sISO TC 44/SC 3

Date: 2016-10-14

ISO 17633.2

ISO TC 44/SC 3

Secretariat: AFNOR

Welding consumables — Tubular cored electrodes and rods for gas shielded and non-gas shielded metal arc welding of stainless and heat-resisting steels — Classification

Produits consommables pour le soudage — Fils et baguettes fourrés pour le soudage à l'arc avec ou sans protection gazeuse des aciers inoxydables et des aciers résistant aux températures élevées — 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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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 17633:2010), which has been technically revised and contains the following changes:

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— the chemical compositions and mechanical properties for a number of alloy designations have been updated;

— new alloy designations have been added;

— a limitation on Bi has been added to the footnotes of Tables 1B-1, 1B-2, 1B-3 and 1B-4;

— the requirements for fillet weld testing have been removed following the same change in ISO 18276;

— the wording in clauses on chemical analysis, rounding procedure and retests has been updated;

— clarification has been brought when a product covers both electrodes and rods;

— additional examples for designations have been inserted.

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 provides a classification system for tubular cored electrodes and rods for welding stainless and heat resisting steels. It recognizes that there are two somewhat different approaches in the global market to classifying a given tubular stainless steel welding consumable, 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 mainly based on EN 12073:1999. The classification in accordance with system B is mainly based upon standards used around the Pacific Rim.

Welding consumables — Tubular cored electrodes and rods for gas shielded and non-gas shielded metal arc welding of stainless and heat-resisting steels — Classification

1 Scope

This document specifies requirements for classification of tubular flux and metal cored electrodes and rods, based on the all-weld metal chemical composition, the type of core, shielding gas, welding position and the all-weld metal mechanical properties, in the as-welded or heat-treated conditions, for gas shielded and non-gas shielded metal arc welding of stainless and heat-resisting steels.

This document is a combined standard providing for classification utilizing a system based upon nominal composition or utilizing a system based upon alloy type.

a) Clauses, subclauses, and tables which carry the suffix letter "A" are applicable only to products classified using the system based upon nominal composition.

b) Clauses, subclauses, and tables which carry the suffix letter "B" are applicable only to products classified using the system based upon alloy type.

c) Clauses, subclauses, and tables which do not have either the suffix letter "A" or the suffix letter "B" are applicable to all products classified in accordance with this document.

This document does not use pulsed current for determining the product 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 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 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 ~~— ISO Online browsing platform: available at~~ Classification

Classification designations are based upon two approaches to indicating the chemical composition of the all-weld metal deposit obtained with a given electrode or rod.

The "nominal composition" approach uses designation components indicating directly the nominal levels of certain alloying elements, given in a particular order, and some symbols for low but significant levels of other elements, whose levels are not conveniently expressed as integers. The "alloy type" approach uses tradition-based three- or four-digit designations for alloy families, and an occasional additional character or characters for compositional modifications of each original alloy within the family.

This clause includes the symbols for the type of product, the chemical composition of all-weld metal, the type of core, the shielding gas and the welding position, in accordance with the symbols defined in Clause 5.

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.

4A Classification according to nominal composition

The classification is divided into five parts:

a) the first part gives a symbol indicating the product to be identified (see 5.~~1A~~2A);

b) the second part gives a symbol indicating the chemical composition of the all-weld metal (see Table 1A);

c) the third part gives a symbol indicating the type of core (see Table 3A);

d) the fourth part gives a symbol indicating the shielding gas (see 5.5);

e) the fifth part gives a symbol indicating the welding position (see Table 4A).

4B Classification according to alloy type

The classification is divided into five parts:

a) the first part gives a symbol indicating the tubular cored electrode and rod (see 5.2B);

b) the second part gives a symbol indicating the chemical composition of the all-weld metal (see Table 1B-1 to Table 1B-4);

c) the third part gives a symbol indicating the type of core (see Table 3B);

d) the fourth part gives a symbol indicating the shielding gas (see 5.5);

e) the fifth part gives a symbol indicating the welding position (see Table 4B).

The full identification (see Clause 11) shall be used on packages and in the manufacturer's literature and data sheets.

5 Symbols and requirements

5.1 General

A given tubular cored electrode may be classified with more than one shielding gas. In such cases, each shielding gas results in a separate classification.

