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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

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 17633 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 3, *Welding consumables*.

Introduction

This International Standard provides a classification system for tubular cored electrodes and rods for welding stainless 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 according to this International Standard.

The classification according to system A is mainly based on EN 12073:1999, *Welding consumables — Tubular cored electrodes for metal arc welding with or without a gas shield of stainless and heat-resisting steels — Classification*. The classification according to system B is mainly based upon standards used around the Pacific Rim.

Requests for official interpretations of any aspect of this International Standard should be directed to the Secretariat of ISO/TC 44/SC 3, via your national standards body, a complete listing of which can be found at www.iso.org.

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 International Standard specifies requirements for classification of tubular flux and metal cored electrodes and rods, based on the all-weld metal chemical composition, the type of electrode 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 International Standard is a combined standard providing for classification utilizing a system based upon classification according to nominal composition, or utilizing a system based upon classification according to alloy type.

1) Paragraphs and tables which carry the label “classification according to nominal composition” are applicable only to products classified to that system.

2) Paragraphs and tables which carry the label “classification according to alloy type” are applicable only to products classified to that system.

3) Paragraphs and tables which carry neither label are applicable to products classified according to either or both systems.

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 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 materials — 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 6947:1990, *Welds — Working positions — Definitions of angles of slope and rotation*

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

ISO 14175:1997, *Welding consumables — Shielding gases for arc welding and cutting*

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*

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

3 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. The two designation approaches include additional designators for all other classification requirements, but not entirely the same classification requirements, 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.

3A Classification according to nominal composition

The classification is divided into five parts:

1) The first part gives a symbol indicating the product/process to be identified (see 4.1A);
2) The second part gives a symbol indicating the chemical composition of the all-weld metal (see Table 1A);
3) The third part gives a symbol indicating the type of electrode core (see Table 3A);
4) The fourth part gives a symbol indicating the shielding gas (see 4.4);
5) The fifth part gives a symbol indicating the welding position (see Table 4A).

3B Classification according to alloy type

The classification is divided into five parts:

1) The first part gives a symbol indicating the tubular cored electrode and rod (see 4.1B);
2) The second part gives a symbol indicating the chemical composition of the all-weld metal (see Table 1B);
3) The third part gives a symbol indicating the type of tubular cored electrode or rod (see Table 3B);
4) The fourth part gives a symbol indicating the shielding gas (see 4.4);
5) The fifth part gives a symbol indicating the welding position (see Table 4B).

In order to promote the use of this International Standard, the classification is split into two sections:

a) Compulsory section

This section includes the symbols for the type of product, the chemical composition of all-weld metal, the type of electrode core and the shielding gas, viz, the symbols defined in Clause 4.

This section includes the symbols for the type of product, the chemical composition of all-weld metal, the type of electrode core, the shielding gas and the welding position, viz, the symbols defined in Clause 4.

b) Optional section

This section includes the symbol for the welding position for which the electrode is suitable, viz, the symbols defined in Table 4A.

The full identification (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

4.1A Classification according to nominal composition

The symbol for the tubular cored electrode used in the metal arc welding process shall be the letter “T”.

4.1B Classification according to alloy type

The symbol for the tubular cored electrode or rod 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.

4.2 Symbol for the chemical composition of all-weld metal

4.2A Classification according to nominal composition

The symbol in Table 1A identifies the chemical composition of all-weld metal determined in accordance with Clause 6. The all-weld metal obtained with the tubular cored electrodes in Table 1A under conditions given in Clause 5 shall also fulfil the requirements given in Table 2A. (See Annex A.)

4.2B Classification according to alloy type

The symbol in Table 1B identifies the chemical composition of all-weld metal determined in accordance with Clause 6. The all-weld metal obtained with the tubular cored electrodes and rods in Table 1B under conditions given in Clause 5 shall also fulfil the requirements given in Table 2B. (See Annex A.)

