

Australian/New Zealand Standard™

Welding consumables for build-up and wear resistance



AS/NZS 2576:2005

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee WD-002, Welding Consumables. It was approved on behalf of the Council of Standards Australia on 6 July 2005 and on behalf of the Council of Standards New Zealand on 15 July 2005.

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The following are represented on Committee WD-002:

Australian Chamber of Commerce and Industry
Australian Industry Group
Bureau of Steel Manufacturers of Australia
Business New Zealand
CSIRO Manufacturing and Infrastructure Technology
Welding Technology Institute of Australia

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Australian/New Zealand Standard™

Welding consumables for build-up and wear resistance

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee WD-002, Welding Consumables, to supersede AS/NZS 2576—1996, *Welding consumables for build-up and wear resistance—Classification system*.

This Standard incorporates Amendment No. 1 (October 2006). 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 Standard is largely based on the Welding Technology Institute of Australia (WTIA) Technical Note 4.

The objective of this Standard is to specify requirements for welding consumables for build-up and wear resistance.

This edition is technically equivalent to the 1996 edition but incorporates the following changes:

- (a) Amendments to Table 2.2, including the deletion of alloy Type 26 for consistency with relevant International Standards.
- (b) Amendments to Table 2.7 with the addition of Suffix B9 for PTA, laser and GTA surfacing using alloy powders or granules.
- (b) Some changes to the description of typical microstructures in Appendix A.
- (c) Editorial changes and adjustments, which include the following:
 - (i) Update of references to other Standards.
 - (ii) Alignment with current Standards Australia/Standards New Zealand policies.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendices 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/STANDARDS NEW ZEALAND

Australian/New Zealand Standard
Welding consumables for build-up and wear resistance

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies requirements for welding consumables for build-up and wear resistance.

NOTES:

- 1 Typical photomicrographs are shown in Appendix A.
- 2 Guidance on the selection of consumables is given in WTIA Technical Note 4.

1.2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

- 1674 Safety in welding and allied processes
 - 1674.1 Part 1: Fire precautions
 - 1674.2 Part 2: Electrical
- 1815 Metallic materials
 - 1815.1 Part 1: Rockwell hardness test—Test method scales (A, B, C, D, E, F, G, H, K, N, T)
- 2812 Welding, brazing and cutting of metals—Glossary of terms

AS/NZS

- 1050 Methods for the analysis of iron and steel
 - 1050.1 Part 1: Sampling iron and steel for chemical analysis
- 1553 Covered electrodes for welding
 - 1553.3 Part 3: Corrosion-resisting chromium and chromium nickel steel electrodes
- 3678 Structural steel—Hot-rolled plates, floorplates and slabs

WTIA

- Technical Note 4—Hardfacing
- Technical Note 7—Health and safety in welding

1.3 DEFINITIONS

For the purpose of this Standard, the definitions given in AS 2812 and those below apply.

1.3.1 Impact

The degree of severity of the impact expressed as follows:

- (a) *High impact* Impact causing fracture or plastic deformation.
- (b) *Low impact* Impact causing no perceptible deformation.

1.3.2 Loading condition

The degree of severity of the loading condition expressed as follows:

- (a) *High loading* Gross local deformation of the surface.
- (b) *Medium loading* Some local deformation.
- (c) *Low loading* No visible deformation.

1.3.3 Lot or batch number

A number from which the manufacturer is able to identify the manufacturing history of the consumable.

1.3.4 Self-shielded arc

An arc where the shielding medium protecting the arc and metal in transfer is obtained from the electrode.

1.3.5 Shall

Indicates a requirement.

1.3.6 Should

Indicates a recommendation.

1.3.7 Temperature

The temperature due to the component's environment, e.g. in a furnace, or due to heat generated during working, expressed as follows:

- (a) *High temperature* Greater than 500°C.
- (b) *Medium temperature* Over 200°C to 500°C.
- (c) *Low temperature* From ambient temperature to 200°C.

