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

Produits consommables pour le soudage — Électrodes 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.

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

This second edition cancels and replaces the first edition (ISO 18275:2005), of which it constitutes a technical revision. It also incorporates Technical Corrigendum ISO 18275:2005/Cor.1:2007.

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.

Introduction

This International Standard 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 757:1997[1]. The classification in accordance with system B is mainly based upon standards used around the Pacific Rim.

This International Standard provides a classification system for covered electrodes for high-strength 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 weld metal is generally higher than that of parent metal. Users should note that matching weld metal yield strength to parent metal yield strength does not necessarily ensure that the weld metal tensile strength matches that of the parent metal. Therefore, where the application requires matching tensile strength, selection of the consumable should be made by reference to column 3 of Table 1A or column 2 of Table 8B.

It should be noted that the mechanical properties of all-weld metal test specimens used to classify covered electrodes can 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.

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.

a) 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.

b) 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.

c) 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 544, *Welding consumables — Technical delivery conditions for filler materials and fluxes — Type of product, dimensions, tolerances and markings*

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

ISO 2560:2009, *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 arc weld metal*[1)]

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

ISO 6947:2011, *Welding and allied processes — Welding positions*

ISO 14344, *Welding consumables — Procurement of filler materials and fluxes*

1) To be published. (Revision of ISO 3690:2000)

ISO 15792-1:2000+Amd.1:—, *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*[2)]

ISO 80000-1:2009, *Quantities and units — Part 1: General*

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 diffusible 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 diffusible hydrogen content of the deposited metal (see Table 7).

2) To be published. (Revision of ISO 15792-3:2000)

In both systems, the electrode classification shall include all compulsory sections and may include optional sections as outlined in 3.2A and 3.2B.

3.2 Compulsory and optional sections

3.2A 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 diffusible hydrogen content, i.e. the symbols defined in 4.6A, 4.7A, 4.8A and 4.9.

3.2B 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 diffusible hydrogen content, i.e. the symbol defined in 4.9.

The designation (see Clause 11) shall be used on packages and in the manufacturer's literature and data sheets. Figure A.1 gives a schematic representation of the designation of electrodes classified by yield strength and 47 J impact energy (system A). Figure A.2 gives a schematic representation of the 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 shall be 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 covering type, as well as upon the tensile strength requirements, as given for the complete classification in Table 8B.

NOTE Post-weld heat treatment (sometimes referred to as stress relief heat treatment) can alter the mechanical properties of the weld from those 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 strength (R_{eL}) shall be used when yielding occurs, otherwise the 0,2 % proof strength ($R_{p0,2}$) shall be 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 47 J °C
Z	No requirements
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 the 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, the number of specimens tested and values obtained shall meet the requirements of 4.3A.

NOTE Post-weld heat treatment (sometimes referred to as stress relief heat treatment) can alter the mechanical properties of the weld 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.

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

Alloy symbol	Chemical composition[ab] % (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[c]	Any other agreed composition			

[a] If not specified, $Mo < 0,2$; $Ni < 0,3$; $Cr < 0,2$; $V < 0,05$; $Nb < 0,05$; $Cu < 0,3$; $0,03 \leqslant C \leqslant 0,10$; $P < 0,025$; $S < 0,020$; $Si < 0,80$.

[b] Single values are maxima.

[c] Consumables for which the chemical composition is not listed shall be symbolized similarly and prefixed by the letter Z. The chemical composition ranges are not specified and it is possible that two electrodes with the same Z classification are not interchangeable.

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 covering type. The complete compulsory classification designation, given in 4.10B, determines the exact chemical composition requirements for a particular electrode classification.

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

Table 3B (*continued*)

Alloy symbol	Chemical composition	
	Principal alloy element(s)	**Nominal level** % (by mass)
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
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
P1	Mn	1,2
	Ni	1,0
	Mo	0,5
P2	Mn	1,3
	Ni	1,0
	Mo	0,5
G[a]	Any other agreed composition	

[a] Consumables for which the chemical composition is not listed shall be symbolized similarly and prefixed by the letter G. The chemical composition ranges are not specified and it is possible that two electrodes with the same G classification are not interchangeable.

4.5 Symbol for type of electrode covering

4.5A Classification by yield strength and 47 J impact energy

Most electrodes of this type have a basic covering and the symbol for this shall be B.

For cellulosic and other electrode coverings, consult ISO 2560:2009, 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. or d.c. (+)
13	Rutile	All[c]	a.c. or d.c. (±)
15	Basic	All[c]	d.c. (+)
16	Basic	All[c]	a.c. or d.c. (+)
18	Basic + iron powder	All[c]	a.c. or d.c. (+)
45	Basic	All[d]	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] Alternating current = a.c.; direct current = d.c.; electrode positive = (+); electrode positive or electrode negative = (±).
[c] The indication “all positions” may or may not include vertical down welding. This shall be specified in the manufacturer's trade literature.
[d] Excluding vertical up welding.

4.6 Symbol for condition of post-weld heat treatment of all-weld metal

4.6A Classification by yield strength and 47 J impact energy

The letter T indicates that strength, elongation and impact properties in the classification of the deposited metal are obtained after a post-weld heat treatment between 560 °C and 600 °C for 1 h. The test piece shall be left in the furnace to cool down to 300 °C.