5.2 Symbol for the product

5.2A Classification according to nominal composition

The symbol for tubular cored product used in the metal arc welding process shall be the letter "T".

5.2B Classification according to alloy type

The symbol for tubular cored product used in the metal arc welding process shall be the letters "TS". The initial letter, "T", indicates tubular cored electrode or rod as distinguished from covered electrodes and from solid electrodes and rods. The second letter, "S", indicates that the alloy system is stainless or heat-resisting steel.

5.3 Symbol for the chemical composition of all-weld metal

5.3A Classification according to nominal composition

The symbols in Table 1A identify the chemical composition of all-weld metal determined in accordance with Clause 7.

The all-weld metal obtained with the tubular cored product in Table 1A under conditions given in Clause 6 shall also fulfil the requirements given in Table 2A. (See Annex A.)

5.3B Classification according to alloy type

The symbols in Table 1B-1 identify the chemical composition of all-weld metal for gas shielded flux cored electrodes determined in accordance with Clause 7.

The symbols in Table 1B-2 identify the chemical composition of all-weld metal for non-gas shielded flux cored electrodes determined in accordance with Clause 7.

The symbols in Table 1B-3 identify the chemical composition of all-weld metal for gas shielded metal cored electrodes determined in accordance with Clause 7.

The symbols in Table 1B-4 identify the chemical composition of all-weld metal for cored products for gas tungsten arc welding determined in accordance with Clause 7.

The all-weld metal obtained with the tubular cored electrodes and rods in Table 1B-1, Table 1B-2, Table 1B-3 and Table 1B-4 under conditions given in Clause 6 shall also fulfil the requirements given in Table 2B. (See Annex A.)

Table 1A — Symbols and all-weld metal chemical composition requirements (classification according to nominal composition)

Alloy designation according to nominal composition	Chemical composition, % (by mass)[a,b]											
	C	Mn	Si	P[c]	S[c]	Cr	Ni	Mo	Nb + Ta[d]	Cu	N	Others
Martensitic/ferritic types												
13	0,12	1,5	1,0	0,030	0,025	11,0 to 14,0	0,3	0,3	—	0,5	—	—
13 Ti	0,10	0,80	1,0	0,030	0,030	10,5 to 13,0	0,3	0,3	—	0,5	—	Ti: 10 × C to 1,5
13 4	0,06	1,5	1,0	0,030	0,025	11,0 to 14,5	3,0 to 5,0	0,4 to 1,0	—	0,5	—	—
17	0,12	1,5	1,0	0,030	0,025	16,0 to 18,0	0,3	0,3	—	0,5	—	—
Austenitic types												
19 9 L	0,04	2,0	1,2	0,030	0,025	18,0 to 21,0	9,0 to 11,0	0,3	—	0,5	—	—
19 9 Nb	0,08	2,0	1,2	0,030	0,025	18,0 to 21,0	9,0 to 11,0	0,3	8 × C to 1,1	0,5	—	—
19 12 3 L	0,04	2,0	1,2	0,030	0,025	17,0 to 20,0	10,0 to 13,0	2,5 to 3,0	—	0,5	—	—
19 12 3 Nb	0,08	2,0	1,2	0,030	0,025	17,0 to 20,0	10,0 to 13,0	2,5 to 3,0	8 × C to 1,1	0,5	—	—
Ferritic-austenitic types (sometimes referred to as austenitic-ferritic types)												
22 9 3 N L	0,04	2,5	1,2	0,030	0,025	21,0 to 24,0	7,5 to 10,5	2,5 to 4,0	—	0,5	0,08 to 0,20	—
23 7 N L	0,04	0,4 to 1,5	1,0	0,030	0,020	22,5 to 25,5	6,5 to 10,0	0,8	—	0,5	0,10 to 0,20	—
25 9 4 N L	0,04	2,5	1,2	0,030	0,025	24,0 to 27,0	8,0 to 10,5	2,5 to 4,5	—	—	0,20 to 0,30	—
25 9 4 Cu N L	0,04	2,5	1,2	0,030	0,025	24,0 to 27,0	8,0 to 10,5	2,5 to 4,5	—	1,0 to 2,5	0,20 to 0,30	—
Fully austenitic types												
18 16 5 N L[e]	0,03	1,0 to 4,0	1,0	0,03	0,02	17,0 to 20,0	16,0 to 19,0	3,5 to 5,0	—	0,5	0,10 to 0,20	—
19 13 4 N L[e]	0,04	1,0 to 5,0	1,2	0,030	0,025	17,0 to 20,0	12,0 to 15,0	3,0 to 4,5	—	0,5	0,08 to 0,20	—

