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Welding consumables — Covered electrodes for manual metal arc welding of high-strength steels — Classification

Produits consommables pour le soudage — Electrodes enrobées pour le soudage manuel à l'arc des aciers à haute résistance — Classification

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 18275 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 3, *Welding consumables*.

Introduction

This International Standard was prepared by Technical Committee ISO/TC 44/SC 3 through the International Institute of Welding, Commission II. It recognizes that there are two somewhat different approaches in the global market to classifying a given electrode, and allows for either or both to be used, to suit a particular market need. Application of either type of classification designation (or of both where suitable) identifies a product as classified in accordance with this International Standard. The classification in accordance with system A is mainly based on EN 757. The classification in accordance with system B is mainly based upon standards used around the Pacific Rim.

This International Standard proposes a classification system for covered electrodes for high-tensile steels in terms of the tensile properties, impact properties and chemical composition of the all-weld metal, as well as the type of electrode covering. The ratio of yield strength to tensile strength of the weld metal is generally higher than that of the parent metal. Users should note that matching weld metal yield strength to parent metal yield strength will not necessarily ensure that the weld metal tensile strength matches that of the parent metal. Where the application requires matching tensile strength, therefore, selection of the consumable should be made by reference to column 3 of Table 1A or Table 8B.

It should be noted that the mechanical properties of all-weld metal test specimens used to classify covered electrodes will vary from those obtained in production joints because of differences in welding procedure such as electrode size, width of weave, welding position and parent metal composition.

Requests for official interpretations of any aspect of this International Standard should be directed to the Secretariat of ISO/TC 44/SC 3 via your national standards body. A complete listing of these bodies can be found at www.iso.org.

Welding consumables — Covered electrodes for manual metal arc welding of high-strength steels — Classification

1 Scope

This International Standard specifies requirements for classification of covered electrodes and deposited metal in the as-welded condition and in the post-weld heat-treated condition for manual metal arc welding of high-strength steels with a minimum yield strength greater than 500 MPa or a minimum tensile strength greater than 570 MPa.

This International Standard is a combined specification providing a classification utilizing a system based upon the yield strength and an average impact energy of 47 J of the all-weld metal, or utilizing a system based upon the tensile strength and an average impact energy of 27 J of the all-weld metal.

1) Subclauses and tables which carry the suffix letter "A" are applicable only to covered electrodes classified under the system based upon the yield strength and an average impact energy of 47 J of the all-weld metal given in this International Standard.

2) Subclauses and tables which carry the suffix letter "B" are applicable only to covered electrodes classified under the system based upon the tensile strength and an average impact energy of 27 J of the all-weld metal given in this International Standard.

3) Subclauses and tables which do not have either the suffix letter "A" or the suffix letter "B" are applicable to all covered electrodes classified under this International Standard.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 31-0:1992, *Quantities and units — Part 0: General principles*

ISO 544, *Welding consumables — Technical delivery conditions for welding filler materials — Type of product, dimensions, tolerances and markings*

ISO 2401, *Covered electrodes — Determination of the efficiency, metal recovery and deposition coefficient*

ISO 2560:2002, *Welding consumables — Covered electrodes for manual metal arc welding of non-alloy and fine grain steels — Classification*

ISO 3690, *Welding and allied processes — Determination of hydrogen content in ferritic steel arc weld metal*

ISO 6847, *Welding consumables — Deposition of a weld metal pad for chemical analysis*

ISO 6947, *Welds — Working positions — Definitions of angles of slope and rotation*

ISO 14344, *Welding and allied processes — Flux and gas shielded electrical welding processes — Procurement guidelines for consumables*

ISO 15792-1:2000, *Welding consumables — Test methods — Part 1: Test methods for all-weld metal test specimens in steel, nickel and nickel alloys*

ISO 15792-3, *Welding consumables — Test methods — Part 3: Classification testing of positional capacity and root penetration of welding consumables in a fillet weld*

3 Classification

Classification designations are based upon two approaches to indicate the tensile properties and the impact properties of the all-weld metal obtained with a given electrode. The two designation approaches include additional designators for some other classification requirements, but not all, as will be clear from the following subclauses. In most cases, a given commercial product can be classified in both systems. Then either or both classification designations can be used for the product.