4.6B Classification by tensile strength and 27 J impact energy

If the electrode has been classified in the as-welded condition, the symbol A shall be added to the classification. If the electrode has been classified in the post-weld heat-treated condition, the temperature of the post-weld heat treatment shall be 620 °C ± 15 °C, or 580 °C ± 15 °C in the case of chemical composition N13L, and the symbol P shall be added to the classification. If the electrode has been classified in both conditions, the symbol AP shall be added to the classification. See Table 9B for the use of A and P in specific classifications.

The furnace shall be at a temperature not higher than 300 °C when the test assembly is placed in it. The heating rate, from that point to the specified holding temperature, shall not exceed 300 °C/h. When the holding time has been completed, the assembly shall be allowed to cool in the furnace to a temperature below 300 °C at a rate not exceeding 200 °C/h. The assembly may be removed from the furnace at any temperature below 300 °C, and allowed to cool in still air to room temperature.

4.7 Symbol for nominal electrode efficiency and type of current

4.7A Classification by yield strength and 47 J impact energy

The symbols in Table 5A indicate the nominal electrode efficiency, determined in accordance with ISO 2401 with the type of current shown in Table 5A.

Table 5A — Symbol for nominal electrode efficiency and type of current
(Classification by yield strength and 47 J impact energy)

Symbol	Nominal electrode efficiency %	Type of current[a]
1 2	⩽105 ⩽105	a.c. + d.c. d.c.
3 4	> 105 ⩽ 125 > 105 ⩽ 125	a.c. + d.c. d.c.
5 6	> 125 ⩽ 160 > 125 ⩽ 160	a.c. + d.c. d.c.
7 8	>160 >160	a.c. + d.c. d.c.

[a] In order to demonstrate operability on a.c., tests shall be carried out with no load voltage higher than 65 V.

4.7B Classification by tensile strength and 27 J impact energy

There is no specific symbol for nominal electrode efficiency and type of current. Type of current is included in the symbol for type of covering (Table 4B). Nominal electrode efficiency is not addressed.

4.8 Symbol for welding position

4.8A Classification by yield strength and 47 J impact energy

The symbols in Table 6A for welding positions indicate the positions for which the electrode is tested in accordance with ISO 15792-3.

Table 6A — Symbol for welding position
(Classification by yield strength
and 47 J impact energy)

Symbol	Welding positions in accordance with ISO 6947:2011
1	PA, PB, PC, PD, PE, PF, PG
2	PA, PB, PC, PD, PE, PF
3	PA, PB
4	PA
5	PA, PB, PG

4.8B Classification by tensile strength and 27 J impact energy

There is no specific symbol for welding position. The welding position requirements are included with the symbol for type of covering (Table 4B).

4.9 Symbol for diffusible hydrogen content of deposited metal

The symbols in Table 7 indicate the diffusible hydrogen content determined in the metal deposited from an electrode of size 4,0 mm in accordance with the method given in ISO 3690. The current used shall be 70 % to 90 % of the maximum value recommended by the manufacturer. Electrodes recommended for use with a.c. shall be tested using a.c. Electrodes recommended for d.c. only shall be tested using d.c. with the electrode positive [d.c.(+)].

The manufacturer shall provide information on the recommended type of current and drying conditions for achieving the diffusible hydrogen levels.

Table 7 — Symbol for diffusible hydrogen content of deposited metal

Symbol	**Diffusible hydrogen content** max. ml/100 g of deposited weld metal
H5	5
H10	10
H15	15

See Annex D for additional information about diffusible hydrogen.

4.10 Mechanical property and composition requirements

4.10A Classification by yield strength and 47 J impact energy

The mechanical property and chemical composition requirements are determined from the symbols with reference to Tables 1A, 2A and 3A. No additional information is required.

4.10B Classification by tensile strength and 27 J impact energy

The mechanical property and chemical composition requirements are only determined from the complete compulsory section of the electrode designation. Mechanical property requirements are specified in Table 8B. Chemical composition requirements are specified in Table 9B.

Table 8B — Mechanical property requirements
(Classification by tensile strength and 27 J impact energy)

Classification, compulsory section	Tensile strength[a] MPa	Yield strength[ab] MPa	Minimum elongation[c] %	Temperature of Charpy V notch determination[a] °C
E5916-3 M2 A and/or P	590	490	16	–20
E5916-N1M1 A and/or P	590	490	16	–20
E5916-N5M1 A and/or P	590	490	16	–60
E5918-N1M1 A and/or P	590	490	16	–20
E6210-G A and/or P	620	530	15	—
E6210-P1 A	620	530	15	–30
E6211-G A and/or P	620	530	15	—
E6213-G A and/or P	620	530	12	—
E6215-G A and/or P	620	530	15	—
E6216-G A and/or P	620	530	15	—
E6218-G A and/or P	620	530	15	—
E6215-N13L P	620	530	15	–115
E6215-3 M2 P	620	530	15	–50
E6216-3 M2 A and/or P	620	530	15	–20
E6216-N1M1 A and/or P	620	530	15	–20
E6216-N2M1 A and/or P	620	530	15	–20
E6216-N4M1 A and/or P	620	530	15	–40
E6216-N5M1 A and/or P	620	530	15	–60
E6218-3 M2 P	620	530	15	–50
E6218-3 M3 P	620	530	15	–50
E6218-N1M1 A and/or P	620	530	15	–20
E6218-N2M1 A and/or P	620	530	15	–20
E6218-N3M1 A	620	540 to 620[d]	21	–50
E6218-P2 A	620	530	15	–30
E6245-P2 A	620	530	15	–30
E6910-G A and/or P	690	600	14	—
E6911-G A and/or P	690	600	14	—
E6913-G A and/or P	690	600	11	—
E6915-G A and/or P	690	600	14	—
E6916-G A and/or P	690	600	14	—
E6918-G A and/or P	690	600	14	—
E6915-4 M2 P	690	600	14	–50

