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EN ISO 14171:2010

Welding consumables ─ Solid wire electrodes, tubular cored electrodes and electrode/flux combinations for submerged arc welding of non alloy and fine grain steels ─ Classification (ISO 14171:2010)

прийнято як національний стандарт
методом «підтвердження» за позначенням

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(EN ISO 14171:2010, IDT; ISO 14171:2010, IDT)

Зварювальні матеріали. Дроти електродні суцільні й порошкові та комбінації дріт електродний/флюс для дугового зварювання під флюсом нелегованих та дрібнозернистих сталей. Класифікація

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Welding consumables - Solid wire electrodes, tubular cored electrodes and electrode/flux combinations for submerged arc welding of non alloy and fine grain steels - Classification (ISO 14171:2010)

Produits consommables pour le soudage - Fils-électrodes pleins, fils-électrodes fourrés et couples fils-flux pour le soudage à l'arc sous flux des aciers non alliés et à grains fins - Classification (ISO 14171:2010)

Schweißzusätze - Massivdrahtelektroden, Fülldrahtelektroden und Draht-Pulver-Kombinationen zum Unterpulverschweißen von unlegierten Stählen und Feinkornstählen - Einteilung (ISO 14171:2010)

This European Standard was approved by CEN on 30 September 2010.

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Foreword

The text of ISO 14171:2010 has been prepared by Technical Committee ISO/TC 44 "Welding and allied processes" of the International Organization for Standardization (ISO) and has been taken over as EN ISO 14171:2010 by Technical Committee CEN/TC 121 "Welding" the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2011, and conflicting national standards shall be withdrawn at the latest by April 2011.

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This document supersedes EN 756:2004.

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The text of ISO 14171:2010 has been approved by CEN as a EN ISO 14171:2010 without any modification.

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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 14171 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 14171:2002), which has been technically revised.

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/flux combination, 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.

This International Standard provides a classification system for the designation of solid wire electrodes in terms of their chemical composition, tubular cored electrodes in terms of the deposit composition obtained with a particular submerged arc flux and, where required, electrode/flux combinations in terms of the yield strength, tensile strength and elongation of the all-weld metal deposit. The ratio of yield to tensile strength of weld metal is generally higher than that of parent material. Users should note that matching weld metal yield strength to parent material yield strength does not necessarily ensure that the weld metal tensile strength matches that of the parent material. Thus, where the application of the material requires matching tensile strengths, selection of the consumable should be made by reference to column 3 of Table 1A or 1B, as appropriate.

Although combinations of electrodes and fluxes supplied by individual companies may have the same classification, the individual wire electrodes and fluxes from different companies are not interchangeable unless verified in accordance with this International Standard.

The mechanical properties of all-weld metal test specimens used to classify the electrode/flux combinations vary from those obtained in production joints because of differences in welding procedures such as electrode size and parent material composition.

Welding consumables — Solid wire electrodes, tubular cored electrodes and electrode/flux combinations for submerged arc welding of non alloy and fine grain steels — Classification

1 Scope

This International Standard specifies requirements for the classification of electrode/flux combinations and weld metal in the as-welded condition and in the post-weld heat-treated condition for submerged arc welding of non alloy and fine grain steels with a minimum yield strength of up to 500 MPa or a minimum tensile strength of up to 570 MPa. One flux can be classified with different solid wire electrodes and tubular cored electrodes. The solid wire electrode is also classified separately based on chemical composition.

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

a) Clauses, subclauses, and tables which carry the suffix letter "A" are applicable only to electrode/flux combinations and wire electrodes classified using the system based upon the yield strength and the average impact energy for weld metal of 47 J, in accordance with this International Standard.

b) Clauses, subclauses, and tables which carry the suffix letter "B" are applicable only to electrode/flux combinations and wire electrodes classified using the system based upon the tensile strength and the average impact energy for weld metal of 27 J, in accordance with this International Standard.

c) Clauses, subclauses, and tables which do not have either the suffix letter "A" or the suffix letter "B" are applicable to all electrode/flux combinations and wire electrodes classified in accordance with this International Standard.

Fluxes for the single-run and two-run techniques are classified on the basis of the two-run technique.

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

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

ISO 13916, *Welding — Guidance on the measurement of preheating temperature, interpass temperature and preheat maintenance temperature*

ISO 14174, *Welding consumables — Fluxes for submerged arc welding and electroslag welding — Classification*

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

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 15792-2:2000, *Welding consumables — Test methods — Part 2: Preparation of single-run and two-run technique test specimens in steel*

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 weld metal obtained with a given electrode/flux combination. The two designation approaches include additional symbols for some other classification requirements, but not all, as is clear from the following clauses. In most cases, a given commercial product can be classified in accordance with both systems. Then either or both classification designations can be used for the product.

A solid wire electrode shall be classified in accordance with its chemical composition as given in Table 4A or 4B.

An all-weld metal deposit from a tubular cored electrode shall be classified in accordance with the all-weld metal composition, as given in Table 5A or 5B, obtained with a particular flux.

When the solid wire electrode or tubular cored electrode is classified in combination with a flux for submerged arc welding, the classification shall be prefixed with a symbol in accordance with Clause 4 as appropriate.

The electrode/flux classification includes weld metal properties obtained with a manufacturer's specific electrode/flux combination as given below. A wire electrode may be separately classified with the symbol for its chemical composition in Table 4A or 4B.