The classification is based on an electrode diameter of 4,0 mm, with the exception of the symbol for welding position which is based on ISO 15792-3.

3.1A Classification by yield strength and 47 J impact energy

The classification is divided into nine parts:

1) the first part gives a symbol indicating the product/process to be identified;

2) the second part gives a symbol indicating the strength and elongation of the all-weld metal (see Table 1A);

3) the third part gives a symbol indicating the impact properties of the all-weld metal (see Table 2A);

4) the fourth part gives a symbol indicating the chemical composition of the all-weld metal (see Table 3A);

5) the fifth part gives a symbol indicating the type of electrode covering (see 4.5A);

6) the sixth part gives a symbol indicating post-weld heat treatment if this is applied (see 4.6A);

7) the seventh part gives a symbol indicating the nominal electrode efficiency and type of current (see Table 5A);

8) the eighth part gives a symbol indicating the welding position (see Table 6A);

9) the ninth part gives a symbol indicating the hydrogen content of the deposited metal (see Table 7).

3.1B Classification by tensile strength and 27 J impact energy

The classification is divided into seven parts:

1) the first part gives a symbol indicating the product/process to be identified;

2) the second part gives a symbol indicating the strength of the all-weld metal (see Table 1B);

3) the third part gives a symbol indicating the type of electrode covering, the type of current and the welding position (see Table 4B);

4) the fourth part gives a symbol indicating the chemical composition of the all-weld metal (see Table 3B);

5) the fifth part gives a symbol indicating the condition of the post-weld heat treatment under which the all-weld metal test was conducted (see 4.6B);

6) the sixth part gives a symbol indicating that the electrode has satisfied a requirement for 47 J impact energy at the temperature normally used for the 27 J requirement;

7) the seventh part gives a symbol indicating the hydrogen content of the deposited metal (see Table 7).

In both systems, the electrode classification shall include all compulsory sections and may include optional sections as outlined below.

3.2A Compulsory and optional sections in the classification by yield strength and 47 J impact energy

a) Compulsory section

This section includes the symbols for the type of product, the strength and elongation, the impact properties, the chemical composition and the type of covering, i.e. the symbols defined in 4.1, 4.2A, 4.3A, 4.4A and 4.5A.

b) Optional section

This section includes the symbols for post-weld heat treatment, the weld metal recovery, the type of current, the welding positions for which the electrode is suitable, and the symbol for hydrogen content, i.e. the symbols defined in 4.6A, 4.7A, 4.8A and 4.9.

3.2B Compulsory and optional sections in the classification by tensile strength and 27 J impact energy

a) Compulsory section

This section includes the symbols for the type of product, the strength, the type of covering (which includes the type of current and the welding position), the chemical composition and the condition of heat treatment, i.e. the symbols defined in 4.1, 4.2B, 4.4B, 4.5B and 4.6B.

b) Optional section

This section includes the symbol for the optional supplemental designator for 47 J impact energy, i.e. the symbol defined in 4.3B, and the symbol for the hydrogen content, i.e. the symbol defined in 4.9.

The full designation (see Clause 10) shall be used on packages and in the manufacturer's literature and data sheets. See Figure A.1 in Annex A for a schematic representation of the full designation of electrodes classified by yield strength and 47 J impact energy, system A. See Figure A.2 for a schematic representation of the full designation of electrodes classified by tensile strength and 27 J impact energy, system B.

4 Symbols and requirements

4.1 Symbol for the product/process

The symbol for the covered electrode used in the manual metal arc process is the letter E.

4.2 Symbol for tensile properties of all-weld metal

4.2A Classification by yield strength and 47 J impact energy

The symbols in Table 1A indicate the yield strength, tensile strength and elongation of the all-weld metal in the as-welded condition or, if a T is added to the designation, after post-weld heat treatment as described in 4.6, determined in accordance with Clause 5.

