International Standard

ISO 18276

Third edition
2024-07

Welding consumables — Tubular cored electrodes for gas-shielded and non-gas-shielded metal arc welding of high strength steels — Classification

Produits consommables pour le soudage — Fils-électrodes fourrés pour le soudage à l'arc avec ou sans gaz de protection des aciers à haute résistance — Classification

Reference number
ISO 18276:2024(en)

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Published in Switzerland

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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 document 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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This document was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 3, *Welding consumables*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 121, *Welding and allied processes*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 18276:2017), which has been technically revised.

The main changes are as follows:

— document has been reformatted in single column format. Some clauses and subclauses have been merged or separated and some tables have been merged;

— dated normative references have been updated to the latest editions;

— Tables 3A and 3B have been revised and merged and is now Table 6;

— sub-clause 5.7 has been revised and is now 5.8;

— Clause 11 contains new designation examples.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html. Official interpretations of ISO/TC 44 documents, where they exist, are available from this page: https://committee.iso.org/sites/tc44/home/interpretation.html.

Introduction

This document proposes a classification system for tubular cored electrodes in terms of the tensile properties, impact properties, chemical composition of the all-weld metal, type of electrode core, shielding gas and welding position. The ratio of yield strength to tensile strength of the weld metal is generally higher than that of the parent metal. 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 metal. Where the application requires matching tensile strength, therefore, selection of the consumable should be made by reference to columns 3 and 7 of Table 3.

Note that the mechanical properties of all-weld metal test specimens used to classify tubular cored electrodes differ from those obtained with production joints because of 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 12535. 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 high strength steels — Classification

1 Scope

This document specifies the requirements for classification of tubular cored electrodes with or without a gas shield for metal arc welding of high-strength steels in the as-welded condition or in the post-weld heat-treated condition with a minimum yield strength higher than 550 MPa or a minimum tensile strength higher than 590 MPa. One tubular cored electrode can be tested and classified with different shielding gases, if used with more than one.

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

— Subclauses and tables which carry the suffix "system A" are applicable only to tubular cored electrodes classified under the system based upon the yield strength and an average impact energy of 47 J of the all-weld metal given in this document.

— Subclauses and tables which carry the suffix "system B" are applicable only to tubular cored electrodes classified under the system based upon the tensile strength and an average impact energy of 27 J of the all-weld metal given in this document.

— Subclauses and tables which do not have either the suffix "system A" or the suffix "system B" are applicable to all tubular cored electrodes classified under this document.

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 document, pulsed current is not used for determining the electrode classification.

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 6947, *Welding and allied processes — Welding positions*

ISO 13916, *Welding — 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, *Welding consumables — Test methods — Part 1: Preparation of all-weld metal test pieces and specimens in steel, nickel and nickel alloys*

ISO 80000-1:2022, *Quantities and units — Part 1: General*

3 Terms and definitions

No terms and definitions are listed in this document.

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

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

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

4 Classification

4.1 General

Classification designations are based upon two approaches to indicate the tensile properties and the impact properties of the all-weld metal obtained with a given electrode. The two designation approaches include additional designators for some other classification requirements, but not all, as will be clear from the following subclauses. In most cases, a given commercial product can be classified under both systems. Then, either or both classification designations can be used for the product. Annex A gives figures that explain how the classification systems are structured. Annex B gives information on composition designations for electrodes in the classification system based upon tensile strength and average impact energy of 27 J.

The classification includes all-weld metal properties obtained with a tubular cored electrode and appropriate shielding gas combination as given in 4.2. With the exception of the symbol for welding position, the classification of gas-shielded tubular cored electrodes is based on an electrode size of 1,2 mm or, if this size is not manufactured, the next largest diameter manufactured and the classification of self-shielded tubular cored electrodes is based on a diameter of 2,4 mm or the largest diameter manufactured if less than 2,4 mm.

4.2 Classification systems

Each classification system, A and B, is split into nine parts as given in Table 1.