3A Classification by yield strength and 47 J impact energy

The classification is divided into five mandatory parts and an optional sixth part:

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

2) the second part gives a symbol indicating the strength and elongation of all-weld metal for multi-run technique or the strength of the parent material used in classification for the two-run technique (see Table 1A or 2A);

3B Classification by tensile strength and 27 J impact energy

The classification is divided into five mandatory parts and an optional sixth part:

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

2) the second part gives a symbol indicating the strength and elongation of all-weld metal in either the as-welded or post-weld heat-treated condition for a multi-run technique or the specified minimum tensile strength of the parent material or the weld metal used in classification for the two-run technique (see Table 1B or 2B);

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

3) the third part gives a symbol indicating the impact properties of all-weld metal or welded joint in the same condition as specified for the tensile strength (see Table 3). The letter "U" after this designator indicates that the deposit meets an average optional requirement of 47 J at the designated Charpy test temperature;

4) the fourth part gives a symbol indicating the type of flux used in accordance with ISO 14174 (see 4.4);

4) the fourth part gives a symbol indicating the type of flux used in accordance with ISO 14174 (see 4.4);

5) the fifth part gives a symbol indicating the chemical composition of the solid wire electrode used (see Table 4A) or the chemical composition of the all-weld metal obtained with a tubular cored electrode/flux combination (see Table 5A);

5) the fifth part gives a symbol indicating the chemical composition of the solid wire electrode used (see Table 4B) or the chemical composition of the all-weld metal obtained with a tubular cored electrode/flux combination (see Table 5B);

6) the sixth part gives an optional symbol indicating the diffusible hydrogen content of the weld metal obtained in accordance with ISO 3690 (see Table 6).

6) the sixth part gives an optional symbol indicating the diffusible hydrogen content of the weld metal obtained in accordance with ISO 3690 (see Table 6).

4 Symbols and requirements

4.1 Symbol for the process

The symbol for an electrode/flux combination used in the submerged arc welding process shall be the letter S at the beginning of the designation.

4.2 Symbol for tensile properties

4.2.1 Multi-run technique

4.2.1A Classification by yield strength and 47 J impact energy

For products suitable for multi-run welding, the symbols in Table 1A indicate yield strength, tensile strength and elongation of the all-weld metal in the as-welded condition determined in accordance with 5.1A.

4.2.1B Classification by tensile strength and 27 J impact energy

For products suitable for multi-run welding, the symbols in Table 1B indicate yield strength, tensile strength and elongation of the all-weld metal in the as-welded condition or in the post-weld heat-treated condition determined in accordance with 5.1B.

Table 1A — Symbols for tensile properties by multi-run technique
(Classification by yield strength and 47 J impact energy)

Symbol	Minimum yield strength[a] MPa	Tensile strength MPa	Minimum elongation[b] %
35	355	440 to 570	22
38	380	470 to 600	20
42	420	500 to 640	20
46	460	530 to 680	20
50	500	560 to 720	18

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

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

Table 1B — Symbols for tensile properties by multi-run technique
(Classification by tensile strength and 27 J impact energy)

Symbol[a]	Minimum yield strength[b] MPa	Tensile strength MPa	Minimum elongation[c] %
43X	330	430 to 600	20
49X	390	490 to 670	18
55X	460	550 to 740	17
57X	490	570 to 770	17

[a] X is "A" or "P", where "A" indicates testing in the as-welded condition and "P" indicates testing in the post-weld heat-treated condition.

[b] For yield strength, the 0,2 % proof strength, $R_{p0,2}$, is used.

[c] Gauge length is equal to five times the test specimen diameter.

4.2.2 Two-run technique

For products suitable for two-run welding, the symbols in Table 2A or 2B indicate the minimum tensile strength of the welded joint in relation to the specified minimum strength of the parent material used in two-run welding tests satisfactorily completed in accordance with 5.2.

Table 2A — Symbols for tensile properties by two-run technique
(Classification by yield strength and 47 J impact energy)

Symbol	Minimum parent material yield strength MPa	Minimum tensile strength of the welded joint MPa
2T	275	370
3T	355	470
4T	420	520
5T	500	600

Table 2B — Symbols for tensile properties by two-run technique
(Classification by tensile strength and 27 J impact energy)

Symbol	Minimum tensile strength of the parent material and of the welded joint MPa
43S	430
49S	490
55S	550
57S	570

4.3 Symbol for the impact properties of all-weld metal or two-run welded joint

The symbols in Table 3 indicate the temperature at which an impact energy of 47 J or 27 J is achieved under the conditions given in Clause 5.

4.3A Classification by yield strength and 47 J impact energy

Three test specimens shall be tested. Only one individual value may be lower than 47 J but not lower than 32 J.

4.3B Classification by tensile strength and 27 J impact energy

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 requirement of 4.3A.

When an all-weld metal or a welded joint has been classified for a certain temperature, it automatically covers any higher temperature in Table 3.

Table 3 — Symbols for impact properties of all-weld metal or welded joint

Symbol	Temperature for minimum average impact energy of 47 J[a][b] or 27 J[b] °C
Z	No requirements
A[a] or Y[b]	+20
0	0
2	−20
3	−30
4	−40
5	−50
6	−60
7	−70
8	−80
9	−90
10	−100

[a] See 4.3A.

[b] See 4.3B.

4.4 Symbol for type of welding flux

The symbol for welding flux type shall be in accordance with ISO 14174.