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

Alloy designation according to nominal composition	Chemical composition (percentage mass fraction) [a, b, c]												
	Shielding gas [d]	C	Mn	Si	P [e]	S [e]	Cr	Ni	Mo	Nb + Ta [f]	Cu	N	Ti
13	M, C, N	0,12	1,5	1,0	0,030	0,025	11,0 to 14,0	0,3	0,3	–	0,3	–	–
13 Ti	M, C, N	0,10	0,80	1,0	0,030	0,030	10,5 to 13,0	0,3	0,3	–	0,3	–	10 × C to 1,5
13 4	M, C, N	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	–	0,3	–	–
17	M, C, N	0,12	1,5	1,0	0,030	0,025	16,0 to 18,0	0,3	0,3	–	0,3	–	–
19 9 L	M, C, N	0,04	2,0	1,2	0,030	0,025	18,0 to 21,0	9,0 to 11,0	0,3	–	0,3	–	–
19 9 Nb	M, C, N	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	0,3	–	–
19 12 3 L	M, C, N	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	–	0,3	–	–
19 12 3 Nb	M, C, N	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	0,3	–	–
19 13 4 N L	M, C, N	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	–	0,3	0,08 to 0,20	–
22 9 3 N L	M, C, N	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	–	0,3	0,08 to 0,20	–
18 16 5 N L	M, C, N	0,04	1,0 to 4,0	1,2	0,035	0,025	17,0 to 20,0	15,5 to 19,0	3,5 to 5,0	–	0,3	0,08 to 0,20	–
18 8 Mn	M, C, N	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	–	0,3	–	–
20 10 3	M, C, N	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	–	0,3	–	–
23 12 L	M, C, N	0,04	2,5	1,2	0,030	0,025	22,0 to 25,0	11,0 to 14,0	0,3	–	0,3	–	–
23 12 2 L	M, C, N	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	–	0,3	–	–
29 9	M, C, N	0,15	2,5	1,2	0,035	0,025	27,0 to 31,0	8,0 to 12,0	0,3	–	0,3	–	–
22 12 H	M, C, N	0,15	2,5	1,2	0,030	0,025	20,0 to 23,0	10,0 to 13,0	0,3	–	0,3	–	–
25 20	M, C, N	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	–	0,3	–	–

a Single values shown in the table are maximum values.

b Tubular cored electrodes not listed in the table shall be symbolized similarly and prefixed by the letter “Z”.

c The results shall be rounded to the same number of significant figures as in the specified value using the rules in accordance with Annex B, Rule A of ISO 31-0:1992.

d The symbol N shall be used for tubular cored electrodes without a gas shield.

e The sum of P and S shall not exceed 0,050 %, except for 18 16 5 L, 18 8 Mn and 29 9.

f Up to 20 % of the amount of Nb can be replaced by Ta.

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

Alloy designation according to alloy type	Chemical composition (percentage mass fraction) [a, b, c]												
	Shielding gas (see 4.4)	C	Mn	Si	P	S	Cr	Ni	Mo	Nb + Ta	Cu	N	Ti
307	M, B, C, G	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	–	0,5	–	–
308	M, B, C, G	0,08	0,5 to 2,5	1,0	0,04	0,03	18,0 to 21,0	9,0 to 11,0	0,5	–	0,5	–	–
308L	M, B, C, G	0,04	0,5 to 2,5	1,0	0,04	0,03	18,0 to 21,0	9,0 to 12,0	0,5	–	0,5	–	–
308H	M, B, C, G	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	0,5	–	0,5	–	–
308Mo	M, B, C, G	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	–	0,5	–	–
308LMo	M, B, C, G	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	–	0,5	–	–
309	M, B, C, G	0,10	0,5 to 2,5	1,0	0,04	0,03	22,0 to 25,0	12,0 to 14,0	0,5	–	0,5	–	–
309L	M, B, C, G	0,04	0,5 to 2,5	1,0	0,04	0,03	22,0 to 25,0	12,0 to 14,0	0,5	–	0,5	–	–
309Mo	M, B, C, G	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	–	0,5	–	–
309LMo	M, B, C, G	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	–	0,5	–	–
309LNb	M, B, C, G	0,04	0,5 to 2,5	1,0	0,04	0,03	22,0 to 25,0	12,0 to 14,0	0,5	0,7 to 1,0	0,5	–	–
310	M, B, C, G	0,20	1,0 to 2,5	1,0	0,03	0,03	25,0 to 28,0	20,0 to 22,5	0,5	–	0,5	–	–
312	M, B, C, G	0,15	0,5 to 2,5	1,0	0,04	0,03	28,0 to 32,0	8,0 to 10,5	0,5	–	0,5	–	–
316	M, B, C, G	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	–	0,5	–	–
316L	M, B, C, G	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	–	0,5	–	–
316H	M, B, C, G	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	–	0,5	–	–
316LCu	M, B, C, G	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	–	–

Table 1B-1 (*continued*)