Table 1 — Parts of the classification systems, A and B

Part of classification designation	Classification system	
	System A Classification by yield strength and 47 J impact energy	System B Classification by tensile strength and 27 J impact energy
1	T indicates a tubular cored electrode.	
2	symbol indicating the strength and elongation of the all-weld metal in the as-welded or post-weld heat-treated condition (see Table 3).	
3	symbol indicating the impact properties of the all-weld metal (see Table 4 and 5).	symbol indicating the impact properties of the all-weld metal (see Table 4 and 5). 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	symbol indicating the chemical composition of the all-weld metal (see Table 6)	symbol indicating the usability characteristics of the electrode (see Table 8)
5	symbol indicating the type of electrode core (see Table 7).	symbol indicating the welding position (see Table 9).
6	symbol indicating the shielding gas (see 5.7)	
7	symbol indicating the welding position (see Table 9).	symbol indicating the classification tests were conducted in the: a) as-welded condition (A) or b) post-weld heat-treated condition (P)
8	symbol indicating the hydrogen content of the deposited metal (see Table 10).	symbol indicating the chemical composition of the all-weld metal (see Table 6)
9	symbol indicating the post-weld heat treatment if this is applied (see 5.10.1).	symbol indicating the hydrogen content of the deposited metal (see Table 10).

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 the compulsory section and can include the optional section, as given in 4.3.

4.3 Compulsory and optional sections in classifications

Table 2 gives the compulsory and optional sections in each classification system, A and B.

Table 2 — Compulsory and optional sections in classifications

Section	Classification system	
	System A **Classification by yield strength and 47 J impact energy**	**System B** **Classification by tensile strength and 27 J impact energy**
Compulsory	symbols for the: a) type of product (see 5.1); b) strength and elongation (see 5.2); c) impact properties (see 5.3); d) chemical composition (see 5.4); e) type of electrode core (see 5.5); f) shielding gas (see 5.7); and g) post-weld heat treatment (see 5.10).	symbols for the: a) type of product (see 5.1); b) strength and elongation in the as-welded condition or post-weld heat-treated condition (see 5.2); c) welding positions for which the electrode is suitable (see 5.8); d) usability characteristics (see 5.6); e) shielding gas (see 5.7); f) impact properties (se 5.3); and g) chemical composition (see 5.4).
Optional	symbols for: a) the welding positions for which the electrode is suitable (see 5.8); and b) hydrogen content (see 5.9).	a) symbol “U” to indicate that the weld metal will have an average of 47 J impact energy at the classification test temperature (see 5.3); and b) the symbol for hydrogen content (see 5.9).

The designation, compulsory section and any chosen elements of the optional section shall be used on packages and in the manufacturer's literature and data sheets.

5 Symbols and requirements

5.1 Symbol for the product or process

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

5.2 Symbol for tensile properties of all-weld metal

The symbols in Table 3 give the, tensile properties of the all-weld metal, determined in accordance with Clause 7.

Table 3 — Symbols for tensile properties of all-weld metal

System A — Classification by yield strength and 47 J impact energy				System B — Classification by tensile strength and 27 J impact energy			
Symbol	**Minimum yield strength**[a] MPa	**Tensile strength** MPa	**Minimum elongation**[b] %	**Symbol**	**Minimum yield strength**[a] MPa	**Tensile strength** MPa	**Minimum elongation**[b] %
55	550	640 to 820	18	59	490	590 to 790	16
62	620	700 to 890	18	62	530	620 to 820	15
69	690	770 to 940	17	69	600	690 to 890	14
79	790	880 to 1 080	16	76	680	760 to 960	13
89	890	940 to 1 180	15	78	680	780 to 980	13
96	960	≥ 1 180	14	83	745	830 to 1 030	12

[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.

5.3 Symbol for impact properties of all-weld metal

Table 4 gives the requirements for impact properties of the all-weld metal, determined in accordance with Clause 7.

Table 4 — Requirements for impact properties of all-weld metal

Symbol	System A — Classification by yield strength and 47 J impact energy	System B — Classification by tensile strength and 27 J impact energy
See Table 5	Indicates the temperature at which an impact energy of 47 J is achieved under the conditions given in Clause 7.	Indicates the temperature at which impact energy of 27 J is achieved in the as-welded condition or in the post-weld heat-treated condition under the conditions given in Clause 7.
	Three test specimens shall be tested. Only one individual value can be lower than 47 J but not lower than 32 J.	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 not be less than 20 J. The average of the three remaining values shall be at least 27 J. 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 5.3, System A.

When an all-weld metal has been classified for a certain temperature, it automatically covers any higher temperature in Table 5.