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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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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

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

This third edition cancels and replaces the second edition (ISO 26304:2011), which has been technically revised. The main changes compared to the previous edition are as follows:

— the chemical compositions of a number of solid wire electrodes and all-weld metal from tubular cored electrode-flux combinations have been changed;

— H2 and H4 are now options for hydrogen content;

— an example of a Z designation has been added to Clause 11.

Requests for official interpretations of any aspect of this document 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 document recognizes that there are two somewhat different approaches in the global market to classifying a given solid 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 in accordance with this document. The classification in accordance with system A was originally based on EN 14295. The classification in accordance with system B is mainly based on standards used around the Pacific Rim. Future revisions aim to merge the two approaches into a single classification system.

This document provides a classification 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, elongation, and impact properties 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 metal yield strength does not necessarily ensure that the weld metal tensile strength matches that of the parent material. Thus, where the application requires matching tensile strength, 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 can have the same classification, it is possible that the combination of an electrode with a flux from one manufacturer and the same electrode with the flux from another manufacturer — both fluxes having the same classification — might not be interchangeable unless verified in accordance with this document. Two tubular cored wires of the same classification can likewise produce different results with the same flux.

The mechanical properties of the 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, width of weave, welding position, and material composition.

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

1 Scope

This document specifies requirements for classification of solid wire electrodes, tubular cored electrodes, and electrode-flux combinations (the 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 on the yield strength and average impact energy of 47 J for the all-weld metal, or utilizing a system based on the tensile strength and average impact energy of 27 J for the all-weld metal.

a) Clauses, subclauses and tables which carry the suffix letter "A" are applicable only to solid wire electrodes, tubular cored electrodes and the all-weld metal deposits classified to the system based on the yield strength and the average impact energy of 47 J for the all-weld metal obtained with electrode-flux combinations in accordance with this document.

b) Clauses, subclauses and tables which carry the suffix letter "B" are applicable only to solid wire electrodes, tubular cored electrodes and the all-weld metal deposits classified to the system based on the tensile strength and the average impact energy of 27 J for the all-weld metal obtained with electrode-flux combinations in accordance with this document.

c) Clauses, subclauses 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 document.

For comparison purposes, some tables include requirements for electrodes classified in accordance with both systems, placing individual electrodes from the two systems, which are similar in composition and properties, on adjacent lines in the particular table. In a particular line of the table that is mandatory in one system, the symbol for the similar electrode from the other system is indicated in parentheses. By appropriate restriction of the formulation of a particular electrode, it is often, but not always, possible to produce an electrode that can be classified in both systems, in which case the electrode, or its packaging, can be marked with the classification in either or both systems.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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*. Amended by ISO 15792-1:2000/Amd 1:2011

ISO 80000-1:2009, *Quantities and units — Part 1: General*. Corrected by ISO 80000-1:2009/ Cor 1:2011

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Classification

4.1 General

Classification designations are based on 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 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 specific flux. The two designation approaches include additional designators for some other classification requirements, but not all, as is clear from the following clauses. 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 the all-weld metal properties obtained with a specific electrode-flux combination as given in 4.1A and 4.1B. A solid wire electrode shall be classified in accordance with its chemical composition in Table 3.

A tubular cored electrode shall be classified in accordance with the all-weld metal deposit composition in Table 4, obtained with a specific 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 5 as appropriate.

4.1A 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 or process to be identified;

4.1B 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 or process to be identified;

2) the second part gives a symbol indicating the tensile properties 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 2);

4) the fourth part gives a symbol indicating the type of flux used (see 5.4);

5) the fifth part gives a symbol indicating the chemical composition of the solid wire electrode used (see Table 3) or of the all-weld metal deposited by a tubular cored electrode-flux combination (see Table 4);

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

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

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 the 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 5.4);

5) the fifth part gives a symbol indicating the chemical composition of the solid wire electrode used (see Table 3), or of the all-weld metal deposited by a tubular cored electrode-flux combination (see Table 4);

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

5 Symbols and requirements

5.1 General

A solid wire electrode can be classified separately based on its chemical composition, as specified in Table 3. The all-weld metal deposit composition and mechanical properties obtained with a particular solid wire electrode or tubular cored electrode vary somewhat depending on the flux used. Accordingly, the classification of the all-weld metal deposit obtained with a particular solid wire electrode or tubular cored electrode can be different for different fluxes. However, deposit composition is only a classification requirement for tubular cored electrode-flux combinations.

5.2 Symbol for the product or process

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

5.2A 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.

5.2B 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.

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

5.3A 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 after stress relief treatment in accordance with 5.6A, determined in accordance with Clause 6 (A-side).

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

Symbol[a]	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 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.

5.3B 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 in accordance with 5.6B, determined in accordance with Clause 6 (B-side).

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

Symbol[a]	Minimum yield strength[b] MPa	Tensile strength MPa	Minimum elongation[c] %
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] 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.