4.5 Symbol for the chemical composition

4.5.1 Solid wire electrodes

The symbols in Tables 4A and 4B indicate the chemical composition of the solid wire electrode and include an indication of characteristic alloying elements.

The symbol for a wire electrode used in the submerged arc welding process shall be the letters S or SU at the beginning of the wire electrode designation.

NOTE The chemical composition of the weld metal is dependent on the chemical composition of the wire electrode and the metallurgical behaviour of the flux (see ISO 14174).

4.5.2 Tubular cored electrode/flux combinations

The symbols in Tables 5A and 5B indicate the chemical composition of the all-weld metal obtained with a tubular cored electrode/flux combination and include an indication of characteristic alloying elements.

The symbol for all-weld metal obtained with a tubular cored electrode used in the submerged arc welding process shall be the letters T or TU at the beginning of the wire electrode designation.

In cases of dispute, the sample for all-weld metal deposit shall be in accordance with ISO 6847.

Table 4A — Chemical composition of solid wire electrodes for submerged arc welding
(Classification by yield strength and 47 J impact energy)

Symbol	Chemical composition, % (by mass)[abc]								
	C	Si	Mn	P	S	Mo	Ni	Cr	Cu
S1	0,05 to 0,15	0,15	0,35 to 0,60	0,025	0,025	0,15	0,15	0,15	0,30
S2	0,07 to 0,15	0,15	0,80 to 1,30	0,025	0,025	0,15	0,15	0,15	0,30
S3	0,07 to 0,15	0,15	1,30 to 1,75	0,025	0,025	0,15	0,15	0,15	0,30
S4	0,07 to 0,15	0,15	1,75 to 2,25	0,025	0,025	0,15	0,15	0,15	0,30
S1Si	0,07 to 0,15	0,15 to 0,40	0,35 to 0,60	0,025	0,025	0,15	0,15	0,15	0,30
S2Si	0,07 to 0,15	0,15 to 0,40	0,80 to 1,30	0,025	0,025	0,15	0,15	0,15	0,30
S2Si2	0,07 to 0,15	0,40 to 0,60	0,80 to 1,30	0,025	0,025	0,15	0,15	0,15	0,30
S3Si	0,07 to 0,15	0,15 to 0,40	1,30 to 1,85	0,025	0,025	0,15	0,15	0,15	0,30
S4Si	0,07 to 0,15	0,15 to 0,40	1,85 to 2,25	0,025	0,025	0,15	0,15	0,15	0,30
S1Mo	0,05 to 0,15	0,05 to 0,25	0,35 to 0,60	0,025	0,025	0,45 to 0,65	0,15	0,15	0,30
S2Mo	0,07 to 0,15	0,05 to 0,25	0,80 to 1,30	0,025	0,025	0,45 to 0,65	0,15	0,15	0,30
S2MoTiB[d]	0,05 to 0,15	0,15 to 0,35	1,00 to 1,35	0,025	0,025	0,40 to 0,65	—	—	0,30
S3Mo	0,07 to 0,15	0,05 to 0,25	1,30 to 1,75	0,025	0,025	0,45 to 0,65	0,15	0,15	0,30
S4Mo	0,07 to 0,15	0,05 to 0,25	1,75 to 2,25	0,025	0,025	0,45 to 0,65	0,15	0,15	0,30
S2Ni1	0,07 to 0,15	0,05 to 0,25	0,80 to 1,30	0,020	0,020	0,15	0,80 to 1,20	0,15	0,30
S2Ni1,5	0,07 to 0,15	0,05 to 0,25	0,80 to 1,30	0,020	0,020	0,15	1,20 to 1,80	0,15	0,30
S2Ni2	0,07 to 0,15	0,05 to 0,25	0,80 to 1,30	0,020	0,020	0,15	1,80 to 2,40	0,15	0,30
S2Ni3	0,07 to 0,15	0,05 to 0,25	0,80 to 1,30	0,020	0,020	0,15	2,80 to 3,70	0,15	0,30
S2Ni1Mo	0,07 to 0,15	0,05 to 0,25	0,80 to 1,30	0,020	0,020	0,45 to 0,65	0,80 to 1,20	0,20	0,30
S3Ni1,5	0,07 to 0,15	0,05 to 0,25	1,30 to 1,70	0,020	0,020	0,15	1,20 to 1,80	0,20	0,30
S3Ni1Mo	0,07 to 0,15	0,05 to 0,25	1,30 to 1,80	0,020	0,020	0,45 to 0,65	0,80 to 1,20	0,20	0,30
S3Ni1Mo0,2	0,07 to 0,15	0,10 to 0,35	1,20 to 1,60	0,015	0,015	0,15 to 0,30	0,80 to 1,2	0,15	0,30
S3Ni1,5Mo	0,07 to 0,15	0,05 to 0,25	1,20 to 1,80	0,020	0,020	0,30 to 0,50	1,20 to 1,80	0,20	0,30

Table 4A (*continued*)

Symbol	Chemical composition, % (by mass)[abc]								
	C	Si	Mn	P	S	Mo	Ni	Cr	Cu
S2Ni1Cu	0,08 to 0,12	0,15 to 0,35	0,70 to 1,20	0,020	0,020	0,15	0,65 to 0,90	0,40	0,40 to 0,65
S3Ni1Cu	0,05 to 0,15	0,15 to 0,40	1,20 to 1,70	0,025	0,025	0,15	0,60 to 1,20	0,15	0,30 to 0,60
SZ[c]	Any other agreed composition								

[a] Finished product chemical composition, Cu inclusive of a copper coating, ≤0,30 % (by mass), Al ≤0,030 % (by mass).

