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Welding consumables — Solid wire electrodes, tubular cored electrodes and electrode-flux combinations for submerged arc welding of high strength steels — Classification

Produits consommables pour le soudage — Fils-électrodes pleins, fils-électrodes fourrés et couples électrodes-flux pour le soudage à l'arc sous flux des aciers à haute résistance — Classification

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Foreword

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

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

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

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

ISO 26304 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 3, *Welding consumables*.

Requests for official interpretations of technical aspects of this International Standard should be directed to the Secretariat of ISO/TC 44/SC 3 via the user's national standardization body; a listing of these bodies can be found at www.iso.org.

Introduction

This International Standard provides a classification in order to designate 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, elongation and impact properties of the all-weld metal. The ratio of yield 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 will not necessarily ensure that the weld metal tensile strength matches that of the parent material. Where the application requires matching tensile strength therefore, selection of the consumable should be made by reference to column 3 of Table 1A or Table 1B, as appropriate.

Although combinations of electrodes and fluxes supplied by individual companies may have the same grading, the combination of an electrode with a flux from one manufacturer versus the flux from another manufacturer, both fluxes having the same classification, may not be interchangeable unless verified according to this International Standard. Two tubular cored wires of the same classification may likewise produce different results with the same flux.

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

ISO 26304 was prepared with assistance from the International Institute of Welding, Commission II. It recognizes that there are two somewhat different approaches in the global market to classifying a given wire electrode, tubular cored electrode, and 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 according to this International Standard. The classification according to system A is mainly based on EN 14295. The classification according to system B is mainly based upon standards used around the Pacific Rim. Future revisions will aim to merge the two approaches into a single classification system.

Welding consumables — Solid wire electrodes, tubular cored electrodes and electrode-flux combinations for submerged arc welding of high strength steels — Classification

1 Scope

This International Standard specifies requirements for classification of solid wire electrodes, tubular cored electrodes, and electrode/flux combinations (all-weld metal deposits) in the as-welded condition and in the post weld heat-treated condition for submerged arc welding of high strength steels with a minimum yield strength greater than 500 MPa or a minimum tensile strength greater than 570 MPa. One flux can be tested and classified with different electrodes. One electrode can be tested and classified with different fluxes. The solid wire electrode is also classified separately based on its chemical composition.

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

1) Paragraphs and tables which carry the suffix letter “A” are applicable only to solid wire electrodes, tubular cored electrodes and all-weld metal deposits classified to the system based upon the yield strength and the average impact energy of 47 J for all-weld metal obtained with electrode/flux combinations in accordance with this International Standard.

2) Paragraphs and tables which carry the suffix letter “B” are applicable only to solid wire electrodes, tubular cored electrodes and all-weld metal deposits classified to the system based upon the tensile strength and the average impact energy of 27 J for all-weld metal obtained with electrode/flux combinations in accordance with this International Standard.

3) Paragraphs and tables which do not have either the suffix letter “A” or the suffix letter “B” are applicable to all solid wire electrodes, tubular cored electrodes and electrode/flux combinations classified in accordance with this International Standard.

2 Normative references

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

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

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

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

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

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

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

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

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

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/flux combination. The two designation approaches also include additional designators for the chemical composition of a solid wire electrode or the chemical composition of the all-weld metal deposit obtained with a tubular cored electrode and a particular flux. The two designation approaches include additional designators for some other classification requirements, but not all, as will be clear from the following sections. A given commercial product may be classified to the classification requirements in both systems; then either or both classification designations may be used for the product.

The classification includes all-weld metal properties obtained with a specific electrode/flux combination as given below. A solid wire electrode shall be classified according to its chemical composition in Table 4.

A tubular cored electrode shall be classified according to the all-weld metal deposit composition in Table 5, 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.

3.1A Classification by yield strength and 47 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 tensile properties of all-weld metal (see Table 1A);

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

4) the fourth part gives a symbol indicating the type of flux used (see Table 3);

3.1B Classification by tensile strength and 27 J impact energy

The classification is divided into six 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 in either the as-welded or the post weld heat treated condition (see Table 1B);

3) the third part gives a symbol indicating the impact properties of all-weld metal in the same condition as specified for the tensile strength (see Table 2). The letter “U” after this designator indicates that the deposit meets an average optional requirement of 47 J at the designated impact test temperature;

4) the fourth part gives a symbol indicating the type of flux used (see Table 3);

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

6) the sixth part gives a symbol indicating the stress relief treatment in case this is applied;

7) the seventh part gives a symbol indicating the diffusible hydrogen content of the weld metal obtained in accordance with ISO 3690.