Table 8B (*continued*)

Classification, compulsory section	Tensile strength[a] MPa	Yield strength[ab] MPa	Minimum elongation[c] %	Temperature of Charpy V notch determination[a] °C
E6916-4 M2 P	690	600	14	–50
E6916-N3CM1 A	690	600	14	–20
E6916-N4M3 A and/or P	690	600	14	–20
E6916-N7CM3 A	690	600	14	–60
E6918-4 M2 P	690	600	14	–50
E6945-P2 A	690	600	14	–30
E6918-N3M2 A	690	610 to 690[d]	18	–50
E7610-G A and/or P	760	670	13	—
E7611-G A and/or P	760	670	13	—
E7613-G A and/or P	760	670	11	—
E7615-G A and/or P	760	670	13	—
E7616-G A and/or P	760	670	13	—
E7618-G A and/or P	760	670	13	—
E7618-N4M2 A	760	680 to 760[d]	18	–50
E7816-N4CM2 A	780	690	13	–20
E7816-N4C2M1 A	780	690	13	–40
E7816-N5M4 A	780	690	13	–60
E7816-N5CM3 A and/or P	780	690	13	–20
E7816-N9M3 A	780	690	13	–80
E8310-G A and/or P	830	740	12	—
E8311-G A and/or P	830	740	12	—
E8313-G A and/or P	830	740	10	—
E8315-G A and/or P	830	740	12	—
E8316-G A and/or P	830	740	12	—
E8318-G A and/or P	830	740	12	—
E8318-N4C2M2 A	830	745 to 830[d]	16	–50

[a] Single values are minima. Not specified = —.

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

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

[d] For 2,4 mm electrodes, the upper limit may be 35 MPa greater.

Table 9B — Chemical composition requirements
(Classification by tensile strength and 27 J impact energy)

Classification, compulsory section	Chemical composition, % (by mass)[a]								
	C	Si	Mn	P	S	Ni	Cr	Mo	Others
E5916-3 M2 A and/or P	0,12	0,60	1,00 to 1,75	0,03	0,03	0,90	—	0,25 to 0,45	—
E5916-N1M1 A and/or P	0,12	0,80	0,70 to 1,50	0,03	0,03	0,30 to 1,00	—	0,10 to 0,40	—
E5916-N5M1 A and/or P	0,12	0,80	0,60 to 1,20	0,03	0,03	2,00 to 2,75	—	0,30	—
E5918-N1M1 A and/or P	0,12	0,80	0,70 to 1,50	0,03	0,03	0,30 to 1,00	—	0,10 to 0,40	—
E6210-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E6210–P1 A	0,20	0,60	1,20	0,03	0,03	1,00	0,30	0,50	V: 0,10
E6211-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E6213-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E6215-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E6216-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E6218-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E6218-P2 A	0,12	0,80	0,90 to 1,70	0,03	0,03	1,00	0,20	0,50	V: 0,05
E6215-N13L P	0,05	0,50	0,40 to 1,00	0,03	0,03	6,00 to 7,25	—	—	—
E6215-3 M2 P	0,12	0,60	1,00 to 1,75	0,03	0,03	0,90	—	0,25 to 0,45	—
E6216-3 M2 A and/or P	0,12	0,60	1,00 to 1,75	0,03	0,03	0,90	—	0,20 to 0,50	—
E6216-N1M1 A and/or P	0,12	0,80	0,70 to 1,50	0,03	0,03	0,30 to 1,00	—	0,10 to 0,40	—
E6216-N2M1 A and/or P	0,12	0,80	0,70 to 1,50	0,03	0,03	0,80 to 1,50	—	0,10 to 0,40	—
E6216-N4M1 A and/or P	0,12	0,80	0,75 to 1,35	0,03	0,03	1,30 to 2,30	—	0,10 to 0,30	—
E6216-N5M1 A and/or P	0,12	0,80	0,60 to 1,20	0,03	0,03	2,00 to 2,75	—	0,30	—
E6218-3 M2 P	0,12	0,80	1,00 to 1,75	0,03	0,03	0,90	—	0,25 to 0,45	—
E6218-3 M3 P	0,12	0,80	1,00 to 1,80	0,03	0,03	0,90	—	0,40 to 0,65	—

Table 9B (*continued*)