Alloy designation according to alloy type	Chemical composition (percentage mass fraction) [a, b, c]												
	Shielding gas (see 4.4)	C	Mn	Si	P	S	Cr	Ni	Mo	Nb + Ta	Cu	N	Ti
317	M, B, C, G	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	–	0,5	–	–
317L	M, B, C, G	0,04	0,5 to 2,5	1,0	0,04	0,03	18,0 to 21,0	12,0 to 16,0	3,0 to 4,0	–	0,5	–	–
318	M, B, C, G	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	8 × C to 1,0	0,5	–	–
347	M, B, C, G	0,08	0,5 to 2,5	1,0	0,04	0,03	18,0 to 21,0	9,0 to 11,0	0,5	8 × C to 1,0	0,5	–	–
347L	M, B, C, G	0,04	0,5 to 2,5	1,0	0,04	0,03	18,0 to 21,0	9,0 to 11,0	0,5	8 × C to 1,0	0,5	–	–
409	M, B, C, G	0,10	0,80	1,0	0,04	0,03	10,5 to 13,5	0,6	0,5	–	0,5	–	10 × C to 1,5
409Nb	M, B, C, G	0,12	1,2	1,0	0,04	0,03	10,5 to14,0	0,6	0,5	8 × C to 1,5	0,5	–	–
410	M, B, C, G	0,12	1,2	1,0	0,04	0,03	11,0 to 13,5	0,6	0,5	–	0,5	–	–
410NiMo	M, B, C, G	0,06	1,0	1,0	0,04	0,03	11,0 to 12,5	4,0 to 5,0	0,4 to 0,7	–	0,5	–	–
430	M, B, C, G	0,10	1,2	1,0	0,04	0,03	15,0 to 18,0	0,6	0,5	–	0,5	–	–
430Nb	M, B, C, G	0,10	1,2	1,0	0,04	0,03	15,0 to 18,0	0,6	0,5	0,5 to 1,5	0,5	–	–
16-8-2	M, B, C, G	0,10	0,5 to 2,5	0,75	0,04	0,03	14,5 to 16,5	7,5 to 9,5	1,0 to 2,0	–	0,5	–	–
2209	M, B, C, G	0,04	0,5 to 2,0	1,0	0,04	0,03	21,0 to 24,0	7,5 to 10,0	2,5 to 4,0	–	0,5	0,08 to 0,20	–
2553	M, B, C, G	0,04	0,5 to 1,5	0,75	0,04	0,03	24,0 to 27,0	8,5 to 10,5	2,9 to 3,9	–	1,5 to 2,5	0,10 to 0,20	–

a "–" signs in the table are used to indicate that these elements are not required to be analysed.

b Single values shown in the table are maximum values.

c The results shall be rounded to the same number of significant figures as in the specified value using the rules in accordance with Annex B, Rule A of ISO 31-0:1992.

Table 1B-2 — Symbol for chemical composition requirements for all-weld metal of self-shielded flux cored electrodes (classification according to alloy type)

Alloy designation according to alloy type	Chemical composition (percentage mass fraction) [a, b, c]												
	Shielding gas (see 4.4)	C	Mn	Si	P	S	Cr	Ni	Mo	Nb + Ta	Cu	N	Ti
307	N	0,13	3,30 to 4,75	1,0	0,04	0,03	19,5 to 22,0	9,0 to 10,5	0,5 to 1,5	–	0,5	–	–
308	N	0,08	0,5 to 2,5	1,0	0,04	0,03	19,5 to 22,0	9,0 to 11,0	0,5	–	0,5	–	–
308L	N	0,03	0,5 to 2,5	1,0	0,04	0,03	19,5 to 22,0	9,0 to 12,0	0,5	–	0,5	–	–
308H	N	0,04 to 0,08	0,5 to 2,5	1,0	0,04	0,03	19,0 to 22,0	9,0 to 11,0	0,5	–	0,5	–	–
308Mo	N	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	–	0,5	–	–
308LMo	N	0,03	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	–	0,5	–	–
308HMo	N	0,07 to 0,12	1,25 to 2,25	0,25 to 0,80	0,04	0,03	19,0 to 21,5	9,0 to 10,7	1,8 to 2,4	–	0,5	–	–
309	N	0,10	0,5 to 2,5	1,0	0,04	0,03	23,0 to 25,5	12,0 to 14,0	0,5	–	0,5	–	–
309L	N	0,03	0,5 to 2,5	1,0	0,04	0,03	23,0 to 25,5	12,0 to 14,0	0,5	–	0,5	–	–
309Mo	N	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	–	0,5	–	–
309LMo	N	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	–	0,5	–	–
309LNb	N	0,03	0,5 to 2,5	1,0	0,04	0,03	23,0 to 25,5	12,0 to 14,0	0,5	0,7 to 1,0	0,5	–	–
310	N	0,20	1,0 to 2,5	1,0	0,03	0,03	25,0 to 28,0	20,0 to 22,5	0,5	–	0,5	–	–
312	N	0,15	0,5 to 2,5	1,0	0,04	0,03	28,0 to 32,0	8,0 to 10,5	0,5	–	0,5	–	–
316	N	0,08	0,5 to 2,5	1,0	0,04	0,03	18,0 to 20,5	11,0 to 14,0	2,0 to 3,0	–	0,5	–	–
316L	N	0,03	0,5 to 2,5	1,0	0,04	0,03	18,0 to 20,5	11,0 to 14,0	2,0 to 3,0	–	0,5	–	–
316H	N	0,04 to 0,08	0,5 to 2,5	1,0	0,04	0,03	18,0 to 20,5	11,0 to 14,0	2,0 to 3,0	–	0,5	–	–
316LCu	N	0,03	0,5 to 2,5	1,0	0,04	0,03	18,0 to 20,5	11,0 to 16,0	1,25 to 2,75	–	1,0 to 2,5	–	–

