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Welding consumables — Tubular cored electrodes for gas shielded and non-gas shielded metal arc welding of non-alloy and fine grain steels — Classification

Produits consommables pour le soudage — Fils-électrodes fourrés pour soudage à l'arc avec ou sans gaz de protection des aciers non alliés et des aciers à grains fins — Classification

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Foreword

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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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 44, *Welding and allied processes*, Subcommittee SC 3, *Welding consumables*.

This second edition cancels and replaces the first edition (ISO 17632:2004), 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, through your national standards body, a complete listing of which can be found at www.iso.org.

Introduction

This International Standard provides a classification system for tubular cored electrodes in terms of tensile properties, impact properties, chemical composition of the all-weld metal, type of electrode core, shielding gas, and welding position. The ratio of yield to tensile strength of weld metal is generally higher than that of the parent metal. Matching weld metal yield strength to parent metal yield strength will not necessarily ensure that the weld metal tensile strength matches that of the parent metal. Where the application requires matching tensile strengths, selection of consumables is made by reference to column 3 of Table 1A or Table 1B.

Of note is that the mechanical properties of all-weld metal test specimens used to classify the tubular cored electrodes will vary from those obtained in production joints because of the differences in welding procedure such as electrode size, width of weave, welding position, and parent metal composition.

The classification in accordance with system A is mainly based on EN 758:1997. The classification in accordance with system B is mainly based upon standards used around the Pacific Rim.

Welding consumables — Tubular cored electrodes for gas shielded and non-gas shielded metal arc welding of non-alloy and fine grain steels — Classification

1 Scope

This International Standard specifies requirements for classification of tubular cored electrodes with or without a gas shield for metal arc welding of non-alloy and fine grain steels in the as-welded condition or in the post-weld heat-treated condition with a minimum yield strength of up to 500 MPa or a minimum tensile strength of up to 570 MPa. One tubular cored electrode can be tested and classified with different shielding gases, if any.

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

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

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

3) Paragraphs and tables which have neither the suffix letter “A” nor the suffix letter “B” are applicable to all tubular cored electrodes classified in accordance with this International Standard.

It is recognized that the operating characteristics of tubular cored electrodes can be modified by the use of pulsed current, but for the purposes of this International Standard, pulsed current is not permitted for determining the electrode classification.

2 Normative references

The following referenced documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 6947:2011, *Welding and allied processes — Welding positions*

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

ISO 14175, *Welding consumables — Gases and gas mixtures for fusion welding and allied processes*

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

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

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

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. 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 (see Annex A).

The classification includes all-weld metal properties obtained with a tubular cored electrode and appropriate shielding gas combination as given below. With the exception of the symbol for welding position which is based on ISO 15792-3, the classification of gas shielded tubular cored electrodes is based on the 1,2 mm electrode size or if this size is not manufactured, the next larger diameter manufactured. The classification of self-shielded tubular cored electrodes is based on the 2,4 mm diameter or the largest diameter manufactured if less than 2,4 mm.

3.1A Classification by yield strength and 47 J impact energy

The classification is divided into eight parts.

1) The first part (T) indicates a tubular cored electrode.

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

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

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

5) The fifth part gives a symbol indicating the type of electrode core (see Table 5A).

6) The sixth part gives a symbol indicating the shielding gas (see 4.6).

3.1B Classification by tensile strength and 27 J impact energy

The classification is divided into nine parts.

1) The first part (T) indicates a tubular cored electrode.

2) The second part gives a symbol indicating the tensile strength and elongation of all-weld metal for multi-run technique or the strength of the parent material used in classification for the single-run technique (see Table 1B or Table 2B).

3) The third part gives a symbol indicating the impact properties of all-weld metal (see Table 3). The symbol "U" added as an optional supplemental designator at or near the end of the complete tubular cored electrode designation 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 usability characteristics of the electrode (see Table 5B).

5) The fifth part gives a symbol indicating the welding position (see Table 6B).

6) The sixth part gives a symbol indicating the shielding gas (see 4.6). The letter "S" added to this designator indicates that the electrode is classified for single-pass welding.

7) The seventh part gives a symbol indicating the welding position (see Table 6A);

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

7) The seventh part gives a symbol indicating whether the classification tests were conducted in the as-welded (A) or post-weld heat-treated condition (P). If the electrode has been classified in both conditions, the symbol AP shall be added to the classification. This designator is omitted in the classification for single-pass welding electrodes as these are tested only in the as-welded condition;

8) The eighth part gives a symbol indicating the chemical composition of all-weld metal (see Table 4B). The symbol is omitted for weld deposits conforming to the "No symbol" in Table 4B.