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

6) the sixth part gives a symbol indicating the diffusible hydrogen content of the weld metal obtained in accordance with ISO 3690.

4 Symbols and requirements

A solid wire electrode can be classified separately based upon its chemical composition, as specified in Table 4. The all-weld metal deposit composition and mechanical properties obtained with a particular solid wire electrode or tubular cored electrode will vary somewhat depending upon the flux used. Accordingly, the classification of the all-weld metal deposit obtained with a particular solid wire electrode or tubular cored electrode may be different for different fluxes. However, deposit composition is only a classification requirement for tubular cored electrode/flux combinations.

4.1 Symbol for the product/process

The symbol for the electrode/flux combination and/or weld deposit produced by a solid wire electrode or by a tubular cored electrode using the submerged arc welding process with a particular flux, shall be the letter S placed at the beginning of the designation.

4.1A Classification by yield strength and 47 J impact energy

The symbol for the solid wire electrode for use in the submerged arc welding process shall be the letter S placed at the beginning of the solid wire electrode designation.

The symbol for the tubular cored electrode for use in the submerged arc welding process shall be the letter T placed at the beginning of the tubular cored electrode designation.

4.1B Classification by tensile strength and 27 J impact energy

The symbol for the solid wire electrode for use in the submerged arc welding process shall be the letters SU placed at the beginning of the solid wire electrode designation.

The symbol for the tubular cored electrode for use in the submerged arc welding process shall be the letters TU placed at the beginning of the tubular cored electrode designation.

4.2 Symbols for the tensile properties of the all-weld metal deposit

4.2A Classification by yield strength and 47 J impact energy

The symbol in Table 1A indicates yield strength, tensile strength and elongation of the all-weld metal in the as-welded condition or after stress relief 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, yield 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, with a particular flux.

Table 1A — Symbol for the tensile properties
(classification by yield strength and 47 J impact energy)

Symbol	Minimum [a] yield strength MPa	Tensile strength MPa	Minimum [b] elongation %
55	550	640 to 820	18
62	620	700 to 890	18
69	690	770 to 940	17
79	790	880 to 1 080	16
89	890	940 to 1 180	15

[a] For yield strength, the lower yield (ReL) shall be used when yielding occurs, otherwise the 0,2% proof strength (Rp 0,2) shall be used.

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

Table 1B — Symbol for the tensile properties
(classification by tensile strength and 27 J impact energy)

Symbol [a]	Minimum [b] yield strength MPa	Tensile strength MPa	Minimum [b] elongation %
59X	490	590 to 790	16
62X	500	620 to 820	15
69X	550	690 to 890	14
76X	670	760 to 960	13
78X	670	780 to 980	13
83X	740	830 to 1 030	12

[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] Yield strength at 0,2 % offset and gauge length is five times the test specimen diameter.

4.3 Symbol for the impact properties of all-weld metal

The symbol in Table 2 indicates the temperature at which an average impact energy of 47 J or 27 J is achieved under the conditions given in Clause 5 in the as-welded condition or after post weld heat treatment.

4.3A Classification by yield strength and 47 J impact energy

Three test specimens shall be tested. The average value shall be at least 47 J. 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.

Table 2 — Symbol for the impact properties of all-weld metal

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

[a] When classified in accordance with 4.3A.

[b] When classified in accordance with 4.3B.

4.4 Symbol for the type of welding flux

The symbols in Table 3 indicate the types of welding flux in accordance with ISO 14174.

Table 3 — Symbol for type of welding flux

Type of flux	Symbol
Manganese-silicate	MS
Calcium-silicate	CS
Calcium-magnesium	CG
Calcium-magnesium-basic	CB
Calcium-magnesium-iron	CI
Calcium-magnesium-iron-basic	IB
Zirconium-silicate	ZS
Rutile-silicate	RS
Aluminate-rutile	AR
Aluminate-basic	AB
Aluminate-silicate	AS
Aluminate-fluoride-basic	AF
Fluoride-basic	FB
Any other type	Z

4.5 Symbol for the chemical composition of solid wire electrodes and of all-weld metal from tubular cored electrode/flux combinations

The symbol in Table 4 indicates the chemical composition of the solid wire electrode, determined under the conditions given in Clause 6.