[b] Single values are maxima.

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

[d] Ti: 0,10 % (by mass) to 0,20 % (by mass), B: 0,005 % (by mass) to 0,020 % (by mass).

Table 4B — Chemical composition of solid wire electrodes for submerged arc welding
(Classification by tensile strength and 27 J impact energy)

Symbol	Chemical composition, % (by mass)[abc]								
	C	Si	Mn	P	S	Mo	Ni	Cr	Cu
SU11	0,15	0,15	0,20 to 0,90	0,025	0,025	0,15	0,15	0,15	0,40
SU12	0,15	0,10 to 0,60	0,20 to 0,90	0,025	0,025	0,15	0,15	0,15	0,40
SU21	0,05 to 0,15	0,10 to 0,35	0,80 to 1,25	0,025	0,025	0,15	0,15	0,15	0,40
SU22	0,15	0,15	0,80 to 1,40	0,025	0,025	0,15	0,15	0,15	0,40
SU23	0,18	0,15 to 0,60	0,80 to 1,40	0,025	0,025	0,15	0,15	0,15	0,40
SU24[d]	0,06 to 0,19	0,35 to 0,75	0,90 to 1,40	0,025	0,025	0,15	0,15	0,15	0,40
SU25	0,06 to 0,16	0,35 to 0,75	0,90 to 1,40	0,030	0,030	0,15	0,15	0,15	0,40
SU31	0,06 to 0,15	0,80 to 1,15	1,40 to 1,85	0,030	0,030	0,15	0,15	0,15	0,40
SU32	0,15	0,05 to 0,60	1,30 to 1,90	0,025	0,025	0,15	0,15	0,15	0,40
SU33	0,15	0,15	1,30 to 1,90	0,025	0,025	0,15	0,15	0,15	0,40
SU41	0,20	0,15	1,60 to 2,30	0,025	0,025	0,15	0,15	0,15	0,40
SU42	0,15	0,15 to 0,65	1,50 to 2,30	0,025	0,025	0,15	0,15	0,15	0,40
SU51	0,15	0,15	2,20 to 2,80	0,025	0,025	0,15	0,15	0,15	0,40
SU1M3	0,15	0,25	0,20 to 1,00	0,025	0,025	0,40 to 0,65	0,15	0,15	0,40
SU1M3TiB[e]	0,05 to 0,15	0,20	0,65 to 1,00	0,025	0,025	0,45 to 0,65	0,15	0,15	0,35
SU2M1	0,15	0,25	0,80 to 1,40	0,025	0,025	0,15 to 0,40	0,15	0,15	0,40
SU3M1	0,15	0,25	1,30 to 1,90	0,025	0,025	0,15 to 0,40	0,15	0,15	0,40
SU2M3	0,17	0,25	0,80 to 1,40	0,025	0,025	0,40 to 0,65	0,15	0,15	0,40
SU2M3TiB[e]	0,05 to 0,17	0,20	0,95 to 1,35	0,025	0,025	0,40 to 0,65	0,15	0,15	0,35
SU3M3	0,17	0,25	1,20 to 1,90	0,025	0,025	0,40 to 0,65	0,15	0,15	0,40
SU4M1	0,15	0,25	1,60 to 2,30	0,025	0,025	0,15 to 0,40	0,15	0,15	0,40
SU4M3	0,17	0,25	1,60 to 2,30	0,025	0,025	0,40 to 0,65	0,15	0,15	0,40
SU4M31	0,05 to 0,15	0,50 to 0,80	1,60 to 2,10	0,025	0,025	0,40 to 0,60	0,15	0,15	0,40

Table 4B (*continued*)

Symbol	Chemical composition, % (by mass)[abc]								
	C	Si	Mn	P	S	Mo	Ni	Cr	Cu
SU5M3	0,15	0,25	2,20 to 2,80	0,025	0,025	0,40 to 0,65	0,15	0,15	0,40
SUN2	0,15	0,30	0,75 to 1,40	0,020	0,020	0,15	0,75 to 1,25	0,20	0,40
SUN21	0,12	0,40 to 0,80	0,80 to 1,40	0,020	0,020	0,15	0,75 to 1,25	0,20	0,40
SUN3	0,15	0,25	0,80 to 1,40	0,020	0,020	0,15	1,20 to 1,80	0,20	0,40
SUN31	0,15	0,25	1,30 to 1,90	0,020	0,020	0,15	1,20 to 1,80	0,20	0,40
SUN5	0,15	0,30	0,75 to 1,40	0,020	0,020	0,15	1,80 to 2,90	0,20	0,40
SUN7	0,15	0,30	0,60 to 1,40	0,020	0,020	0,15	2,40 to 3,80	0,20	0,40
SUCC	0,15	0,30	0,80 to 1,90	0,030	0,030	0,15	0,15	0,30 to 0,60	0,20 to 0,45
SUNCC1	0,12	0,20 to 0,35	0,35 to 0,65	0,025	0,030	0,15	0,40 to 0,80	0,50 to 0,80	0,30 to 0,80
SUNCC3	0,15	0,30	0,80 to 1,90	0,030	0,030	0,15	0,05 to 0,80	0,50 to 0,80	0,30 to 0,55
SUN1M3	0,10 to 0,18	0,20	1,70 to 2,40	0,025	0,025	0,40 to 0,65	0,40 to 0,80	0,20	0,35
SUN2M1	0,12	0,05 to 0,30	1,20 to 1,60	0,020	0,020	0,10 to 0,30	0,75 to 1,25	0,20	0,40
SUN2M3	0,15	0,25	0,80 to 1,40	0,020	0,020	0,40 to 0,65	0,80 to 1,20	0,20	0,40
SUN2M31	0,15	0,25	1,30 to 1,90	0,020	0,020	0,40 to 0,65	0,80 to 1,20	0,20	0,40
SUN2M32	0,15	0,25	1,60 to 2,30	0,020	0,020	0,40 to 0,65	0,80 to 1,20	0,20	0,40
SUN3M3	0,15	0,25	0,80 to 1,40	0,020	0,020	0,40 to 0,65	1,20 to 1,80	0,20	0,40
SUN3M31	0,15	0,25	1,30 to 1,90	0,020	0,020	0,40 to 0,65	1,20 to 1,80	0,20	0,40
SUN4M1	0,12 to 0,19	0,10 to 0,30	0,60 to 1,00	0,015	0,030	0,10 to 0,30	1,60 to 2,10	0,20	0,35
SUZ[c]	Any other agreed composition								