1.4 CLASSIFICATION AND DESIGNATION

1.4.1 Basis of classification

Welding consumables for build-up and wear resistance shall be classified according to the following characteristics:

- (a) Alloy group.
- (b) Hardness of an undiluted deposit.
- (c) Method of deposition.
- (d) Form of the consumable.

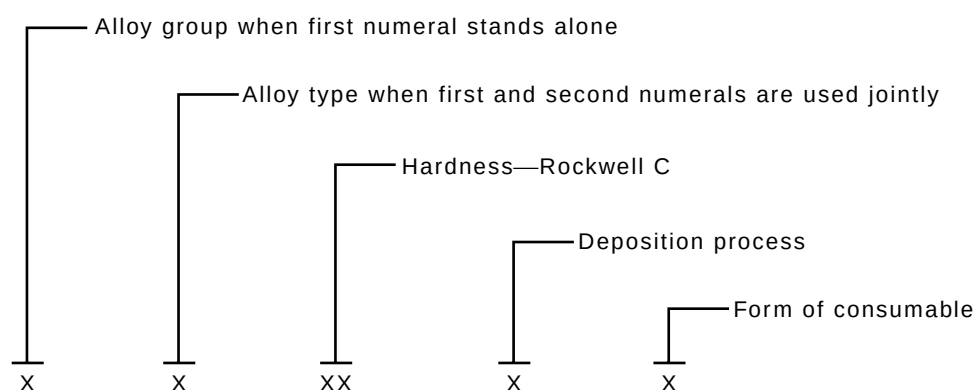
The method of test from which the hardness number, chemical analysis and microstructure are obtained specifies a number of layers, which may be in excess of the number of layers recommended by the manufacturer for a particular application. Consequently, the requirements implied in the classification, which represents the ideal case of undiluted weld metal, may differ from those obtained where fewer layers are applied, as the composition of the weld deposit is affected by the base metal. In practice, dilution of the weld metal will generally result in different microstructure and chemical analysis and in lower hardness than is implied by the classification.

1.4.2 Designation

The consumable shall be designated by four digits followed by an alphanumeric suffix (see Figure 1.1). The elements of the designation shall have the following meanings:

- (a) The first digit shall indicate the alloy group as listed below.
 - (i) Group 1—Steels
 - (ii) Group 2—Chromium white irons
 - (iii) Group 3—Tungsten carbide composites
 - (iv) Group 4—Cobalt alloys
 - (v) Group 5—Nickel alloys
 - (vi) Group 6—Copper alloys
- (b) The second digit in combination with the first digit shall indicate the specific type of alloy within a group, e.g., a tool steel (15XX). (See Tables 2.1 to 2.6.)
- (c) The third and fourth digits shall indicate the mean hardness, as measured in accordance with Clause 2.7, of a typical undiluted deposit prior to any treatment or service, expressed in Rockwell C units in half-decade steps, i.e., 20, 25, 30, 35 and so on, rounded to the lower half-decade. Group 6 alloys (see Table 2.6) shall have 00 as the third and fourth digit (see Note 2 to Clause 2.2(c)).
- (d) The alphanumeric suffix shall indicate the deposition process by a letter and the form of the consumable by a numeral. (See Table 2.7.)

A1



Example: 2360-A1—an austenitic chromium carbide iron, with a mean hardness within the range of 60 HRC to 64 HRC used for manual arc welding, supplied in a tubular form, with the deposited weld metal receiving no alloy contribution from the flux coating

DIMENSIONS IN MILLIMETRES

FIGURE 1.1 ORDER OF EXPRESSION FOR DESIGNATION

SECTION 2 PROPERTIES AND REQUIREMENTS

2.1 MANUFACTURE

Consumables may be made by any method that will yield a product complying with this Standard.