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

Electrodes can be classified under any number of classifications for either or both the as-welded and post-weld heat-treated condition.

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

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

a) Compulsory section

This section includes the symbols for type of product, strength and elongation, impact properties, chemical composition, type of electrode core, and shielding gas, i.e. the symbols defined in 4.1, 4.2.1A, 4.2.2, 4.3A, 4.4, 4.5A, and 4.6.

b) Optional section

This section includes the symbols for the welding positions for which the electrode is suitable and the symbol for hydrogen content, i.e. the symbols defined in 4.7 and 4.8.

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

a) Compulsory section

This section includes the symbols for type of product, strength and elongation in the as-welded condition or post-weld heat-treated condition, welding positions for which the electrode is suitable, usability characteristics, shielding gas, impact properties, and chemical composition, i.e. the symbols defined in 4.1, 4.2.1B, 4.2.2, 4.3B, 4.4, 4.5B, 4.6, 4.7, and 4.9B.

b) Optional section

This section includes the symbol "U" to indicate that the weld metal has an average of 47 J impact energy at the classification test temperature and the symbol for hydrogen content, i.e. the symbol "U" defined in 4.3B and the symbols defined in 4.8.

The full designation shall comprise the compulsory symbols and can include optional symbols chosen by the manufacturer. The full designation (see Clause 10) shall be used on packages and in the manufacturer's literature and data sheets.

4 Symbols and requirements

4.1 Symbol for the product/process

The symbol for the tubular cored electrode used in the metal arc welding process is the letter T.

4.2 Symbol for tensile properties of all-weld metal or welded joint

4.2.1 Multi-run technique

4.2.1A Classification by yield strength and 47 J impact energy

For products suitable for single- and multi-run welding, the symbol in Table 1A indicates 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 electrodes suitable for single- and multi-run welding, the symbol in Table 1B indicates 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.

Classification of products suitable for both single- and multi-run welding does not require the single-run test of 5.2.

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

Symbol	Minimum yield strength[a]	Tensile strength	Minimum elongation[b]
	MPa	MPa	%
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, 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 — Symbol for tensile properties by multi-run technique (classification by tensile strength and 27 J impact energy)

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

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

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

4.2.2 Single-run technique

For tubular cored electrodes suitable for single-run welding only, the symbol in Table 2A or Table 2B indicates strength of the welded joint in the as-welded condition in relation to the parent material used in single-run tests satisfactorily completed in accordance with 5.2.

Table 2A — Symbol for tensile properties by single-run technique (classification by yield strength and 47 J impact energy)

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

Table 2B — Symbol for tensile properties by single-run technique (classification by tensile strength and 27 J impact energy)

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

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

4.3A Classification by yield strength and 47 J impact energy

The symbol in Table 3 indicates the temperature at which an impact energy of 47 J is achieved under the conditions given in 5.1A or 5.2. Three test specimens shall be tested. Only one individual value can be lower than 47 J, but not lower than 32 J.

4.3B Classification by tensile strength and 27 J impact energy

The symbol in Table 3 indicates 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 5.1B or 5.2. 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 can be lower, but shall be no less than 20 J. The average of the three remaining values shall be at least 27 J. Three test specimens shall be tested when the optional supplemental designator "U" is used to indicate that the weld deposit will meet a minimum impact energy of 47 J at the test temperature. The impact value shall be determined by the average of the three test specimens. The average of three values shall be 47 J or greater. Only one individual value can be lower than 47 J, but not lower than 32 J.

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

NOTE Impact testing is not required to classify electrodes for the single-run technique.

Table 3 — Symbol 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[c] °C
Z[a]	No requirements
A[b] or Y[c]	+20
0	0
2	−20
3	−30
4	−40
5	−50
6	−60
7	−70
8	−80
9	−90
10	−100

[a] Only the symbol Z is used for electrodes for the single-run technique.

[b] Classification by yield strength and 47 J impact energy.

[c] Classification by tensile strength and 27 J impact energy.

4.4 Symbol for chemical composition of all-weld metal

The symbol in Table 4A or Table 4B indicates the chemical composition of all-weld metal determined in accordance with Clause 6.