[a] The electrode shall be analysed for the specific elements for which values are shown in this table. If the presence of other elements is indicated, in the course of this work, the amount of those elements shall be determined to ensure that their total (excluding iron) does not exceed 0,50 % (by mass).

[b] Single values are maxima.

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

[d] Ti: 0,03 % (by mass) to 0,17 % (by mass).

[e] Ti: 0,05 % (by mass) to 0,30 % (by mass) and B: 0,005 % (by mass) to 0,030 % (by mass).

Table 5A — All-weld metal classification symbols for tubular cored electrode/flux combinations
(Classification by yield strength and 47 J impact energy)

Symbol	Chemical composition, % (by mass)[a,b,c]			
	Mn	Ni	Mo	Cu
T2	1,4	—	—	0,3
T3	1,4 to 2,0	—	—	0,3
T2Mo	1,4	—	0,3 to 0,6	0,3
T3Mo	1,4 to 2,0	—	0,3 to 0,6	0,3
T2Ni1	1,4	0,6 to 1,2	—	0,3
T2Ni1,5	1,6	1,2 to 1,8	—	0,3
T2Ni2	1,4	1,8 to 2,6	—	0,3
T2Ni3	1,4	2,6 to 3,8	—	0,3
T3Ni1	1,4 to 2,0	0,6 to 1,2	—	0,3
T2Ni1Mo	1,4	0,6 to 1,2	0,3 to 0,6	0,3
T2Ni1Cu	1,4	0,8 to 1,2	—	0,3 to 0,6
TZ[c]	Any other agreed composition			

[a] If not specified Mo: ⩽ 0,2 % (by mass), Ni: ⩽ 0,5 % (by mass), Cr: ⩽ 0,2 % (by mass), V: ⩽ 0,08 % (by mass), Nb: ⩽ 0,05 % (by mass), C: 0,03 % (by mass) to 0,15 % (by mass), Si: ⩽ 0,8 % (by mass), S: ⩽ 0,025 % (by mass), P: ⩽ 0,025 % (by mass).

[b] Single values are maxima.

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

Table 5B — All-weld metal classification symbols for tubular cored electrode/flux combinations
(Classification by tensile strength and 27 J impact energy)

Symbol	Chemical composition, % (by mass)[abc]									
	C	Mn	Si	S	P	Cr	Ni	Mo	Cu	other
TU3M	0,15	1,80	0,90	0,035	0,035	—	—	—	0,35	—
TU2M3	0,12	1,00	0,80	0,030	0,030	—	—	0,40 to 0,65	0,35	—
TU2M31	0,12	1,40	0,80	0,030	0,030	—	—	0,40 to 0,65	0,35	—
TU4M3	0,15	2,10	0,80	0,030	0,030	—	—	0,40 to 0,65	0,35	—
TU3M3	0,15	1,60	0,80	0,030	0,030	—	—	0,40 to 0,65	0,35	—
TUN2	0,12[c]	1,60[d]	0,80	0,025	0,030	0,15	0,75 to 1,10	0,35	0,35	Ti + V + Zr: 0,05
TUN5	0,12[c]	1,60[d]	0,80	0,025	0,030	—	2,00 to 2,90	—	0,35	—
TUN7	0,12	1,60	0,80	0,025	0,030	0,15	2,80 to 3,80	—	0,35	—
TUN4M1	0,14	1,60	0,80	0,025	0,030	—	1,40 to 2,10	0,10 to 0,35	0,35	—
TUN2M1	0,12	1,60	0,80	0,025	0,030	—	0,70 to 1,10	0,10 to 0,35	0,35	—
TUN3M2	0,12	0,70 to 1,50	0,80	0,030	0,030	0,15	0,90 to 1,70	0,55	0,35	—
TUN1M3	0,17	1,25 to 2,25	0,80	0,030	0,030	—	0,40 to 0,80	0,40 to 0,65	0,35	—
TUN2M3	0,17	1,25 to 2,25	0,80	0,030	0,030	—	0,70 to 1,10	0,40 to 0,65	0,35	—
TUN1C2	0,17	1,60	0,80	0,035	0,030	0,60	0,40 to 0,80	0,25	0,35	Ti + V + Zr: 0,03
TUN5C2M3	0,17	1,20 to 1,80	0,80	0,020	0,020	0,65	2,00 to 2,80	0,30 to 0,80	0,50	—
TUN4C2M3	0,14	0,80 to 1,85	0,80	0,020	0,030	0,65	1,50 to 2,25	0,60	0,40	—
TUN3	0,10	0,60 to 1,60	0,80	0,030	0,030	0,15	1,25 to 2,00	0,35	0,30	Ti + V + Zr: 0,03
TUN4M2	0,10	0,90 to 1,80	0,80	0,020	0,020	0,35	1,40 to 2,10	0,25 to 0,65	0,30	Ti + V + Zr: 0,03
TUN4M3	0,10	0,90 to 1,80	0,80	0,020	0,020	0,65	1,80 to 2,60	0,20 to 0,70	0,30	Ti + V + Zr: 0,03
TUN5M3	0,10	1,30 to 2,25	0,80	0,020	0,020	0,80	2,00 to 2,80	0,30 to 0,80	0,30	Ti + V + Zr: 0,03