2.2 QUALIFICATION TESTS

Consumables shall be qualified by compliance with the requirements of Clauses 2.6 and 2.7 for the following:

- (a) Chemical composition test (not applicable for Group 3 alloys—see Table 2.3).
- (b) Determination of microstructure.
- (c) Hardness test.

NOTES:

- 1 For Group 3 alloys, the chemical composition and hardness tests are replaced by determination of the microstructure.
- 2 For Group 6 alloys, the hardness test is not required.

2.3 CONFORMANCE TESTS

The following tests should be carried out at intervals not exceeding one year to ensure that consumables continue to comply with the requirements of this Standard:

- (a) Chemical composition test.
- (b) Hardness test.

Results of tests should be recorded and should be available on request.

2.4 TESTS AND TEST PIECES REQUIRED

2.4.1 Tests

The properties of the consumables shall be determined by tests made on the final layer of weld metal deposited on the test piece described in Paragraph B3, Appendix B.

The number of layers deposited shall be as follows:

- (a) For powders or wires deposited by the oxyacetylene fused spray process—two layers.
- (b) For all other processes—four layers.

2.4.2 Number of test pieces required

The number of test pieces required shall be as follows:

- (a) *Arc welding consumables* Except for the gas and gas tungsten arc welding consumables in Item (b) below, one test piece shall be of the largest and one of the smallest size of electrode in each classification and type.
- (b) *Gas welding* For gas or gas tungsten arc consumables, one test piece shall be prepared.
- (c) *Fused spray process* One test piece shall be prepared.

2.5 RETESTS

Where a specimen fails a test, two more test specimens shall be tested and shall comply with this Standard.

2.6 CHEMICAL COMPOSITION REQUIREMENTS

When analysed in accordance with Paragraph B4, Appendix B, the chemical composition of the deposited weld metal shall comply with the chemical composition requirements for elements specified in Tables 2.1 to 2.6, as appropriate. Other elements not numerically specified in Tables 2.1 to 2.6 may be present.

For 3XXX consumables, the percentage and size of the unfused tungsten carbide granules shall be identified in the consumable.

2.7 MICROSTRUCTURE REQUIREMENTS

When examined in accordance with Paragraph B5, Appendix B, the microstructure of the topmost run of the weld deposit shall be consistent with the typical microstructures (comply with the microstructure) of the alloys given in Tables 2.1 to 2.6, as appropriate.

2.8 HARDNESS REQUIREMENTS

For classification purposes, the hardness number of a consumable shall be the mean, rounded to the lower half-decade, of five hardness readings, obtained when the consumable is tested for hardness in accordance with Paragraph B6, Appendix B.

2.9 PACKAGING

Consumables shall be packaged so as to prevent damage during normal transportation, handling and storage, so that they will be capable of complying with the test requirements of this Standard after being stored (and conditioned in accordance with the manufacturer's recommendations) for a period of at least six months from date of dispatch by the manufacturer.

2.10 MARKING

2.10.1 Information to be displayed

The following information shall be marked on each package of consumables, irrespective of the manner of packaging, or be securely attached thereto so that at least the information in Items (a), (c), (e), (f) and (i) remain intact with the consumable after wrapping has been removed:

- (a) The number of this Standard and the consumable designation marking, e.g., AS/NZS 2576/2360-A1.
- (b) Name of manufacturer or supplier.
- (c) Trade designation of consumables.
- (d) Net mass, in kilograms.
- (e) Size of consumables, in millimetres, where applicable.
- (f) Lot or batch number.
- (g) Manufacturer's recommendations for deposition conditions or heat treatment, or both where applicable.
- (h) Manufacturer's recommendations concerning any or all of storage, drying and conditioning prior to use.

(i) Safety warning (see Clause 2.10.2).

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

2.10.2 General safety warning

A label shall be attached to, or a statement prominently displayed on, the packaging with at least the following warning:

WARNING: PROTECT YOURSELF AND OTHERS. READ AND UNDERSTAND THIS LABEL. FUMES AND GASES CAN BE DANGEROUS TO YOUR HEALTH.