20 25 5 Cu N L[e]	0,03	1,0 to 4,0	1,0	0,03	0,02	19,0 to 22,0	24,0 to 27,0	4,0 to 6,0	—	1,0 to 2,0	0,10 to 0,20	—
Special types — Often used for dissimilar metal joining												
18 8 Mn	0,20	4,5 to 7,5	1,2	0,035	0,025	17,0 to 20,0	7,0 to 10,0	0,3	—	0,5	—	—
18 9 Mn Mo	0,04 to 0,14	3,0 to 5,0	1,2	0,035	0,025	18,0 to 21,5	9,0 to 11,0	0,5 to 1,5	—	—	—	—
20 10 3	0,08	2,5	1,2	0,035	0,025	19,5 to 22,0	9,0 to 11,0	2,0 to 4,0	—	0,5	—	—
23 12 L	0,04	2,5	1,2	0,030	0,025	22,0 to 25,0	11,0 to 14,0	0,3	—	0,5	—	—
23 12 Nb	0,08	1,0 to 2,5	1,0	0,03	0,02	22,0 to 25,0	11,0 to 14,0	0,3	10 × C to 1,0	0,5	—	—
23 12 2 L	0,04	2,5	1,2	0,030	0,025	22,0 to 25,0	11,0 to 14,0	2,0 to 3,0	—	0,5	—	—
29 9	0,15	2,5	1,2	0,035	0,025	27,0 to 31,0	8,0 to 12,0	0,3	—	0,5	—	—
Heat-resisting types												
16 8 2	0,10	1,0	1,0 to 2,5	0,03	0,02	14,5 to 17,5	7,5 to 9,5	1,0 to 2,5	—	0,5	—	Cr + Mo: 18,5
19 9 H	0,04 to 0,08	1,0	1,0 to 2,5	0,03	0,02	18,0 to 21,0	9,0 to 11,0	0,3	—	0,5	—	—
21 10 N	0,06 to 0,09	0,3 to 1,0	1,0 to 2,0	0,02	0,01	20,5 to 22,5	9,5 to 11,0	0,5	—	0,5	0,10 to 0,20	Ce: 0,05
22 12 H	0,15	2,5	1,2	0,030	0,025	20,0 to 23,0	10,0 to 13,0	0,3	—	0,5	—	—
25 4	0,15	2,0	1,0 to 2,5	0,03	0,02	24,0 to 27,0	4,0 to 6,0	0,3	—	0,5	—	—
25 20[e]	0,06 to 0,20	1,0 to 5,0	1,2	0,030	0,025	23,0 to 27,0	18,0 to 22,0	0,3	—	0,5	—	—
Z[f]	Any other agreed composition											

~~For alloys intended for high temperature, Bi should be restricted to 20 ppm maximum.~~

[a] Single values are maximum values.

[b] "No requirement for analysis" is indicated by a dash.

[c] The sum of P and S shall not exceed 0,050 % (by mass), except for 18 16 5 N L, 18 8 Mn, and 29 9.

[d] Up to 20 % (by mass) of the amount of Nb can be replaced by Ta.

[e] The all-weld metal is in most cases fully austenitic and therefore can be susceptible to microfissuring or hot cracking. The occurrence of fissuring or cracking is reduced by increasing the weld metal manganese level and in recognition of this the manganese range is extended for a number of grades.

