

Australian/New Zealand Standard

Covered electrodes for welding

Part 1: Low carbon steel electrodes for manual metal-arc welding of carbon steels and carbon-manganese steels

AS/NZS 1553.1:1995

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PREFACE

This edition of this Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee WD/2 on Welding Consumables to supersede AS 1553.1—1983.

In preparing this edition, cognizance has been taken of ANSI/AWS A5.1—91 *Specifications for carbon steel electrodes for shielded metal arc welding*, and ISO/DIS 2560, *Specification for carbon-manganese steel electrodes for shielded metal arc welding* (Revision of ISO 2560—1973).

This edition incorporates the following significant technical changes from the 1983 edition:

- (a) Optional indicator for supplemental notch toughness, diffusible hydrogen and resistance to coating moisture absorption have been added to the designation system of electrodes.
- (b) Classification designation EXX19 has been added, and classification designation EXX45 deleted.
- (c) Impact test grades and requirements have been reviewed.
- (d) Diffusible hydrogen levels requirements have been reviewed.
- (e) Coating moisture absorption resistance test has been added.

In addition, editorial changes and adjustments have been made, including the following:

- (i) Update of referenced Standards.
- (ii) Alignment with current Standards Australia policy.

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.

This Standard has undergone a considerable number of changes and revisions. Details of the publishing history can be obtained from Standards Australia’s Information Centre and from Standards New Zealand’s Information Centre.

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard**Covered electrodes for welding****Part 1: Low carbon steel electrodes for manual metal-arc welding of carbon steels and carbon-manganese steels**

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE This Standard specifies requirements for unalloyed low carbon steel covered electrodes for the manual metal-arc welding of carbon steels and carbon-manganese steels. The electrodes may also be used for the welding of certain low alloy steels, including quenched and tempered steels.

NOTE: Appendix A gives additional information on the description and intended use of electrodes.

1.2 REFERENCED DOCUMENTS The following documents are referred to in this Standard:

AS

1050	Methods for the analysis of iron and steel
1544	Methods for impact tests on metals
1544.2	Part 2: Charpy V-notch
1674	Safety in welding and allied processes
2177	Radiography of welded butt joints in metal
2177.1	Part 1: Methods of Test
2205	Methods of destructive testing of welds in metal
2205.2	Method 2: Tensile tests
2205.2.1	Method 2.1: Transverse butt tensile test
2205.2.2	Method 2.2: All-weld-metal tensile test
2205.3	Method 3: Bend tests
2205.3.1	Method 3.1: Transverse guided bend test
2205.4	Method 4: Break tests
2205.4.2	Method 4.2: Fillet break test
2205.7	Method 4: Fracture toughness tests
2205.7.1	Method 7.1: Charpy V-notch impact test
2812	Welding, brazing and cutting of metals—Glossary of terms
3545	Welding positions
3678	Structural steel—Hot-rolled plates, floorplates and slabs
3752	Welding—Methods for determination of the diffusible hydrogen content of ferritic weld metal produced by arc welding
K1	Methods for the sampling and analysis of iron and steel
WTIA (Welding Technology Institute of Australia)	
Technical Note 3—Care and conditioning of arc-welding consumables	
Technical Note 7—Health and safety in welding	

ANSI/AWS

A5.01 Filler metal procurement guidelines

1.3 DEFINITIONS For the purpose of this Standard, the definitions given in AS 2812, AS 3545 and those below apply.

1.3.1 Shall—indicates that a statement is mandatory.

1.3.2 Should—indicates a recommendation.

1.4 CLASSIFICATION AND DESIGNATION

1.4.1 Basis of classification Electrodes shall be classified on the basis of the tensile properties of the deposited weld metal and the operational characteristics of the electrodes. An electrode classified under one classification shall not be classified under any other classification.

1.4.2 Designation The designation system is illustrated in Figure 1.1 and shall consist of the following:

- (a) A letter prefix E, denoting electrode.
- (b) A 2-digit number which represents approximately one-tenth of the allowable minimum tensile strength of the deposited weld metal, in megapascals, in two groupings nominally referred to as E41XX and E48XX (see Table 2.4).
- (c) A 2-digit number which indicates the welding position or positions in which the electrode is capable of making satisfactory welds, the type of welding current to be used with the electrode and the type of covering on the electrode, in conformity with Table 1.1.
- (d) Optional indicators relating to notch toughness grading, attainable diffusible hydrogen status and coating moisture absorption resistance.