ARC RADIATION CAN INJURE EYES AND BURN SKIN. ELECTRIC SHOCK CAN KILL.

- READ AND UNDERSTAND THE MANUFACTURER'S MATERIAL SAFETY DATA SHEET (MSDS) AND YOUR EMPLOYER'S SAFETY PRACTICES.
- KEEP YOUR HEAD OUT OF THE FUMES.
- USE NATURAL VENTILATION OR MECHANICAL EXHAUST VENTILATION, OR BOTH, AT THE FUME SOURCE TO KEEP FUMES AND GASES FROM THE BREATHING ZONE AND THE GENERAL AREA.
- WEAR CORRECT EYE, EAR, RESPIRATORY AND BODY PROTECTION.
- DO NOT TOUCH LIVE ELECTRICAL PARTS.
- SEE AS 1674.1, AS 1674.2 AND WTIA TECHNICAL NOTE 7, OR YOUR CONSUMABLE SUPPLIER'S RECOMMENDATIONS FOR FURTHER INFORMATION.

DO NOT REMOVE OR COVER WARNING SIGNS OR MESSAGES.

Where the physical size product is such as to prevent legible presentation of the complete warning as above, the following abbreviated warning may be used, provided that the complete warning as above is displayed on the packaging:

WARNING: PROTECT YOURSELF AND OTHERS. READ AND UNDERSTAND THE INSTRUCTIONS ON THE PACKAGING.

2.11 STORAGE

When stored, the consumable should be kept in its original package in a dry area. Where special conditions for storage are prescribed by the manufacturer, the consumable shall be stored under these conditions.

TABLE 2.1
GROUP 1 ALLOYS—CHEMICAL COMPOSITIONS AND MICROSTRUCTURES FOR STEELS

Type	Alloy description	Microstructure	Chemical composition, percent												Fe
			C		Mn		Ni		Mo		W		Cr		Ti
			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
11	Pearlitic steel	Predominantly acicular ferrite. Minor proportions of grain boundary ferrite, bainite and/or martensite may be present	—	0.3											Rem.
12	Austenitic manganese	Austenite with isolated particles of carbide at grain boundaries	0.6	1.3	10	20	—	—	—	—	—	—	—	—	Rem.
13	Austenitic stainless steel	Austenite which may contain up to 50% ferrite depending upon analysis	—	0.15	Total: 8 min., 20 max.				—	—	—	—	11*	30*	Rem.
14	Low carbon martensitic steel	Predominantly low carbon martensite. Minor proportions of upper and lower bainite may also be present in the structure	—	0.4											Rem.
15	Tool steel	Martensite with particles of iron rich carbide at the grain boundaries	0.3	1.0	—	—	—	—	Total: 4 min.				3.5	8	Rem.
16	Martensitic stainless steel	Martensite which may contain minor amounts of ferrite or austenite	0.1	0.5	—	—	—	—	—	—	—	—	12	18	Rem.
17	High carbon austenitic steel	Complete or incomplete networks of carbide and austenite eutectic in austenite	0.9	1.7	1	4	—	—	—	—	—	—	3	10	Rem.
			0.4	0.9	10	18	—	—	—	—	—	—	10	18	Rem.
18	High carbon martensitic steel	High carbon martensite which may contain minor proportions of retained austenite. Where the carbon is over 1%, networks of carbide and martensite eutectic may be present also	0.4	1.7	—	—	—	—	7	—	—	—	3	12	Rem.
19	High carbon martensitic steel with primary alloy carbide	High carbon martensite matrix containing primary alloy carbide (above 2000 HV) such as titanium, niobium or vanadium carbides	0.9	2.3	—	—	—	—	0.5	2.0	—	—	4.0	8.0	Rem.

* See AS/NZS 1553.3 for individual types.

† 'a' and 'b' represent the two basic groups of alloys in this classification.