Table 5B (*continued*)

Symbol	Chemical composition, % (by mass)[abc]									
	C	Mn	Si	S	P	Cr	Ni	Mo	Cu	other
TUN4M21	0,12	1,60 to 2,50	0,50	0,015	0,015	0,40	1,40 to 2,10	0,20 to 0,50	0,30	Ti: 0,03 V: 0,02 Zr: 0,02
TUN4M4	0,12	1,60 to 2,50	0,50	0,015	0,015	0,40	1,40 to 2,10	0,70 to 1,00	0,30	Ti: 0,03 V: 0,02 Zr: 0,02
TUNCC	0,12	0,50 to 1,60	0,80	0,030	0,035	0,45 to 0,70	0,40 to 0,80	—	0,30 to 0,75	—
TUZ[c]	Any other agreed composition									

[a] The weld metal shall be analysed for the specific elements for which values are shown in this table. If the presence of other elements is indicated in the course of this work, the amount of those elements shall be determined to ensure that their total (excluding iron) does not exceed 0,50 % (by mass).

[b] Single values are maxima.

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

[d] Manganese in the N2 and N5 designated weld metals may be 1,80 % (by mass) maximum when the carbon is restricted to 0,10 % (by mass) maximum.

4.6 Symbol for hydrogen content of deposited metal

The symbols in Table 6 indicate the deposited metal hydrogen content determined in accordance with the method given in ISO 3690.

Table 6 — Symbol for hydrogen content of deposited metal

Symbol	Hydrogen content ml/100 g deposited metal, max.
H5	5
H10	10
H15	15

When a hydrogen symbol in accordance with Table 6 is included in the classification, the manufacturer shall state in their literature what restrictions need to be placed on the conditions of storage and redrying, and on current, arc voltage, electrode extension, and polarity to remain within the limit for that symbol.

5 Mechanical tests

5.1 Multi-run technique

5.1A Welding conditions in the classification by yield strength and 47 J impact energy

Tensile and impact tests shall be carried out on weld metal in the as-welded condition using an all-weld metal test assembly type 1.3 in accordance with ISO 15792-1:2000 using 4,0 mm or nearest commercially available diameter wire electrodes.

Welding conditions (single wire welding) and details of the test assembly shall be selected from Table 7A.

Preheating is not required; welding may start from room temperature.

The interpass temperature shall be measured using temperature indicator crayons, surface thermometers or thermocouples (see ISO 13916).

5.1B Welding conditions in the classification by tensile strength and 27 J impact energy

Tensile and impact tests shall be carried out on weld metal in the as-welded condition or in the post-weld heat-treated condition using an all-weld metal test assembly type 1.4 in accordance with ISO 15792-1:2000 using 4,0 mm or nearest commercially available diameter wire electrodes.

Welding conditions (single wire welding) and details of the test assembly shall be selected from Table 7B. Solid wire diameters not specified and all tubular cored electrodes shall be welded based on the manufacturer's recommendations.

The interpass temperature shall be measured using temperature indicator crayons, surface thermometers or thermocouples (see ISO 13916).

The interpass temperature shall not exceed the interpass temperature range indicated in Table 7B. If, after any pass, the interpass temperature range is exceeded, the test assembly shall be cooled in air to a temperature within the indicated range. If the interpass temperature is below the indicated interpass temperature range, the test assembly shall be reheated into the interpass temperature range.

The interpass temperature shall not exceed the interpass temperature range indicated in Table 7A. If, after any pass, the interpass temperature range is exceeded, the test assembly shall be cooled in air to a temperature within the indicated range. If the interpass temperature is below the indicated interpass temperature range, the test assembly shall be reheated into the interpass temperature range.

Test assemblies made with electrodes classified in the post-weld heat-treated condition shall be heat-treated at 620 °C ± 15 °C for 60 min to 75 min. The furnace shall be at a temperature no higher than 315 °C when the test assembly is placed in it. The heating rate, from that point to the 620 °C ± 15 °C holding temperature, shall not exceed 220 °C/h. When the holding time has been completed, the assembly shall be allowed to cool in the furnace to a temperature below 315 °C at a rate not exceeding 195 °C/h. The assembly may be removed from the furnace at any temperature below 315 °C and allowed to cool in still air to room temperature.