Classification, compulsory section	Chemical composition, % (by mass)[a]								
	C	Si	Mn	P	S	Ni	Cr	Mo	Others
E6218-N1M1 A and/or P	0,12	0,80	0,70 to 1,50	0,03	0,03	0,30 to 1,00	—	0,10 to 0,40	—
E6218-N2M1 A and/or P	0,12	0,80	0,70 to 1,50	0,03	0,03	0,80 to 1,50	—	0,10 to 0,40	—
E6218-N3M1 A	0,10	0,80	0,60 to 1,25	0,030	0,030	1,40 to 1,80	0,15	0,35	V: 0,05
E6245-P2 A	0,12	0,80	0,90 to 1,70	0,03	0,03	1,00	0,20	0,50	V: 0,05
E6910-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E6911-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E6913-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E6915-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E6916-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E6918-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E6915-4 M2 P	0,15	0,60	1,65 to 2,00	0,03	0,03	0,90	—	0,25 to 0,45	—
E6916-4 M2 P	0,15	0,60	1,65 to 2,00	0,03	0,03	0,90	—	0,25 to 0,45	—
E6916-N3CM1 A	0,12	0,80	1,20 to 1,70	0,03	0,03	1,20 to 1,70	0,10 to 0,30	0,10 to 0,30	—
E6916-N4M3 A and/or P	0,12	0,80	0,70 to 1,50	0,03	0,03	1,50 to 2,50	—	0,35 to 0,65	—
E6916-N7CM3 A	0,12	0,80	0,80 to 1,40	0,03	0,03	3,00 to 3,80	0,10 to 0,40	0,30 to 0,60	—
E6918-4 M2 P	0,15	0,80	1,65 to 2,00	0,03	0,03	0,90	—	0,25 to 0,45	—
E6918-N3M2 A	0,10	0,60	0,75 to 1,70	0,030	0,030	1,40 to 2,10	0,35	0,25 to 0,50	V: 0,05
E6945-P2 A	0,12	0,80	0,90 to 1,70	0,03	0,03	1,00	0,20	0,50	V: 0,05
E7610-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E7611-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]

Table 9B (*continued*)

Classification, compulsory section	Chemical composition, % (by mass)[a]								
	C	Si	Mn	P	S	Ni	Cr	Mo	Others
E7613-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E7615-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E7616-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E7618-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E7618-N4M2 A	0,10	0,60	1,30 to 1,80	0,030	0,030	1,25 to 2,50	0,40	0,25 to 0,50	V: 0,05
E7816-N4CM2 A	0,12	0,80	1,20 to 1,80	0,03	0,03	1,50 to 2,10	0,10 to 0,40	0,25 to 0,55	—
E7816-N4C2M1 A	0,12	0,80	1,00 to 1,50	0,03	0,03	1,50 to 2,50	0,50 to 0,90	0,10 to 0,40	—
E7816-N5M4 A	0,12	0,80	1,40 to 2,00	0,03	0,03	2,10 to 2,80	N.S	0,50 to 0,80	—
E7816-N5CM3 A	0,12	0,80	1,00 to 1,50	0,03	0,03	2,10 to 2,80	0,10 to 0,40	0,35 to 0,65	—
E7816-N9M3 A	0,12	0,80	1,00 to 1,80	0,03	0,03	4,20 to 5,00	—	0,35 to 0,65	—
E8310-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E8311-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E8313-G and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E8315-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E8316-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E8318-G A and/or P	—	0,80[b]	1,00[b]	—	—	0,50[b]	0,30[b]	0,20[b]	V: 0,10[b] Cu: 0,20[b]
E8318-N4C2M2 A	0,10	0,60	1,30 to 2,25	0,030	0,030	1,75 to 2,50	0,30 to 1,50	0,30 to 0,55	V: 0,05

[a] Unless otherwise stated, single values are maxima. Not specified = —.

[b] In order to meet the alloy requirements of the "G" composition, the all-weld metal shall have the minimum level of at least one of the elements listed. Additional chemical requirements may be agreed to between supplier and purchaser.

5 Mechanical property tests

5.1 General

Tensile and impact tests shall be carried out on weld metal in the as-welded condition and/or in the post-weld heat-treated condition, using an all-weld metal test assembly in accordance with ISO 15792-1:2000+Amd.1:—, type 1.3 using 4,0 mm electrodes and welding conditions specified in 5.2 and 5.3.

When diffusible hydrogen removal treatment is specified by the manufacturer, it shall be carried out in accordance with ISO 15792-1.

5.2 Preheating and interpass temperatures

5.2A Classification by yield strength and 47 J impact energy

Welding of the all-weld metal test assembly shall be executed in the temperature range 120 °C to 175 °C with the exception of the first layer which may be welded without preheat.

5.2B Classification by tensile strength and 27 J impact energy

Welding of the all-weld metal test assembly for non-low-hydrogen coatings (covering of types 10, 11, and 13) shall be executed in the temperature range 160 °C to 190 °C. Welding of electrodes with basic coatings (covering of types 15, 16, 18, and 45) shall be executed in the temperature range 90 °C to 130 °C.

5.3 Pass sequence

The direction of welding to complete a pass shall not vary. Each pass shall be executed with a welding current of 70 % to 90 % of the maximum current recommended by the manufacturer (see Table 5A or Table 4B, as appropriate). Regardless of the type of covering, welding shall be performed with a.c. for electrodes classified for use with both a.c. and d.c. and with d.c. using the recommended polarity for electrodes classified for use with only d.c.

5.3A Classification by yield strength and 47 J impact energy

The test assembly shall be completed using six to ten layers of weld metal. All layers except the top two shall consist of two passes. The top two layers may be completed with either two or three passes each.

5.3B Classification by tensile strength and 27 J impact energy

The test assembly shall be completed using seven to nine layers of weld metal. All layers shall consist of two passes, except the top two layers may be completed with three passes per layer.