Table 1B-2 (*continued*)

Alloy designation according to alloy type	Chemical composition (percentage mass fraction) [a, b, c]												
	Shielding gas (see 4.4)	C	Mn	Si	P	S	Cr	Ni	Mo	Nb + Ta	Cu	N	Ti
317	N	0,08	0,5 to 2,5	1,0	0,04	0,03	18,5 to 21,0	13,0 to 15,0	3,0 to 4,0	–	0,5	–	–
317L	N	0,03	0,5 to 2,5	1,0	0,04	0,03	18,5 to 21,0	13,0 to 15,0	3,0 to 4,0	–	0,5	–	–
318	N	0,08	0,5 to 2,5	1,0	0,04	0,03	18,0 to 20,5	11,0 to 14,0	2,0 to 3,0	8 × C to 1,0	0,5	–	–
347	N	0,08	0,5 to 2,5	1,0	0,04	0,03	19,0 to 21,5	9,0 to 11,0	0,5	8 × C to 1,0	0,5	–	–
347L	N	0,04	0,5 to 2,5	1,0	0,04	0,03	19,0 to 21,5	9,0 to 11,0	0,5	8 × C to 1,0	0,5	–	–
409	N	0,10	0,80	1,0	0,04	0,03	10,5 to 13,5	0,6	0,5	–	0,5	–	10 × C to 1,5
409Nb	N	0,12	1,0	1,0	0,04	0,03	10,5 to 14,0	0,6	0,5	8 × C to 1,5	0,5	–	–
410	N	0,12	1,0	1,0	0,04	0,03	11,0 to 13,5	0,6	0,5	–	0,5	–	–
410NiMo	N	0,06	1,0	1,0	0,04	0,03	11,0 to 12,5	4,0 to 5,0	0,4 to 0,7	–	0,5	–	–
430	N	0,10	1,0	1,0	0,04	0,03	15,0 to 18,0	0,6	0,5	–	0,5	–	–
430Nb	N	0,10	1,0	1,0	0,04	0,03	15,0 to 18,0	0,6	0,5	0,5 to 1,5	0,5	–	–
16-8-2	N	0,10	0,5 to 2,5	0,75	0,04	0,03	14,5 to 16,5	7,5 to 9,5	1,0 to 2,0	–	0,5	–	–
2209	N	0,04	0,5 to 2,0	1,0	0,04	0,03	21,0 to 24,0	7,5 to 10,0	2,5 to 4,0	–	0,5	0,08 to 0,20	–
2553	N	0,04	0,5 to 1,5	0,75	0,04	0,03	24,0 to 27,0	8,5 to 10,5	2,9 to 3,9	–	1,5 to 2,5	0,10 to 0,20	–

a "–" signs in the table are used to indicate that these elements are not required to be analysed.

b Single values shown in the table are maximum values.

c The results shall be rounded to the same number of significant figures as in the specified value using the rules in accordance with Annex B, Rule A of ISO 31-0:1992.

Table 1B-3 — Symbol for chemical composition requirements for all-weld metal of gas shielded metal cored electrodes (classification according to alloy type)