Table 7A — Welding conditions for multi-run single solid wire welding
(Classification by yield strength and 47 J impact energy)

Conditions[a]	Solid wire electrode diameter[b] mm		Tubular cored electrode diameter[b] mm	
	2,8 to 3,2	4,0	3,0 to 3,2	4,8
Type of current	d.c.[c]			
Length of weld deposit, mm	⩾350			
Welding current, A	440 ± 20	580 ± 20	480 ± 20	550 ± 20
Welding voltage, V	27 ± 2	29 ± 2	30 ± 2	
Welding speed, mm/min	400 ± 50	550 ± 50	450 ± 50	
Interpass temperature range, °C (no preheat)	150 ± 25			
Electrode extension, mm	30 ± 5			

a A.c. or d.c., either polarity, may be used. The reference method shall be as recommended by the manufacturer.

b Diameters not specified are to be welded following the recommendations of the electrode manufacturer.

c Direct current welding polarity shall follow the recommendation of the manufacturer.

Table 7B — Welding conditions for multi-run single solid wire welding
(Classification by tensile strength and 27 J impact energy)

Conditions[a]		Wire electrode diameter mm					
		3,2	4	4,8	3,2	4	4,8
Type of current		d.c.e.p.			a.c.		
Length of weld deposit, mm		⩾200			⩾200		
Welding current, A		450 ± 50	500 ± 50	600 ± 50	450 ± 50	500 ± 50	600 ± 50
Welding voltage, V		28 ± 2	30 ± 2	32 ± 2	30 ± 2	32 ± 2	34 ± 2
Welding speed, mm/min		350 ± 20	400 ± 20	450 ± 20	350 ± 20	400 ± 20	450 ± 20
Preheat temperature, °C	b	Room temperature			Room temperature		
	c	⩾100			⩾100		
Interpass temperature range, °C		150 ± 15			150 ± 15		
Electrode extension, mm		30 ± 5			30 ± 5		

[a] A.c. or d.c., either polarity (e.p.), may be used. The reference method shall be as recommended by the manufacturer.

[b] For SU0, SU11, SU12, SU21, SU22, SU23, SU24, SU25, SU31, SU32, SU33, SU41, SU42, SU51.

[c] For symbols other than those in footnote b.

5.2 Two-run technique

Tensile and impact tests and any required retests shall be carried out on weld metal in the as-welded condition using a test assembly type 2.5 in accordance with ISO 15792-2:2000 using a 4,0 mm solid or tubular cored electrode or the nearest commercially available diameter. Welding conditions shall be within the range recommended by the manufacturer and shall be recorded to demonstrate compliance with this International Standard.

For an electrode/flux combination of a given specified minimum tensile strength, the specified minimum tensile strength of the parent material used for the classification test shall not exceed the specified minimum tensile strength of the tubular cored electrode/flux combination by more than 50 MPa.

6 Chemical analysis

Chemical analysis shall be performed on specimens of the solid wire electrode and all-weld metal deposits from tubular electrodes.

For solid wire electrodes where the chemical composition does not change during production, the analysis of the product being processed, or the raw material itself, or a report of the ladle analysis of the raw material can be substituted.

For tubular cored electrode/flux combinations, chemical analysis is performed on any suitable all-weld metal test specimen. The reference method is described in ISO 6847.

Any analytical technique can be used, but in cases of dispute, reference shall be made to established published methods.

7 Rounding procedure

For purposes of determining compliance with the requirements of this International Standard, the actual test values obtained shall be subjected to the rounding rules of ISO 80000-1:2009, Annex B, 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 average value is to be compared to the requirements of this International Standard, rounding shall be done only after calculating the average. In the case where the testing standard cited in the normative references of this International Standard contains instructions for rounding that conflict with the instructions of this International Standard, the rounding requirements of the testing standard shall apply. The rounded results shall fulfil the requirements of the appropriate table for the classification under test.

8 Retest

If any test fails to meet the requirement, that test shall be repeated twice. The results of both retests shall meet the requirement. 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 the requirement, 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 tests, 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 requirement. That test shall be repeated, following proper prescribed procedures. In this case, the requirement for doubling the number of test specimens does not apply.

9 Technical delivery conditions

Technical delivery conditions shall meet the requirements in ISO 544 and ISO 14344.

10 Examples of designation

10A Classification by yield strength and 47 J impact energy

The designation of the wire electrode and electrode/flux combination shall follow the principles given in the examples below.

EXAMPLE 1A:

An electrode/flux combination for submerged arc welding for multi-run technique depositing a weld metal with a minimum yield strength of 460 MPa (46) and a minimum average impact energy of 47 J at −30 °C (3) produced with an aluminate-basic flux (AB, see 4.4) and a wire S2 is designated as follows:

ISO 14171-A-S 46 3 AB S2

where

ISO 14171-A is the number of this International Standard, with classification by yield strength and 47 J impact energy;

S is the electrode/flux combination for submerged arc welding (see 4.1);

46 indicates the tensile properties (see Table 1A);

3 indicates the impact properties (see Table 3);

AB is the type of welding flux (see Clause 4);

S2 is the chemical composition of wire electrode (see Table 4A).

EXAMPLE 2A:

An electrode/flux combination for submerged arc welding using two-run technique demonstrated in accordance with the manufacturer's recommendation in parent material with minimum yield strength 420 MPa (4T, see Table 2A) depositing a weld metal with minimum transverse tensile strength of 520 MPa and impact energy of 47 J at −20 °C (2) produced with an aluminate-basic flux (AB, see 4.4) and a wire electrode S2Mo is designated as follows:

ISO 14171-A-S 4T 2 AB S2Mo

10B Classification by tensile strength and 27 J impact energy

The designation of the wire electrode and electrode/flux combination shall follow the principles given in the examples below.