6 Chemical analysis

Chemical analysis may be performed on any suitable test piece, but in cases of dispute, specimens in accordance with ISO 6847 shall be used. Any analytical technique may be used, but in cases of dispute, reference shall be made to established published methods.

6A Classification by yield strength and 47 J impact energy

The results of the chemical analysis shall fulfil the requirements given in Table 3A.

6B Classification by tensile strength and 27 J impact energy

The results of the chemical analysis shall fulfil the requirements given in Table 9B for the classification under test.

7 Fillet weld test

The fillet weld test assembly shall be as shown in ISO 15792-3.

7A Classification by yield strength and 47 J impact energy

The plate material shall be selected from the range of materials for which the electrode is recommended by the manufacturer, or shall be unalloyed steel of 0,30 % (by mass) C maximum. The surface shall be free of scale, rust, and other contaminants. The plate thickness, t, shall be 10 mm to 12 mm, the width, w, shall be 75 mm minimum and the length, l, shall be 300 mm minimum. The electrode sizes to be tested for each covering type, the test positions and the required test results are given in Table 10A.

7B Classification by tensile strength and 27 J impact energy

The plate material shall be unalloyed steel of 0,30 % (by mass) C maximum. The surfaces to be welded shall be clean. The test plate thickness, t, width, w, and length, l, the test positions for each covering type, and the required test results are given in Table 10B.

Table 10A — Test requirements for fillet welds

(Classification by yield strength and 47 J impact energy)

Dimensions in millimetres

Symbol of position for classification	Covering Type	Test position	Electrode size[a]	Theoretical throat thickness	Leg length difference	Maximum convexity
1 or 2	C RX[b] B	PB	6,0	⩾4,5 ⩾5,0 ⩾5,0	⩽1,5 ⩽2,0 ⩽2,0	2,5 3,0 3,0
3	A RR	PB	6,0	⩾5,0	⩽2,0	3,0
5	R B	PB	6,0 5,0	⩾4,5	⩽1,5	2,5
1 or 2	C RX[b] B	PF	4,0	⩽4,5 ⩽4,5 ⩽5,5	—	2,0
1, 2 or 5	C RX[b] B	PB	4,0	⩽4,5 ⩽4,5 ⩽5,5	⩽1,5 ⩽1,5 ⩽2,0	2,5 2,5 3,0
5	B	PG	4,0	⩾5,0	—	1,5[c]

[a] Where the largest size claimed for positional welding is smaller than that specified, use the largest size and adjust criteria *pro rata*. Otherwise, electrode sizes not shown are not required to be tested.

[b] RX includes R, RC, RA and RB.

[c] Maximum concavity.

Table 10B — Test requirements for fillet welds
(Classification by tensile strength and 27 J impact energy)

Dimensions in millimetres

Covering type	Current and polarity[a]	Electrode size[b]	Test position	Nominal plate thickness *t*	Minimum plate width *w*	Minimum plate length *l*	Fillet weld size	Maximum leg length difference	Maximum convexity
10	d.c. (+)	5,0 6,0	PF, PD PB	10 12	75	300 400	⩽8,0 ⩾6,5	3,5 2,5	1,5 2,0
11	a.c. and d.c. (+)	5,0 6,0	PF, PD PB	10 12	75	300 400	⩽8,0 ⩾6,5	3,5 2,5	1,5 2,0
13	a.c., d.c. (−) and d.c. (+)	5,0 6,0	PF, PD PB	12	75	300 400	⩽10,0 ⩾8,0	2,0 3,5	1,5 2,0
15	d.c. (+)	4,0 6,0	PF, PD PB	10 12	75	300 400	⩽8,0 ⩾8,0	3,5	2,0
16	a.c. and d.c. (+)	4,0 6,0	PF, PD PB	10 12	75	300 400	⩽8,0 ⩾8,0	3,5	2,0
18	a.c. and d.c. (+)	4,0 6,0	PF, PD PB	10 12	75	300 400	⩽8,0 ⩾8,0	3,5	2,0
45	d.c. (+)	4,0 4,5	PD, PG	12	75	300	⩽8,0 ⩾6,0	3,5	2,0

[a] Electrode negative = (—).

[b] Where the largest size claimed for positional welding is smaller than that specified, use the largest size and adjust criteria *pro rata*. Otherwise, electrode sizes not shown are not required to be tested.

8 Rounding procedure

For purposes of determining compliance with the requirements of this International Standard, the actual test values obtained shall be subjected to ISO 80000-1:2009, B.3, Rule A. If the measured values are obtained by equipment calibrated in units other than those of this International Standard, the measured values shall be converted to the units of this International Standard before rounding. If an arithmetic average value is to be compared to the requirements of this International Standard, rounding shall be done only after calculating the arithmetic average. If the test method standard cited in Clause 2 contains instructions for rounding that conflict with the instructions of this International Standard, the rounding requirements of the test method standard shall apply. The rounded results shall fulfil the requirements of the appropriate table for the classification under test.

9 Retests

If any test fails to meet requirements, that test shall be repeated twice. The results of both retests shall meet the requirements. Specimens for the retest may be taken from the original test assembly or from a new test assembly. For chemical analysis, retests need be only for those specific elements that failed to meet their test requirement. If the results of one or both retests fail to meet requirements, the material under test shall be considered as not meeting the requirements of this specification for that classification.