‡ Only one of these elements needs to be present.

TABLE 2.2
GROUP 2 ALLOYS—CHEMICAL COMPOSITIONS AND MICROSTRUCTURES FOR CHROMIUM WHITE IRONS

Type	Alloy description	Microstructure	Chemical composition, percent											
			C		Cr		Ni		Mo + Nb + Ti + V + W		B		Fe	
			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		
21	Austenitic iron	Austenite dendrites in a carbide-austenite eutectic matrix	2.0	2.75	15	27	—	12	—	—	—	—	Rem.	
22	Martensitic iron	Martensite in a carbide-martensite eutectic matrix	2	2.75	15	27	—	—	—	—	See Note	2	Rem.	
23	Austenitic chromium-carbide iron	Chromium-rich primary carbides in a carbide-austenite eutectic matrix	3.5	7.5	18	35	—	—	—	—	—	—	Rem.	
24	Complex chromium-carbide iron	Chromium-rich primary carbides in a complex carbide-austenite eutectic matrix	3.5	7.5	18	35	—	—	—	5	14	—	Rem.	
25	Martensitic chromium-carbide iron	Chromium-rich primary carbides in a carbide-martensite eutectic matrix	3.5	5	18	35	—	—	—	—	See Note	2	Rem.	

NOTE: Minimum B level is determined by austenite-martensite transformation.

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TABLE 2.3
GROUP 3 ALLOYS—MICROSTRUCTURES FOR TUNGSTEN CARBIDE COMPOSITES

Type	Alloy description	Microstructure		Carbide content, percent	Carbide particle, size, μm*
31	Carbide chips in a 6XXX copper alloy matrix	Coarse tungsten carbide chips in a copper alloy matrix		50 to 70	Over 4000
32	Carbide granules in an iron-rich matrix	Gas welded	Arc welded*	45 to 65	Over 850
		Undissolved tungsten carbide granules in an iron-tungsten-rich austenite matrix. Small amounts of eta tungsten iron carbide and austenite eutectic may be present	Undissolved tungsten carbide granules (fewer than gas welded) in a matrix of primary eta tungsten iron carbide and/or eta plus austenite eutectic		
		As 32		45 to 65	425 to 850
		As 32		45 to 65	150 to 425
		As 32		45 to 65	45 to 65
36	Tungsten carbide granules in a 52XX (Ni-B) matrix	Undissolved tungsten carbide in a 52XX matrix		45 minimum	Less than 75

* With decreasing carbide particle size, an increasing percentage of tungsten carbide granules is dissolved in the weld pool producing a higher percentage of primary eta carbides and/or eutectic in the matrices.

TABLE 2.4
GROUP 4 ALLOYS—CHEMICAL COMPOSITIONS AND MICROSTRUCTURES—COBALT ALLOYS

Type	Alloy description	Microstructure	Chemical composition, percent																
			C		Si		B		Cr		Mo		W		Fe		Ni		Co
			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
41	Complex cobalt base solid solution	Cobalt-rich alpha solid solution containing complex chromium-rich carbides at the grain boundaries	—	0.3	—	—	—	—	25	32	3	6	—	3	—	3	—	—	Rem.
42	Hypoeutectic Co-Cr-W alloy	Networks of complex carbide and alpha solid solution eutectic in a matrix of cobalt-rich alpha solid solution	—	2	—	—	—	—	25	32	—	—	4	10	—	2	—	—	Rem.
43	Hypereutectic Co-Cr-W alloy	Primary chromium tungsten cobalt carbide in a matrix of complex carbide and alpha eutectic	2	3.5	—	—	—	—	28	35	—	—	10	20	—	3	—	—	Rem.
44	Co-Cr-Ni-W alloys used for spray powder transfer	Cobalt-rich alpha solid solution containing complex carbide and nickel-boron-rich eutectics	0.8	2	1	4	0.7	3	18	28	—	—	3.5	15	—	—	12	30	Rem.

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