4.2B Classification by tensile strength and 27 J impact energy

The symbols in Table 1B indicate the tensile strength of the all-weld metal in the as-welded condition, in the post-weld heat-treated condition, or in both conditions, determined in accordance with Clause 5. The yield strength and elongation requirements depend upon the specific chemical composition, heat treatment condition and coating type, as well as upon the tensile strength requirements, as given for the complete classification in Table 8B.

NOTE Stress relief heat treatment can alter the strength of the weld metal from that obtained in the as-welded condition.

Table 1A — Symbol for tensile properties of all-weld metal
(Classification by yield strength and 47 J impact energy)

Symbol	Minimum yield strength [a] MPa	Tensile strength MPa	Minimum elongation [b] %
55	550	610 to 780	18
62	620	690 to 890	18
69	690	760 to 960	17
79	790	880 to 1 080	16
89	890	980 to 1 180	15

[a] For yield strength, the lower yield (R_{eL}) is used when yielding occurs, otherwise the 0,2 % proof strength ($R_{p0,2}$) is used.

[b] The gauge length is equal to five times the test specimen diameter.

Table 1B — Symbol for tensile strength of all-weld metal
(Classification by tensile strength and 27 J impact energy)

Symbol	Minimum tensile strength MPa
59	590
62	620
69	690
76	760
78	780
83	830

4.3 Symbol for impact properties of all-weld metal

4.3A Classification by yield strength and 47 J impact energy

The symbols in Table 2A indicate the temperature at which an average impact energy of 47 J is achieved under the conditions given in Clause 5. Three test specimens shall be tested. Only one individual value may be lower than 47 J, but it shall not be lower than 32 J. When an all-weld metal has been classified for a certain temperature, this automatically covers any higher temperature in Table 2A.

Table 2A — Symbol for impact properties of all-weld metal
(Classification by yield strength and 47 J impact energy)

Symbol	Temperature for minimum average impact energy of 47 J °C
Z	No requirement
A	+ 20
0	0
2	– 20
3	– 30
4	– 40
5	– 50
6	– 60
7	– 70
8	– 80

4.3B Classification by tensile strength and 27 J impact energy

There is no specific symbol for impact properties. The complete classification in Table 8B determines the temperature at which an impact energy of 27 J is achieved in the as-welded condition or in the post-weld heat-treated condition under the conditions given in Clause 5. Five test specimens shall be tested. The lowest and highest values obtained shall be disregarded. Two of the three remaining values shall be greater than the specified 27 J level; one of the three may be lower, but shall not be less than 20 J. The average of these three remaining values shall be at least 27 J.

The addition of the optional symbol U, immediately after the symbol for condition of heat treatment, indicates that the supplemental requirement of 47 J impact energy at the normal 27 J impact test temperature has also been satisfied. For the 47 J impact requirement, three specimens shall be tested. The impact value shall be determined as the average of the three test specimens. The average of the three values shall be 47 J or greater.

NOTE Post-weld heat treatment (sometimes referred to as stress relief heat treatment) can alter the impact properties of the weld metal from those obtained in the as-welded condition.

4.4 Symbol for chemical composition of all-weld metal

4.4A Classification by yield strength and 47 J impact energy

The symbols in Table 3A indicate the chemical composition of the all-weld metal, determined in accordance with Clause 6.

4.4B Classification by tensile strength and 27 J impact energy

The symbols in Table 3B indicate the principal alloying elements, and sometimes the nominal alloy level of the most significant alloy element, of the all-weld metal, determined in accordance with Clause 6. The symbol for chemical composition does not immediately follow the symbol for strength, but follows the symbol for coating type. The complete compulsory classification designation, given in 4.10B, determines the exact chemical composition requirements for a particular electrode classification.