In the event that, during preparation or after completion of any test, it is clearly determined that prescribed or proper procedures were not followed in preparing the weld test assembly or test specimen(s), or in conducting the test, the test shall be considered invalid, without regard to whether the test was actually completed, or whether the test results met, or failed to meet, the requirements. That test shall be repeated, following properly prescribed procedures. In this case, the requirement for doubling the number of test specimens does not apply.

10 Technical delivery conditions

Technical delivery conditions shall be in accordance with ISO 544 and ISO 14344.

11 Examples of designation

11A Classification by yield strength and 47 J impact energy

The designation of the covered electrode is indicated by the suffix letter A given after the number of this International Standard and shall follow the principle given in the examples below:

EXAMPLE 1A:

A basic covered electrode for manual metal arc welding (E) deposits a weld metal with a minimum yield strength of 620 MPa (62), a minimum average impact energy of 47 J at −70 °C (7) and a chemical composition of 1,8 % (by mass) Mn and 0,6 % (by mass) Ni (Mn1Ni). The electrode with basic covering (B) can be used with a.c. or d.c. with a metal recovery of 120 % (3) in flat butt and flat fillet welds (4). The diffusible hydrogen content, determined in accordance with ISO 3690, does not exceed 5 ml/100 g of deposited metal (H5).

The designation is:

ISO 18275-A - E 62 7 Mn1Ni B 3 4 H5

Compulsory section:

ISO 18275-A - E 62 7 Mn1Ni B

or if tested after post-weld heat treatment:

ISO 18275-A - E 62 7 Mn1Ni B T

where

ISO 18275-A indicates the number of this International Standard with classification by yield strength and 47 J impact energy;

E indicates covered electrode/manual metal arc welding (see 4.1);

62 indicates strength and elongation (see Table 1A);

11B Classification by tensile strength and 27 J impact energy

The designation of the covered electrode is indicated by the suffix letter B given after the number of this International Standard and shall follow the principle given in the examples below:

EXAMPLE 1B:

A basic covered electrode for manual metal arc welding (E) deposits a weld metal with a minimum tensile strength of 690 MPa (69). The electrode with basic covering including iron powder may be used with a.c. and d.c. (+) in all positions except vertical down (18). The all-weld metal chemical composition is 1,5 % (by mass) Ni and 0,35 % (by mass) Mo (N3M2) and the impact energy of the deposited weld metal exceeds 27 J at −50 °C in the as-welded condition (A). The diffusible hydrogen content, determined in accordance with ISO 3690, does not exceed 5 ml/100 g of deposited metal (H5).

The designation is:

ISO 18275-B - E6918-N3M2 A H5

Compulsory section:

ISO 18275-B - E6918-N3M2 A

where

ISO 18275-B indicates the number of this International Standard with classification by tensile strength and 27 J impact energy;

E indicates covered electrode/manual metal arc welding (see 4.1);

69 indicates tensile strength (see Table 1B);

7 indicates impact properties (see Table 2A);

Mn1Ni indicates the chemical composition of all-weld metal (see Table 3A) (see Annex E for a description of the symbols for chemical composition);

B indicates the type of electrode covering (see 4.5A);

3 indicates the recovery and type of current (see Table 5A);

4 indicates the welding position (see 4.8A);

H5 indicates the diffusible hydrogen content (see Table 7).

18 indicates basic iron powder covering suitable for a.c. and d.c. (+), in all positions (see Table 4B);

N3M2 indicates the nominal composition comprising 1,5% (by mass) Ni and 0,35% (by mass) Mo (see Table 3B) (see Annex F for a description of the symbols for chemical composition);

A indicates the properties determined in the as-welded condition;

E6918-N3M2 A indicates the complete specification of composition limits and mechanical property requirements (see Tables 8B and 9B);

H5 indicates the diffusible hydrogen content (see Table 7).

EXAMPLE 2A:

Another basic covered electrode for manual metal arc welding (E) deposits a weld metal with a minimum yield strength of 890 MPa (89), a minimum average impact energy of 47 J at −50 °C (5) and a chemical composition outside the limits given in Table 3A (Z). The electrode with basic covering (B) may be used with a.c. or d.c. with a metal recovery of 120 % (3) in flat butt and flat fillet welds (4). The diffusible hydrogen, determined in accordance with ISO 3690, does not exceed 5 ml/100 g of deposited metal (H5).

The designation is:

ISO 18275-A - E 89 5 Z B 3 4 H5

Compulsory section:

ISO 18275-A - E 89 5 Z B

or after post-weld heat treatment:

ISO 18275-A - E 89 5 Z B T

EXAMPLE 2B:

Another basic covered electrode for manual metal arc welding (E) deposits a weld metal with a minimum tensile strength of 830 MPa (83). The electrode with basic covering including iron powder may be used with a.c. and d.c. (+) in all positions (18). The all-weld metal chemical composition does not match any composition given in Table 3B or any composition range given in Table 9B (G). The diffusible hydrogen, determined in accordance with ISO 3690, does not exceed 5 ml/100 g of deposited metal (H5).

If tested in the as-welded condition, the designation is:

ISO 18275-B - E8318-G A H5

Compulsory section:

ISO 18275-B - E8318-G A

or if tested after post-weld heat treatment:

ISO 18275-B - E8318-G P

Annex A
(informative)

Classification systems

A.1 ISO 18275-A

The ISO 18275-A classification system for covered electrodes for high tensile steels, based upon yield strength and 47 J minimum impact energy, is shown in Figure A.1.