Alloy designation according to alloy type	Chemical composition (percentage mass fraction) [a, b, c]												
	Shielding gas (see 4.4)	C	Mn	Si	P	S	Cr	Ni	Mo	Nb + Ta	Cu	N	Ti
308L	A M	0,03 0,04	1,0 to 2,5 0,5 to 2,5	0,30 to 0,65 1,0	0,03 0,04	0,03	19,5 to 22,0 18,0 to 21,0	9,0 to 11,0 9,0 to 12,0	0,75	–	0,75	–	–
308Mo	A, M	0,08	1,0 to 2,5	0,30 to 0,65	0,03	0,03	18,0 to 21,0	9,0 to 12,0	2,0 to 3,0	–	0,75	–	–
309L	A M	0,03 0,04	1,0 to 2,5 0,5 to 2,5	0,30 to 0,65 1,0	0,03 0,04	0,03	23,0 to 25,0 22,0 to 25,0	12,0 to 14,0	0,75	–	0,75	–	–
309LMo	A M	0,03 0,04	1,0 to 2,5 0,5 to 2,5	0,30 to 0,65 1,0	0,03 0,04	0,03	23,0 to 25,0 21,0 to 25,0	12,0 to 14,0 12,0 to 16,0	2,0 to 3,0	–	0,75	–	–
316L	A M	0,03 0,04	1,0 to 2,5 0,5 to 2,5	0,30 to 0,65 1,0	0,03 0,04	0,03	18,0 to 20,0 17,0 to 20,0	11,0 to 14,0	2,0 to 3,0	–	0,75	–	–
347	A M	0,08	1,0 to 2,5 0,5 to 2,5	0,30 to 0,65 1,0	0,04	0,03	19,0 to 21,5 18,0 to 21,0	9,0 to 11,0	0,75	10 × C to 1,0 8 × C to 1,0	0,75	–	–
409	A	0,08	0,8	0,8	0,03	0,03	10,5 to 13,5	0,6	0,75	–	0,75	–	10 × C to 1,5
409Nb	A, M	0,12	1,2	1,0	0,04	0,03	10,5 to 14,0	0,6	0,75	8 × C to 1,5	0,75	–	–
410	A M	0,12	0,6 1,2	0,5 1,0	0,03 0,04	0,03	11,5 to 13,5 11,0 to 13,5	0,6	0,75	–	0,75	–	–
410NiMo	A M	0,06	0,6 1,0	0,5 1,0	0,03 0,04	0,03	11,0 to 12,5	4,0 to 5,0	0,4 to 0,7	–	0,75	–	–
430	A M	0,10	0,6 1,2	0,5 1,0	0,03 0,04	0,03	15,5 to 17,0 15,0 to 18,0	0,6	0,75	–	0,75	–	–
430Nb	A, M	0,10	1,2	1,0	0,04	0,03	15,0 to 18,0	0,6	0,75	0,5 to 1,5	0,75	–	–

a "–" signs in the table are used to indicate that these elements are not required to be analysed.

b Single values shown in the table are maximum values.

c The results shall be rounded to the same number of significant figures as in the specified value using the rules in accordance with Annex B, Rule A of ISO 31-0:1992.

Table 1B-4 — Symbol for chemical composition requirements for all-weld metal of cored rods for gas tungsten arc welding (classification according to alloy type)

Alloy designation according to alloy type	Chemical composition (percent mass fraction) [a, b, c]												
	Shielding gas (see 4.4B)	C	Mn	Si	P	S	Cr	Ni	Mo	Nb + Ta	Cu	N	Ti
308L	I	0,03	0,5 to 2,5	1,2	0,04	0,03	18,0 to 21,0	9,0 to 11,0	0,5	–	0,5	–	–
309L	I	0,03	0,5 to 2,5	1,2	0,04	0,03	22,0 to 25,0	12,0 to 14,0	0,5	–	0,5	–	–
316L	I	0,03	0,5 to 2,5	1,2	0,04	0,03	17,0 to 20,0	11,0 to 14,0	2,0 to 3,0	–	0,5	–	–
347	I	0,08	0,5 to 2,5	1,2	0,04	0,03	18,0 to 21,0	9,0 to 11,0	0,5	8 × C to 1,0	0,5	–	–

[a] "–" signs in the table are used to indicate that these elements are not required to be analysed.

[b] Single values shown in the table are maximum values.

[c] The results shall be rounded to the same number of significant figures as in the specified value using the rules in accordance with Annex B, Rule A of ISO 31-0:1992.

Table 2A — Tensile properties of all-weld metal (classification according to nominal composition)

Alloy designation according to nominal composition	Minimum proof strength MPa	Minimum tensile strength MPa	Minimum [a] elongation %	Post weld heat treatment
13	250	450	15	[b]
13 Ti	250	450	15	[b]
13 4	500	750	15	[c]
17	300	450	15	[d]
19 9 L	320	510	30	None
19 9 Nb	350	550	25	
19 12 3 L	320	510	25	
19 12 3 Nb	350	550	25	
19 13 4 N L	350	550	25	
22 9 3 N L	450	550	20	
18 16 5 N L	300	480	25	
18 8 Mn	350	500	25	
20 10 3	400	620	20	
23 12 L	320	510	25	
23 12 2 L	350	550	25	
29 9	450	650	15	
22 12 H	350	550	25	
25 20	350	550	20	

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

[b] The weld test assembly (or the blank from it, from which the tensile test specimen is to be machined) shall be heated to a temperature between 840 °C and 870 °C, held for 2 h, furnace cooled to 600 °C, then cooled in air.

[c] The weld test assembly (or the blank from it, from which the tensile test specimen is to be machined) shall be heated to a temperature between 580 °C and 620 °C, held for 2 h, then cooled in air.

[d] The weld test assembly (or the blank from it, from which the tensile test specimen is to be machined) shall be heated to a temperature between 760 °C and 790 °C, held for 2 h, furnace cooled to 600 °C, then cooled in air.