Table 3A — Symbol for chemical composition of all-weld metal
(Classification by yield strength and 47 J impact energy)

Alloy symbol	Chemical composition [a, b] (% by mass)			
	Mn	Ni	Cr	Mo
MnMo	1,4 to 2,0	—	—	0,3 to 0,6
Mn1Ni	1,4 to 2,0	0,6 to 1,2	—	—
1NiMo	1,4	0,6 to 1,2	—	0,3 to 0,6
1,5NiMo	1,4	1,2 to 1,8	—	0,3 to 0,6
2NiMo	1,4	1,8 to 2,6	—	0,3 to 0,6
Mn1NiMo	1,4 to 2,0	0,6 to 1,2	—	0,3 to 0,6
Mn2NiMo	1,4 to 2,0	1,8 to 2,6	—	0,3 to 0,6
Mn2NiCrMo	1,4 to 2,0	1,8 to 2,6	0,3 to 0,6	0,3 to 0,6
Mn2Ni1CrMo	1,4 to 2,0	1,8 to 2,6	0,6 to 1,0	0,3 to 0,6
Z	Any other agreed composition			

[a] If not specified, Mo < 0,2; Ni < 0,3; Cr < 0,2; V < 0,05; Nb < 0,05; Cu < 0,3; 0,03 ⩽ C ⩽ 0,10; P < 0,025; S < 0,020.

[b] Single values shown in the table mean maximum values.

Table 3B — Symbol for chemical composition of all-weld metal
(Classification by tensile strength and 27 J impact energy)

Alloy symbol	Chemical composition	
	Principal alloy element(s)	Nominal level (% by mass)
-3 M2	Mn	1,5
	Mo	0,4
-4 M2	Mn	2,0
	Mo	0,4
-3 M3	Mn	1,5
	Mo	0,5
-N1M1	Ni	0,5
	Mo	0,2
-N2M1	Ni	1,0
	Mo	0,2
-N3M1	Ni	1,5
	Mo	0,2
-N3M2	Ni	1,5
	Mo	0,4
-N4M1	Ni	2,0
	Mo	0,2
-N4M2	Ni	2,0
	Mo	0,4
-N4M3	Ni	2,0
	Mo	0,5
-N5M1	Ni	2,5
	Mo	0,2
-N5M4	Ni	2,5
	Mo	0,6
-N9M3	Ni	4,5
	Mo	0,5
-N13L	Ni	6,5

Table 3B — *(continued)*

Alloy symbol	Chemical composition	
	Principal alloy element(s)	Nominal level (% by mass)
-N3CM1	Ni	1,5
	Cr	0,2
	Mo	0,2
-N4CM2	Ni	1,8
	Cr	0,3
	Mo	0,4
-N4C2M1	Ni	2,0
	Cr	0,7
	Mo	0,3
-N4C2M2	Ni	2,0
	Cr	1,0
	Mo	0,4
-N5CM3	Ni	2,5
	Cr	0,3
	Mo	0,5
-N7CM3	Ni	3,5
	Cr	0,3
	Mo	0,5
-G	Any other agreed composition	

4.5 Symbol for type of electrode covering

4.5A Classification by yield strength and 47 J impact energy

The type of covering of these electrodes is basic and the symbol is B.

For cellulosic and other electrode coverings, see ISO 2560:2002, 4.5A.

NOTE A description of the characteristics of each of the types of covering is given in Annex B.

4.5B Classification by tensile strength and 27 J impact energy

The type of covering of a covered electrode depends substantially on the types of slag-forming component. The type of covering also determines the positions suitable for welding and the type of current, in accordance with Table 4B.

Table 4B — Symbol for type of covering
(Classification by tensile strength and 27 J impact energy)

Symbol	Type of covering	Welding positions [a]	Type of current [b]
10	Cellulosic	All	d.c. (+)
11	Cellulosic	All	a.c. and d.c. (+)
13	Rutile	All[c]	a.c. and d.c. (±)
15	Basic	All[c]	d.c. (+)
16	Basic	All[c]	a.c. and d.c. (+)
18	Basic + iron powder	All[c]	a.c. and d.c. (+)

NOTE A description of the characteristics of each of the types of covering is given in Annex C.

[a] Positions are defined in ISO 6947.

[b] a.c. = alternating current; d.c. = direct current.

[c] The indication “all positions” may or may not include vertical down welding. This shall be specified in the manufacturer's trade literature.