A.2 ISO 18275-B

The ISO 18275-B classification system for covered electrodes for high tensile steels, based upon tensile strength and 27 J minimum impact energy, is shown in Figure A.2.

Compulsory classification designators[a]

Number of this International Standard. The "A" in the final position indicates classification by yield strength and 47 J impact requirement.

Designates a covered electrode.

Yield strength designator. The symbol "55, 62, 69, 79 or 89" is used to indicate a minimum yield strength of 550 MPa, 620 MPa, 690 MPa, 790 MPa or 890 MPa, respectively (see Table 1A).

Charpy V-Notch impact energy designator. Indicates the temperature in degrees Celsius at or above which the impact strength of the weld metal meets or exceeds 47 J. The letter "A" is used to indicate a test temperature of +20 °C. The letter "Z" indicates that there is no impact requirement (see Table 2A).

Chemical composition designator. Indicates composition of all-weld metal (see Table 3A).

Designator for type of electrode coating. The symbol "B" is used to indicate basic covering. For other coating types, see ISO 2560:2009, 4.5A.

ISO 18275-A - E XX X XXX X T X X HX

Optional supplemental designators[b]

Optional supplemental diffusible hydrogen designator. "H5, H10 or H15" is used to indicate a maximum diffusible hydrogen content of 5 ml/100 g, 10 ml/100 g or 15 ml/100 g of deposited metal, respectively (see Table 7).

Position designator. The symbol "1, 2, 3, 4 or 5" indicates the welding position(s) for which the electrode is suitable (see Table 6A).

Metal recovery and type of current indicator. The symbol "1, 2, 3, 4, 5, 6, 7 or 8" indicates the weld metal recovery and type of current (see Table 5A).

The symbol "T" is used to indicate classification in the post-weld heat-treated condition (see 4.6A).

[a] The combination of these designators constitutes the covered electrode classification.

[b] These designators are optional and do not constitute part of the covered electrode classification.

Figure A.1 — Designation of electrodes in accordance with ISO 18275-A
(Classification by yield strength and 47 J impact energy)

Compulsory classification designators[a]

Number of this International Standard. The "B" in the final position indicates classification by tensile strength and 27 J impact requirement.

Designates a covered electrode.

Tensile strength desigator. The symbol "59, 62, 69, 76, 78 or 83" is used to indicate a minimum tensile strength of 590 MPa, 620 MPa, 690 MPa, 760 MPa, 780 MPa or 830 MPa, respectively (see Table 1B).

Type of covering designator (see Table 4B).

Chemical composition designator. Indicates composition of all-weld metal (see Table 3B).

Designator for condition of heat treatment. The symbols "A", "P" and "AP" are used to indicate, respectively, the as-welded condition, the post-weld heat-treated condition or both conditions (see 4.6B).

ISO 18275-B - EXXXX-XXX X U HX

Optional supplemental designators[b]

Optional supplemental diffusible hydrogen designator. The symbol "H5, H10 or H15" is used to indicate a maximum diffusible hydrogen content of 5 ml/100 g, 10 ml/100 g or 15 ml/100 g of deposited metal, respectively (see Table 7).

Optional supplemental designator "U" to indicate 47 J impact energy at the normal 27J test temperature.

[a] The combination of these designators constitutes the covered electrode classification.

[b] These designators are optional and do not constitute part of the covered electrode classification.

Figure A.2 — Designation of electrodes in accordance with ISO 18275-B
(Classification by tensile strength and 27 J impact energy)

Annex B
(informative)

Description of types of electrode covering — Classification by yield strength and 47 J impact energy

B.1 General

The properties of a covered electrode, i.e. both its welding characteristics and the mechanical properties of the weld metal, are decisively influenced by the covering. This homogeneous mixture of substances generally contains the following six main components:

— slag-forming materials;

— deoxidants;

— shielding-gas-forming materials;

— ionizing agents;

— binders;

— alloying elements (if necessary).

In addition, iron powder may be added to increase the weld metal recovery, which may affect the positional welding properties.

B.2 Basic covered electrodes

A characteristic feature of the thick covering of these electrodes is the large quantity of carbonates of alkaline-earth metals, e.g. calcium carbonate (lime) and calcium fluoride (fluorspar). To improve the welding properties, particularly with a.c. welding, higher concentrations of non-basic components (e.g. rutile and/or quartz) may be required.

Basic covered electrodes have two outstanding properties: a) the impact energy of the weld metal is higher, particularly at low temperatures; b) they are more resistant to cracking than all other types.

Their resistance to solidification cracking results from the high metallurgical purity of the weld metal, whilst the low risk of cold cracking, provided dry electrodes are used, is attributable to the low hydrogen content. It is lower than with all other types: it should not exceed an upper permissible limit of H_D = 15 ml/100 g of deposited metal.

Generally, electrodes of the basic type are suitable for all welding positions, except the vertical downward position. Basic-type electrodes especially suited for the vertical downward position have a particular slag composition.

B.3 Other electrode covering types

Most covered electrodes for welding of high-tensile steels have basic coverings. However, other covering types are possible (see ISO 2560:2009, Annex B).