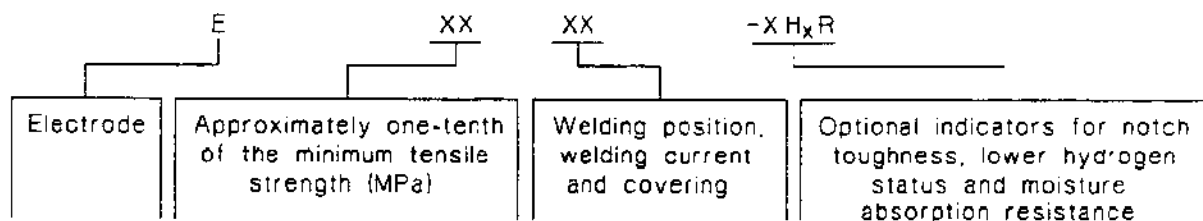


FIGURE 1.1 PRINCIPLES OF DESIGNATION

TABLE 1.1
WELDING POSITION, CURRENT AND COVERING

Third and fourth digit of designation	Welding position (see Note 1)	Type of current and polarity (see Note 2)	Type of covering and slag
10	F,V,OH,H	d.c. electrode positive	High cellulose
11	F,V,OH,H	a.c., or d.c. electrode positive	High cellulose
12	F,V,OH,H	a.c., or d.c. electrode positive or negative	High titania viscous slag
13	F,V,OH,H	a.c., or d.c. electrode positive or negative	High titania fluid slag
14	F,V,OH,H	a.c., or d.c. electrode positive or negative	Low iron powder, titania
15	F,V,OH,H	d.c. electrode positive	Hydrogen controlled, basic
16	F,V,OH,H	a.c., or d.c. electrode positive	Hydrogen controlled, basic
18	F,V,OH,H	a.c., or d.c. electrode positive	Hydrogen controlled, basic
19	F,V,OH,H	a.c., or d.c. electrode positive or negative	Low iron powder
20	F,H-fillet	a.c., or d.c. electrode positive or negative	Iron oxide titania potassium
24	F,H-fillet	a.c., or d.c. electrode positive or negative	High iron oxide
27	F,H-fillet	a.c., or d.c. electrode positive or negative	High iron powder, titania
28	F,H-fillet	a.c., or d.c. electrode positive	High iron powder, iron oxide
46	F,V-down, OH,H	a.c. or d.c. electrode positive	Hydrogen controlled high iron powder, basic
48	F,V-down, OH,H	a.c., or d.c. electrode positive	Hydrogen controlled, basic
99	As specified by manufacturer	As specified by manufacturer	Low iron powder
			As described by manufacture

NOTES:

1 The abbreviations F, V, V-down, OH, H, H-fillet indicate the following welding positions, as defined in AS 2812 and AS 3545.

F = Flat

V = Vertical

V-down = Vertical down

OH = Overhead

H = Horizontal

H-fillet = Horizontal fillet (position 2F in AS 3545)

2 See Appendix A for possible exceptions.

SECTION 2 PROPERTIES AND REQUIREMENTS

2.1 GENERAL

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

2.1.2 Qualification tests Electrodes shall be qualified by compliance with the requirements of this Section, when subjected to the tests listed in Table 2.2 by the methods of test given in Appendix B.

2.1.3 Conformance tests To ensure that electrodes continue to comply with this Standard the following tests should be carried out using 4 mm electrodes, at intervals not exceeding 1 year:

- (a) Chemical composition test. (See Clause 2.2).
- (b) All-weld-metal tensile test. (See Clause 2.3.2.1).
- (c) All-weld-metal impact test. (See Clause 2.3.2.2).

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

2.1.4 Number of test specimens The number of test specimens required shall be as listed in Table 2.2.

2.1.5 Retests Where a specimen fails a test, other than the Charpy V-notch test where special retest provisions apply (see Clauses 2.3.2.2 and 2.3.3.2), two more test specimens shall be tested and shall comply with this Standard.

2.2 CHEMICAL COMPOSITION When determined in accordance with Paragraph B6.3 of Appendix B, the analysis of the all-weld-metal test specimen shall comply with the chemical composition requirements given in Table 2.1.

TABLE 2.1
CHEMICAL COMPOSITION REQUIREMENTS OF DEPOSITED WELD METAL

Class- ification	Chemical composition, maximum percent								
	C	S	P	Mn*	Si	Ni*	Cr*	Mo*	V*
E41XX	0.15	0.030	0.030	Values not specified					
E48X4	}	}	}	1.25	0.90	}	}	}	}
E48X5				1.25	0.90				
E48X6				1.60	0.75				
E48X7				1.60	0.75				
E4818				1.60	0.75				
E48X8				1.60	0.90				
E4X99	As specified by the manufacturer								

* Total of all these elements not to exceed the following:

E48X4	} 1.5 percent
E48X5	
E48X6	} 1.75 percent
E48X7	
E48X8	

TABLE 2.2
SUMMARY OF TESTS REQUIRED FOR ELECTRODES

1	2	3	4	5	6
Test	Qualification tests			Property requirements	Test method of Appendix B
	Number of specimens	Electrode diameter	Welding position (Note 1)		
Chemical composition	1 1	4 mm 8 mm*	Flat Flat	Clause 2.2	Paragraph B6.3
All-weld metal radiograph	1	4 mm 8 mm*	Flat Flat	Clause 2.3.1	Paragraph B6.1
All-weld metal tensile	1 1	4 mm 8 mm*	Flat Flat	Clause 2.3.2.1	Paragraph B6.2.2
All-weld metal impact	3 3	4 mm 8 mm*	Flat Flat	Clause 2.3.2.2	Paragraph B6.2.3
Butt weld tensile	1 or 2 (Note 2) 1 (Note 3) 1 (Note 4) 1 (Note 4) 1	Various as defined	Flat Horizontal Vertical up Vertical down Overhead	Clause 2.3.3.1	Paragraph B8.2
Butt weld impact	3 or 6 (Note 2) 3 (Note 4) 3 (Note 4)	As corresponding butt weld tensile test	Flat Vertical up Vertical down	Clause 2.3.3.2	Paragraph B8.3
Butt weld bend	2 or 4 (Note 2) 2 (Note 3) 2 (Note 4) 2 (Note 4) 2	As corresponding butt weld tensile test	Flat Horizontal Vertical up Vertical down Overhead	Clause 2.3.3.3	Paragraph B8.4
Diffusible hydrogen content (Note 5)	3	4 mm	Flat	Clause 2.4	Paragraph B9
Absorbed moisture (Note 6)	3	4 mm	Flat	Clause 2.5	Paragraph B10
Deposition efficiency (Note 7)	1 1 1	4 mm 4.8 mm or 5 mm 8 mm*	Flat Flat Flat	Clause 2.6	Paragraph B11
Fillet weld	1	See Appendix B, Paragraph B11	H-fillet	Clause 2.7	Paragraph B12

* Or largest diameter manufactured, whichever is the smaller.

NOTES:

- 1 Positions are as detailed in Table 1.1. Tests are not required for positions not recommended by manufacturer.
- 2 The additional specimens are required when electrode is classified for flat and H-fillet welding, i.e. EXX20, EXX24, EXX27, EXX28, and should be taken from a second test plate. (See Appendix B, Paragraph B7.2(a)).
- 3 These specimens not required when electrode also classified for vertical position.
- 4 The test plate is welded in the position for which classification is sought.
- 5 This test is required only where electrode is hydrogen-controlled type, i.e. EXXX5, EXXX6, EXXX8.
- 6 This test is required only where an 'R' indicator is sought (see Clause 2.5).
- 7 This test is required only where electrode is an iron powder type, i.e. EXXX4, EXXX7, EXXX8.

2.3 PHYSICAL REQUIREMENTS

2.3.1 Soundness Radiographs made in accordance with Paragraph B6.1 of Appendix B, which show inclusions or zones of incomplete fusion shall be indicative of 'no test' and a new test piece shall be welded and radiographed. Cracks shall not be accepted. Porosity and inclusions shall not exceed the acceptance levels given in Table 2.3 and Figure 2.1. The acceptance level achieved shall be recorded.

TABLE 2.3
POROSITY AND INCLUSION
ACCEPTANCE LEVELS

Classification	Radiographic level
EXXX5 EXXX6 EXX18 EXX19 EXX20 EXX48	Level I
EXXX0 EXXX1 EXXX2 EXXX3 EXXX4 EXX27 EXX28 EXX99	Level II

2.3.2 All-weld-metal properties

2.3.2.1 Tensile properties When all-weld-metal test specimens are prepared and tested in accordance with Paragraph B6.2.2 of Appendix B, i.e. in the as-welded condition, they shall comply with the requirements for tensile properties given in Table 2.4.

For electrodes in the tensile strength range 430 MPa to 550 MPa (reference (1) in Table 2.4), the yield strength or the tensile strength, or both, may, with each increase of 1 percent in the value of the elongation over the minimum, decrease 10 MPa to a minimum of—

- (a) for the yield strength 330 MPa; and
- (b) for the tensile strength 410 MPa.

For electrodes in the tensile strength range 500 MPa to 620 MPa (reference (2) in Table 2.4), the yield strength or the tensile strength, or both, may, with each increase of 1 percent in the value of the elongation over the minimum, decrease 10 MPa to a minimum of—

- (i) for the yield strength 400 MPa; and
- (ii) for the tensile strength 480 MPa.

2.3.2.2 Impact energy value When a set of three Charpy V-notch test specimens is prepared and tested for impact properties in accordance with the method described in Paragraph B6.2.3 of Appendix B, the specimens shall comply with the requirement appropriate to the grade of electrode given in Table 2.5, subject to the following limitations and modifications:

- (a) Where the set of three test specimens has an average impact energy value that complies with Column 3 of Table 2.5 but contains one or more values less than those given in Column 4 of Table 2.5, the set shall be discarded. A further set of three Charpy V-notch test specimens shall be prepared and tested in its place and this set shall comply with Columns 3 and 4 of Table 2.5.