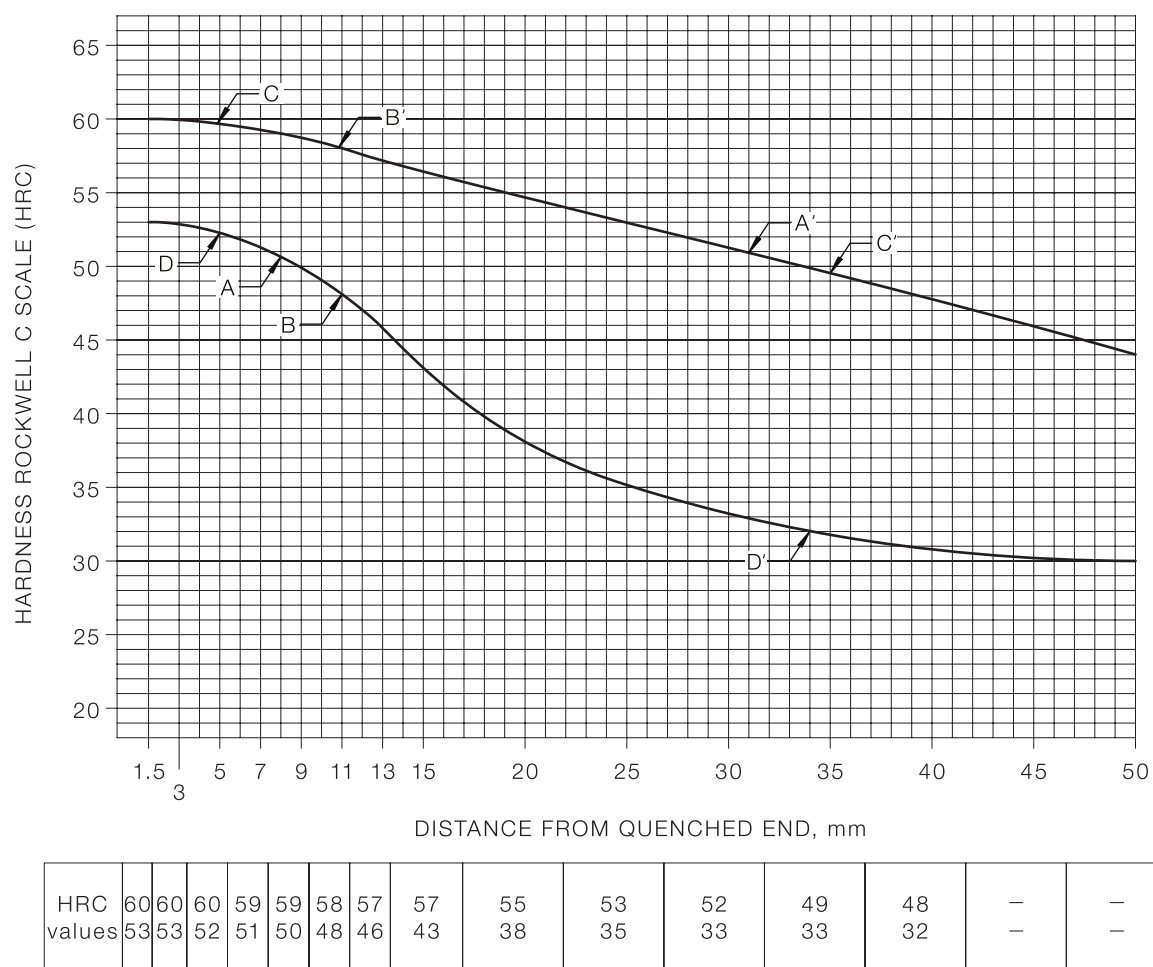


FIGURE 3.1 EXAMPLES OF THE USE OF TWO POINTS TO SPECIFY HARDENABILITY LIMITS

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.

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)