Annex C
(informative)

Description of types of electrode covering — Classification by tensile strength and 27 J impact energy

C.1 General

The properties of a covered electrode, i.e. both its welding characteristics and the mechanical properties of the weld metal, are decisively influenced by the covering. This homogeneous mixture of substances generally contains the following six main components:

- slag-forming materials;
- deoxidants;
- shielding-gas-forming materials;
- ionizing agents;
- binders;
- alloying elements (if necessary).

In addition, iron powder may be added to increase the weld metal recovery, which may affect the positional welding properties.

Certain electrode designs, while usable on both a.c. and d.c. (either or both polarities), may be optimized by their manufacturer for one particular current type for a particular market need.

C.2 Type 10 covering

Electrodes of this type contain a large quantity of combustible organic substances, particularly cellulose, in the covering. Owing to the intensive arc, such electrodes are especially suitable for welding in the vertical downward position. Arc stabilization is primarily by sodium, so the electrodes are mainly suitable for d.c. welding, normally with the electrode positive [d.c.(+)].

C.3 Type 11 covering

Electrodes of this type contain a large quantity of combustible organic substances, particularly cellulose, in the covering. Owing to the intensive arc, such electrodes are especially suitable for welding in the vertical downward position. Arc stabilization is primarily by potassium, so the electrodes are suitable for both a.c. and d.c. electrode positive [d.c.(+)] welding.

C.4 Type 13 covering

Electrodes of this type contain a large quantity of titanium dioxide (rutile) and are heavily stabilized with potassium. They produce a soft quiet arc, even at low currents, and are especially suitable for sheet metal.

C.5 Type 15 covering

Electrodes of this type have a covering that is highly basic, consisting largely of lime and fluorspar. Arc stabilization is provided mainly by sodium, and they are generally suitable for use on d.c. electrode positive [d.c.(+)] only. They produce weld metal of high metallurgical quality with low diffusible hydrogen.

C.6 Type 16 covering

Electrodes of this type have a covering that is highly basic, consisting largely of lime and fluorspar. Arc stabilization with potassium is responsible for their ability to weld with alternating current. They produce weld metal of high metallurgical quality with low diffusible hydrogen.

C.7 Type 18 covering

Electrodes of this type are similar to electrodes of type 16 covering, except that they have a somewhat thicker covering with the addition of iron powder. The iron powder increases their current-carrying capacity and deposition rate, as compared to electrodes of type 16 covering.

C.8 Type 45 covering

Electrodes of this type are similar to electrodes of type 15 covering, except that the covering is specifically designed for vertical downward welding.

Annex D
(informative)

Notes on diffusible hydrogen

Other methods of collection and measurement of diffusible hydrogen may be used for batch testing, provided they possess equal reproducibility with, and are calibrated against, the method given in ISO 3690. The hydrogen content is influenced by the type of current.

Cracks in welded joints may be caused or significantly influenced by diffusible hydrogen. The risk of hydrogen-induced cracks increases with rising alloy content and stress level. Such cracks generally develop after the joint has become cold and are therefore termed cold cracks.

Assuming that the external conditions are satisfactory (i.e. weld areas clean and dry, no excessive air movement), the hydrogen in the weld metal stems from hydrogen-containing compounds in the consumables; in the case of basic covered electrodes, the water taken up by the covering is the main source. The water dissociates in the arc and gives rise to atomic hydrogen which is absorbed by the weld metal. Under given material and stress conditions, the risk of cold cracking diminishes with decreasing hydrogen content of the weld metal.

In practice, the appropriate hydrogen level depends on the particular application and, to ensure that this is achieved, the relevant handling, storage and drying conditions recommended by the electrode manufacturer should be followed.

Annex E
(informative)

Description of chemical composition symbols — Classification by yield strength and 47 J impact energy

The symbol used to identify a particular composition consists of the chemical symbols for the principal alloying elements. A numerical symbol, indicating the nominal level of Ni or Cr, precedes the chemical symbol when one or more of these two elements is present at a level of approximately 1 % (by mass) or higher.

Annex F
(informative)

Description of chemical composition symbols — Classification by tensile strength and 27 J impact energy

F.1 XMX (manganese-molybdenum) type

Compositions containing only manganese and molybdenum as significant alloy elements are symbolized by "M". A digit preceding the M is equal to twice the nominal manganese content. So a leading digit 3 would indicate approximately 1,5 % (by mass) Mn, and so forth.

The nominal molybdenum level in the manganese-molybdenum electrode deposits is indicated by a digit following the M, as follows:

1 = approximately 0,25 % (by mass) Mo = low Mo;

2 = approximately 0,4 % (by mass) Mo = medium Mo;

3 = approximately 0,5 % (by mass) Mo = high Mo;

4 = approximately 0,7 % (by mass) Mo = extra-high Mo.

F.2 Other types

Compositions containing significant amounts of nickel or chromium are symbolized, respectively, by N, C and M (the last symbol representing molybdenum). Manganese, though present, is not symbolized. The N and/or C, when nickel and/or chromium is present, is followed by a digit equal to twice the nominal nickel or chromium level. The M, when molybdenum is present, is followed by a digit indicating the nominal Mo level in accordance with the scheme in F.1. So, for example, N4C2M2 indicates 2 % (by mass) Ni, 1 % (by mass) Cr and 0,4 % (by mass) Mo. The symbol L indicates low carbon.

Bibliography

[1] EN 757:1997, *Welding consumables — Covered electrodes for manual metal arc welding of high strength steels — Classification*

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