Table 2B — Tensile properties of all-weld metal (classification according to alloy type)

Alloy designation according to alloy type	Minimum tensile strength MPa	Minimum elongation [a] %	Post weld heat treatment
307	590	25	None
308	550	30	
308L	520	30	
308H	550	30	
308Mo	550	30	
308LMo	520	30	
308HMo	550	30	
309	550	25	
309L	520	25	
309Mo	550	15	
309LMo	520	15	
309LNb	520	25	
310	550	25	
312	660	15	
316	520	25	
316L	485	25	
316H	520	25	
316LCu	485	25	
317	550	20	
317L	520	20	
318	520	20	
347	520	25	
347L	520	25	
409	450	15	
409Nb	450	15	[b]
410	480	15	[b]
410NiMo	760	10	[c]
430	450	15	[d]
430Nb	450	13	[d]
16-8-2	520	25	None
2209	690	15	
2553	760	13	

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

[b] The weld test assembly (or the blank from it, from which the tensile test specimen is to be machined) shall be heated to a temperature between 730 °C and 760 °C, held for 1 h, furnace cooled to 315 °C, then cooled in air.

[c] The weld test assembly (or the blank from it, from which the tensile test specimen is to be machined) shall be heated to a temperature between 590 °C and 620 °C, held for 1 h, then cooled in air.

[d] The weld test assembly (or the blank from it, from which the tensile test specimen is to be machined) shall be heated to a temperature between 760 °C and 790 °C, held for 2 h, furnace cooled to 600 °C, then cooled in air.

4.3 Symbol for type of electrode core

The symbols in Tables 3A and 3B indicate different type of tubular cored electrodes and rods relative to their core composition and slag characteristics.

Table 3A — Symbol for type of electrode core (classification according to nominal composition)

Symbol	Characteristics
R	Rutile, slow-freezing slag
P	Rutile, fast-freezing slag
M	Metal powder
U	Self-shielding
Z	Other types
(See Annex B)	

Table 3B — Symbol for type of tubular cored electrode and rod (classification according to alloy type)

Symbol	Characteristics
F	Flux cored electrodes
M	Metal cored electrodes
R	Cored rods for gas tungsten arc welding
(See Annex C)	

4.4 Symbol for shielding gas

The symbols M, C, and I indicate shielding gas as described in ISO 14175:1997.

The symbol C shall be used when the classification has been performed with shielding gas ISO 14175-C1, carbon dioxide.

The symbol N shall be used for tubular cored electrodes without a gas shield.

4.4A Classification according to nominal composition

The symbol M, for mixed gases, shall be used when the classification has been performed with shielding gas ISO 14175-M2, but without helium.

4.4B Classification according to alloy type

The symbol M shall be used when the classification has been performed with shielding gas ISO 14175-M21, but restricted to Ar + 20 % to 25 % CO_2.

The symbol B shall be used when the classification has been performed both with shielding gas ISO 14175-M21 (restricted as above) and with shielding gas ISO 14175-C1 (carbon dioxide).

The symbol A shall be used when the classification has been performed with shielding gas ISO 14175-M13, argon plus up to 3 % O_2 gas.

The symbol I shall be used when the classification has been performed with shielding gas ISO 14175-I-1, argon.

The symbol G is used for an unspecified shielding gas.

4.5 Symbol for welding position

The symbols in Tables 4A and 4B indicate the positions for which the electrode is suitable in accordance with ISO 15792-3. PA, PB, PC, PD, PE, PF and PG are the symbols specified in ISO 6947:1990. See Clause 7 for testing requirements.

Table 4A — Symbol for welding position (classification according to nominal composition)

Symbol	Welding positions [a]
1	PA, PB, PC, PD, PE, PF and PG
2	PA, PB, PC, PD, PE and PF
3	PA and PB
4	PA
5	PA, PB and PG

[a] PA = Flat position
PB = Horizontal vertical position
PC = Horizontal position
PD = Horizontal overhead position
PE = Overhead position
PF = Vertical up position
PG = Vertical down position

Table 4B — Symbol for welding position (classification according to alloy type)

Symbol	Welding positions [a]
0	PA and PB
1	PA, PB, PC, PD, PE, PF or PG, or PF + PG

[a] PA = Flat position
PB = Horizontal vertical position
PC = Horizontal position
PD = Horizontal overhead position
PE = Overhead position
PF = Vertical up position
PG = Vertical down position

5 Mechanical tests

5A Classification according to nominal composition

Tensile tests and any required retests for tubular cored electrodes shall be carried out on weld metal in the condition specified in Table 2A (as-welded or post weld heat treatment) using an all-weld metal test assembly in accordance with ISO 15792-1 of a type specified in Table 6 using 1,2 mm, or, if this diameter is not manufactured, the next larger diameter manufactured as described in 5.1 and 5.2.