EXAMPLE 1B:

An electrode/flux combination for submerged arc welding for multi-run technique depositing a weld metal with a minimum tensile strength of 490 MPa (49) and a minimum average impact energy of 27 J at −20 °C (2) in the as-welded condition produced with an aluminate-basic flux (AB, see 4.4) and a wire SU32 is designated as follows:

ISO 14171-B-S49A2 AB SU32

where

ISO 14171-B is the number of this International Standard, with classification by tensile strength and 27 J impact energy;

S is the electrode/flux combination for submerged arc welding (see 4.1);

49A indicates the tensile properties in the as-welded condition (see Table 1B);

2 indicates the impact properties (see Table 3);

AB is the type of welding flux (see Clause 4);

SU32 is the chemical composition of wire electrode (see Table 4B).

EXAMPLE 2B:

An electrode/flux combination for submerged arc welding using two-run technique demonstrated in accordance with the manufacturer's recommendation in parent material with minimum tensile strength 550 MPa (55S, see Table 2B) depositing a weld metal with minimum transverse tensile strength of 550 MPa and impact energy of 27 J at −40 °C (4), in the as-welded condition, produced with an aluminate-basic flux (AB, see 4.4) and a wire electrode SU2M3 is designated as follows:

ISO 14171-B-S55S4 AB SU2M3

where

ISO 14171-A is the number of this International Standard, with classification by yield strength and 47 J impact energy;

S is the electrode/flux combination for submerged arc welding (see 4.1);

4T indicates the tensile properties (see Table 2A);

2 indicates the impact properties (see Table 3);

AB is the type of welding flux (see Clause 4);

S2Mo is the chemical composition of wire electrode (see Table 4A).

EXAMPLE 3A:

A wire electrode complying with the chemical requirement of S2Mo in Table 4A is designated as follows:

ISO 14171-A-S2Mo

where

ISO 14171-A is the number of this International Standard, with classification by yield strength and 47 J impact energy;

S2Mo is the chemical composition of wire electrode (see Table 4A).

EXAMPLE 4A:

A tubular cored electrode/flux combination for submerged arc welding for multi-run technique depositing a weld metal with a minimum yield strength of 420 MPa (42) and a minimum average impact energy of 47 J at −20 °C (2) produced with an aluminate-basic flux (AB, see 4.4) and an all-weld metal T3Mo is designated as follows:

ISO 14171-A-S 42 2 AB T3Mo

where

ISO 14171-B is the number of this International Standard, with classification by tensile strength and 27 J impact energy;

S is the electrode/flux combination for submerged arc welding (see 4.1);

55S indicates the tensile properties in the as-welded condition (see Table 1B);

4 indicates the impact properties (see Table 3);

AB is the type of welding flux (see Clause 4);

SU2M3 is the chemical composition of wire electrode (see Table 4B).

EXAMPLE 3B:

A wire electrode complying with the chemical requirement of SU2M3 in Table 4B is designated as follows:

ISO 14171-B-SU2M3

where

ISO 14171-B is the number of this International Standard, with classification by tensile strength and 27 J impact energy;

SU2M3 is the chemical composition of wire electrode (see Table 4B).

EXAMPLE 4B:

An electrode/flux combination for submerged arc welding for multi-run technique depositing a weld metal with a minimum tensile strength of 490 MPa (49) and a minimum average impact energy of 47 J at −20 °C (2) in the as-welded condition produced with an aluminate-basic flux (AB, see 4.4) and a wire SU41 is designated as follows:

ISO 14171-B-S49A2U AB SU41

where

ISO 14171-A is the number of this International Standard, with classification by yield strength and 47 J impact energy;

S is the electrode/flux combination for submerged arc welding (see 4.1);

42 indicates the tensile properties (see Table 1A);

2 indicates the impact properties (see Table 3);

AB is the type of welding flux (see Clause 4);

T3Mo is the chemical composition of weld metal (see Table 5A).

where

ISO 14171-B is the number of this International Standard, with classification by tensile strength and 27 J impact energy;

S is the electrode/flux combination for submerged arc welding (see 4.1);

49A indicates the tensile properties in the as-welded condition (see Table 1B);

2U indicates the impact properties [see Table 3 and Clause 3B, item 3)];

AB is the type of welding flux (see Clause 4);

SU41 is the chemical composition of wire electrode (see Table 4B).

EXAMPLE 5B:

A tubular electrode/flux combination for submerged arc welding for multi-run technique depositing a weld metal with a minimum tensile strength of 550 MPa (55) and a minimum average impact energy of 47 J at −80 °C (8U) in the as-welded condition and a deposit composition complying with the TUN7 composition limits of Table 5B, produced with an aluminate-basic flux (AB) is designated as follows:

ISO 14171-B-S55A8U AB TUN7

where

ISO 14171-B is the number of this International Standard, with classification by tensile strength and 27 J impact energy;

S is the electrode/flux combination for submerged arc welding (see 4.1);

55A indicates the tensile properties in the as-welded condition (see Table 1B);

8U indicates the impact properties [see Table 3 and Clause 3B, item 3)];

AB is the type of welding flux (see Clause 4);

TUN7 is the weld metal symbol (see Table 5B).