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

Table 1B-1 — Symbols and all-weld metal chemical composition requirements of gas shielded flux cored electrodes (classification according to alloy type)

Alloy designation according to alloy type	**Chemical composition,** % (by mass)[a,b]												
	Typical shielding gas (see 5.5)	C	Mn	Si	P	S	Cr	Ni	Mo	Nb + Ta	Cu	N	Others[c]
307	C1, M12, M21, Z	0,13	3,30 to 4,75	1,0	0,04	0,03	18,0 to 20,5	9,0 to 10,5	0,5 to 1,5	—	0,75	—	—
308	C1, M12, M21, Z	0,08	0,5 to 2,5	1,0	0,04	0,03	18,0 to 21,0	9,0 to 11,0	0,75	—	0,75	—	—
308L	C1, M12, M21, Z	0,04	0,5 to 2,5	1,0	0,04	0,03	18,0 to 21,0	9,0 to 12,0	0,75	—	0,75	—	—
308H	C1, M12, M21, Z	0,04 to 0,08	0,5 to 2,5	1,0	0,04	0,03	18,0 to 21,0	9,0 to 11,0	0,75	—	0,75	—	—
308Mo	C1, M12, M21, Z	0,08	0,5 to 2,5	1,0	0,04	0,03	18,0 to 21,0	9,0 to 11,0	2,0 to 3,0	—	0,75	—	—
308LMo	C1, M12, M21, Z	0,04	0,5 to 2,5	1,0	0,04	0,03	18,0 to 21,0	9,0 to 12,0	2,0 to 3,0	—	0,75	—	—
308N	C1, M12, M21, Z	0,10	1,0 to 4,0	1,0	0,04	0,03	20,0 to 25,0	7,0 to 11,0	0,5	—	0,5	0,12 to 0,30	

309	C1, M12, M21, Z	0,10	0,5 to 2,5	1,0	0,04	0,03	22,0 to 25,0	12,0 to 14,0	0,75	—	0,75	—	—
309L	C1, M12, M21, Z	0,04	0,5 to 2,5	1,0	0,04	0,03	22,0 to 25,0	12,0 to 14,0	0,75	—	0,75	—	—
309H	C1, M12, M21, Z	0,04 to 0,10	0,5 to 2,5	1,0	0,04	0,03	22,0 to 25,0	12,0 to 14,0	0,75	—	0,75	—	—
309Mo	C1, M12, M21, Z	0,12	0,5 to 2,5	1,0	0,04	0,03	21,0 to 25,0	12,0 to 16,0	2,0 to 3,0	—	0,75	—	—
309LMo	C1, M12, M21, Z	0,04	0,5 to 2,5	1,0	0,04	0,03	21,0 to 25,0	12,0 to 16,0	2,0 to 3,0	—	0,75	—	—
309LNb	C1, M12, M21, Z	0,04	0,5 to 2,5	1,0	0,04	0,03	22,0 to 25,0	12,0 to 14,0	0,75	0,70 to 1,00	0,75	—	—
309LNiMo	C1, M12, M21, Z	0,04	0,5 to 2,5	1,0	0,04	0,03	20,5 to 23,5	15,0 to 17,0	2,5 to 3,5	—	0,75	—	—
310	C1, M12, M21, Z	0,20	1,0 to 2,5	1,0	0,03	0,03	25,0 to 28,0	20,0 to 22,5	0,75	—	0,75	—	—
312	C1, M12, M21, Z	0,15	0,5 to 2,5	1,0	0,04	0,03	28,0 to 32,0	8,0 to 10,5	0,75	—	0,75	—	—
316	C1, M12, M21, Z	0,08	0,5 to 2,5	1,0	0,04	0,03	17,0 to 20,0	11,0 to 14,0	2,0 to 3,0	—	0,75	—	—
316L	C1, M12, M21, Z	0,04	0,5 to 2,5	1,0	0,04	0,03	17,0 to 20,0	11,0 to 14,0	2,0 to 3,0	—	0,75	—	—
316H	C1, M12, M21, Z	0,04 to 0,08	0,5 to 2,5	1,0	0,04	0,03	17,0 to 20,0	11,0 to 14,0	2,0 to 3,0	—	0,75	—	—
316LCu	C1, M12, M21, Z	0,04	0,5 to 2,5	1,0	0,04	0,03	17,0 to 20,0	11,0 to 16,0	1,25 to 2,75	—	1,0 to 2,5	—	—
317	C1, M12, M21, Z	0,08	0,5 to 2,5	1,0	0,04	0,03	18,0 to 21,0	12,0 to 14,0	3,0 to 4,0	—	0,75	—	—
317L	C1, M12, M21, Z	0,04	0,5 to 2,5	1,0	0,04	0,03	18,0 to 21,0	12,0 to 14,0	3,0 to 4,0	—	0,75	—	—