5B Classification according to alloy type

Tensile tests for tubular cored electrodes shall be carried out on weld metal in the condition specified in Table 2B (as-welded or post weld heat treatment) using an all-weld metal test assembly in accordance with ISO 15792-1 of a type specified in Table 6 using 1,2 mm, or, if this diameter is not manufactured, the next larger diameter manufactured as described in 5.1 and 5.2.

Tensile tests for tubular cored rods shall be carried out on weld metal in the condition specified in Table 2B using an all-weld metal test assembly in accordance with ISO 15792-1 of a type specified in Table 6 using 2.2 mm, or if this diameter is not manufactured the next larger diameter manufactured as described in 5.1 and 5.2.

5.1 Preheating and interpass temperatures

Preheating and interpass temperatures shall be selected for the appropriate weld metal type from Table 5A or Table 5B.

The preheating and interpass temperatures shall be measured using temperature indicator crayons, surface thermometers or thermocouples (see ISO 13916).

The interpass temperature shall not exceed the maximum temperature indicated in Table 5A or Table 5B. If, after any pass, the interpass temperature is exceeded, the test assembly shall be cooled in air to a temperature within the limits of the interpass temperature.

Table 5A — Preheating and interpass temperatures (classification according to nominal composition)

Alloy designation according to nominal composition	Type of weld metal	Preheating and interpass temperatures °C
13 13Ti 17	Martensitic and ferritic chromium steel	200 to 300
13 4	Soft martensitic stainless steel	100 to 180
All others	Austenitic and ferritic-austenitic stainless steel	⩽ 150

Table 5B — Preheating and interpass temperatures (classification according to alloy type)

Alloy designation according to alloy type	Type of weld metal	Preheating and interpass temperatures °C
410	Martensitic and ferritic chromium steel	200 to 300
409 409Nb 430 430Nb		150 to 260
410NiMo	Soft martensitic stainless steel	100 to 260
All others	Austenitic and ferritic-austenitic stainless steel	⩽ 150

5.2 Pass sequence

The total number of runs, the number of runs per layer and the total number of layers shall be as given in Table 6.

Table 6 — Pass sequence

Process	Diameter mm	ISO 15792-1 test assembly type	Passes per layer		Total number of layers
			First layer	Other layers	
Gas shielded and self-shielded metal arc welding	< 1,2	1.0	1 or 2	2 or 3 [a]	6 to 9
	1,2	1.3	1 or 2	2 or 3 [a]	5 to 9
	1,4, 1,6, 2,0	1.3	1 or 2	2 or 3 [a]	5 to 8
	2,4, 3,2	1.3	1 or 2	1 or 2 [b]	4 to 7
Gas tungsten arc welding	2,0, 2,2, 2,4	1.0	1 or 2	2 or 3 [a]	5 to 8

[a] Final layer may have four passes.

[b] Final layer may have three passes.

6 Chemical analysis

Chemical analysis is performed on any suitable all-weld metal test specimen. The referee method is described in ISO 6847. Any analytical technique can be used but in case of dispute reference shall be made to established published methods.

7 Fillet weld test

The fillet weld test assembly shall be as shown in ISO 15792-3.

7A Classification according to nominal composition

The plate material shall be selected from the range of materials for which the electrode is recommended by the manufacturer. The fillet welds shall be deposited as a single run using the diameter of electrode and welding position shown in Table 7A. Throat thickness, leg length and convexity shall conform to the requirements of Table 7A.

7B Classification according to alloy type

For electrodes classified as symbol 1 in Table 4B, fillet weld test shall be performed in PD and PF positions. The steel to be used shall conform to the following specifications:

1) For 300 series electrodes: matching or type 304 stainless steel.

2) For 400 series electrodes: matching or non alloy steel.

3) For duplex alloy electrodes: matching or type 304 stainless steel.

The fillet weld tests shall be conducted on all diameters manufactured. The amperage or electrode feed speed and arc voltage shall be selected by the manufacturer.

A single-pass fillet weld shall be deposited on one side of the joint. After completing the weld on the first side of the joint, the fillet weld shall be deposited on the second side of the joint with the same procedure used for the fillet weld on the first side.

Table 7A — Test requirements for fillet welds (classification according to nominal composition)

Symbol of position for classification	Test position	Electrode size [a] mm	Fillet theoretical throat mm	Maximum leg length difference mm	Maximum convexity mm
1 or 2	PB	2,4	5,5 min.	2,0	3,0
3	PB	2,4	5,5 min.	2,0	3,0
5	PB	2,4 [b]	5,5 min.	2,0	3,0
1 or 2	PF	2,4 [c]	7,0 max.		2,0
1, 2 or 5	PD	1,2 [d]	4,5 max.	1,5	2,5
5	PG	1,2 [d]	4,5 min.		1,5 [e]

[a] Where the largest size claimed for positional welding is smaller than that specified, use the largest size and adjust the criteria pro rata.

[b] Or largest size made up to 2,4 mm.

[c] Maximum size for which positional classification is sought.

[d] Or as recommended by the manufacturer.

[e] Maximum concavity.

The maximum convexity and length difference shall conform to the following dimensional requirements:

a) Maximum convexity: 2,0 mm for $< 7{,}0$ mm in measured fillet weld size and 2,5 mm for $\geqslant 7{,}0$ mm in measured fillet weld size

b) Maximum leg length difference (mm) $= 0{,}5 \times$ [fillet weld size (mm)] $- 0{,}5$

8 Retests

If any test fails to meet the requirement, that test shall be repeated twice. The results of both retests shall meet the requirement. Specimens for the retest may be taken from the original test assembly or from a new test assembly. For chemical analysis, retests need be only for those specific elements that failed to meet their test requirement. If the results of one or both retests fail to meet the requirement, the material under test shall be considered as not meeting the requirements of this specification for that classification.

In the event that, during preparation or after completion of any test, it is clearly determined that prescribed or proper procedures were not followed in preparing the weld test assembly or test specimen(s), or in conducting the tests, the test shall be considered invalid, without regard to whether the test was actually completed, or whether the test results met, or failed to meet, the requirement. That test shall be repeated, following proper prescribed procedures. In this case, the requirement for doubling the number of test specimens does not apply.

9 Technical delivery conditions

Technical delivery conditions shall meet the requirements in ISO 544 and ISO 14344.

10 Examples of designation

The designation of tubular cored electrodes shall follow the principles given in the examples below.

10A Classification according to nominal composition

EXAMPLE

A tubular cored electrode (T) for gas shielded arc welding deposits a weld metal of chemical composition within the limits for the nominal composition 19 12 3 L of Table 1A.

The electrode with a rutile type core with a slow freezing slag (R) was tested under mixed gas (M) and can be used in flat and horizontal vertical positions (3).

This is designated as follows:

ISO 17633-A - T 19 12 3L R M 3

Compulsory section:

ISO 17633-A - T 19 12 3L R M

where

ISO 17633-A is the number of this International Standard with classification according to nominal composition;

T indicates a tubular cored electrode/metal arc welding (see 4.1A);

19 12 3L represents the chemical composition of the all-weld metal (see Table 1A);

R is the type of electrode core (see Table 3A);

M is the shielding gas (see 4.4);

3 is the welding position (see Table 4A).

10B Classification according to alloy type

EXAMPLE

A tubular cored electrode (TS) for gas shielded arc welding deposits a weld metal of chemical composition within the limits for the alloy type 316L of Table 1B.

The flux cored electrode type (F) was tested under mixed gas (M) and can be used in flat and horizontal vertical positions (0).

This is designated as follows:

ISO 17633-B - TS316L-FM0

where

ISO 17633-B is the number of this International Standard with classification according to alloy type;

TS indicates a tubular cored stainless steel electrode/metal arc welding (see 4.1B);

316L represents the chemical composition of the all-weld metal (see Table 1B);

F is the type of electrode core (see Table 3B);

M is the shielding gas (see 4.4);

0 is the welding position (see Table 4B).

Annex A
(informative)

Comparison charts of alloy designation according to nominal composition and alloy type

Table A.1A — Correspondence of alloy, designated according to nominal composition, with alloy, designated according to alloy type, of similar, but not identical, requirements

Nominal composition	Alloy type [a]
13	410
13 Ti	409
13 4	410NiMo
17	430
19 9 L	308L
19 9 Nb	347
19 12 3 L	316L
19 12 3 Nb	318
19 13 4 N L	—
22 9 3 N L	2209
18 16 5 N L	—
18 8 Mn	—
20 10 3	308Mo
23 12 L	309L
23 12 2 L	309LMo
29 9	312
22 12 H	—
25 20	310

[a] "—" signs in the table indicate no correspondence of alloy designation in the classification according to alloy type.

Table A.1B — Correspondence of alloy, designated according to alloy type, with alloy, designated according to nominal composition, of similar, but not identical, requirements

Alloy type	Nominal composition [a]
307	—
308	—
308L	19 9 L
308H	—
308Mo	20 10 3
308LMo	—
308HMo	—
309	—
309L	23 12 L
309Mo	—
309LMo	23 12 2 L
309LNb	—
310	25 20
312	29 9
316	—
316L	19 12 3 L
316H	—
316LCu	—
317	—
317L	—
318	19 12 3 Nb
347	19 9 Nb
347L	—
409	13 Ti
409Nb	—
410	13
410NiMo	13 4
430	17
430Nb	—
16-8-2	—
2209	22 9 3 N L
2553	—

[a] "—" signs in the table indicate no correspondence of alloy designation in the classification according to nominal composition.