INTERNATIONAL STANDARD

ISO 3581

Second edition
2003-02-01

Welding consumables — Covered electrodes for manual metal arc welding of stainless and heat-resisting steels — Classification

Produits consommables pour le soudage — Électrodes enrobées pour le soudage manuel à l'arc des aciers inoxydables et résistant aux températures élevées — Classification

Reference number
ISO 3581:2003(E)

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Published in Switzerland

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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 3581 was prepared in collaboration with the International Institute of Welding which has been approved by the ISO Council as an international standardizing body in the field of welding.

This second edition cancels and replaces the first edition (ISO 3581:1976), which has been technically revised.

Introduction

This International Standard provides a classification system for stainless steel, covered welding electrodes in terms of chemical composition of deposited weld metal and type of electrode covering. Other properties of the electrodes are specified by reference to tables.

This International Standard has been prepared by the International Institute of Welding, Commission II “Arc Welding”, Subcommission II-E. It recognizes that there are two somewhat different approaches in the global market, for classifying a given stainless steel, covered electrode, and allows for either or both to be used to suit a particular need. Application of either (or both) type(s) of classification designation identifies a product as classified according to this International Standard. It should be noted that the two systems are not exactly equivalent, therefore each system must be used independent of the other, without combining designators in any way.

The classification according to ISO 3581, system A, is mainly based upon EN 1600; the classification according to ISO 3581, system B, is mainly based upon standards used around the Pacific Rim.

Welding consumables — Covered electrodes for manual metal arc welding of stainless and heat-resisting steels — Classification

1 Scope

This International Standard specifies requirements for classification of covered electrodes, based on the all-weld metal chemical composition, the type of electrode covering and other electrode properties, and the all-weld metal mechanical properties, in the as-welded or heat-treated conditions, for manual 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.

a) Paragraphs and tables which carry the label "classification according to nominal composition" or "ISO 3581-A" are applicable only to products classified to that system.

b) Paragraphs and tables which carry the label "classification according to alloy type" or "ISO 3581-B" are applicable only to products classified to that system.

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

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 metals — Type of product, dimensions, tolerances and markings*

ISO 2401, *Covered electrodes — Determination of the efficiency, metal recovery and deposition coefficient*

ISO 6847, *Welding consumables — Deposition of a weld metal pad for chemical analysis*

ISO 6947, *Welds — Working positions — Definitions of angles of slope and rotation*

ISO 8249, *Welding — Determination of Ferrite Number (FN) in austenitic and duplex ferritic-austenitic Cr-Ni stainless steel weld metals*

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

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 for indicating the chemical composition of the all-weld metal deposit obtained with a given electrode.

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 occasionally additional character or characters for compositional modifications of each original alloy within the family. Both designation approaches include additional designators for some other classification requirements, but not entirely the same classification requirements, as will be clear from the following sections.

Table 1 lists the tests required for classification of an electrode in each approach.

In many cases, a given commercial product can be classified using both approaches. Then either or both classification designations can be used for the product.

Table 1 — Summary of test requirements

Electrode designation		Size [a] mm	Position of welding [b]					
			Chemical analysis test		All-weld metal tension test		Fillet weld test	
ISO 3581-A	ISO 3581-B		ISO 3581-A	ISO 3581-B	ISO 3581-A	ISO 3581-B	ISO 3581-A	ISO 3581-B
Coating type symbol B and position symbols 1 and 2	Position and coating type symbol - 15	3,2 or 3,0 4,0 5,0 or 4,8 6,0 (or 5,6 or 6,4)	PA PA Not required Not required	PA PA PA PA	Not required PA Not required Not required	Not required PA Not required Not required	PB, PF, PD Not required Not required Not required	Not required PB, PF, PD PB PB
All coating types and position symbol 3	Not applicable	3,2 or 3,0 4,0 5,0 or 4,8	PA PA Not required	Not applicable	Not required PA Not required	Not applicable	PB Not required Not required	Not applicable
All coating types and position symbol 4	Position symbol - 4 and all coating types	2,4 or 2,5 3,2 or 3,0 4,0 5,0 or 4,8	Not required PA PA Not required	PA PA PA PA	Not required Not required PA Not required	Not required Not required PA Not required	Not required Not required Not required Not required	PG PG PG PG
All coating types and position symbol 5	Not applicable	3,2 (or 3,0) 4,0 5,0 (or 4,8)	PA PA Not required	Not applicable	Not required PA Not required	Not applicable	PB, PG Not required Not required	Not applicable
Coating type symbol R and position symbols 1 and 2	Position and coating type symbols - 16 and - 17	3,2 (or 3,0) 4,0 5,0 (or 4,8) 6,0 (or 5,6 or 6,4)	PA PA Not required Not required	PA PA PA Not required	Not required PA Not required Not required	Not required PA Not required Not required	PB, PF, PD Not required Not required Not required	Not required PB, PF, PD PB PB
Not applicable	Position and coating type symbols - 26 and - 27	3,2 (or 3,0) 4,0 5,0 (or 4,8) 6,0 (or 5,6 or 6,4)	Not applicable	PA PA PA PA	Not applicable	Not required PA Not required Not required	Not applicable	Not required PB PB PB

a If the size is not manufactured, the next nearest size may be substituted (provided that the substituted size is different from those specified in this table).

b The abbreviation PA, PB, PD, PF and PG indicate welding positions in accordance with ISO 6947, as follows:

PA = flat
PB = horizontal vertical
PD = horizontal overhead
PF = vertical up
PG = vertical down

3A Classification according to nominal composition

The classification includes all-weld metal properties obtained with a covered electrode as given below. The classification is based on an electrode diameter of 4 mm with the exception of testing for welding position.

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 all-weld metal (see Table 2);
3) the third part gives a symbol indicating the type of electrode covering (see 4.3A);
4) the fourth part gives a symbol indicating the effective electrode efficiency and type of current (see Table 4A);
5) the fifth part gives a symbol indicating the welding position (see Table 5A).

In order to promote the use of this International Standard, the classification to ISO 3581-A is split into two sections:

a) Compulsory section

This section includes the symbols for the type of product, the chemical composition and the type of covering, i.e. symbols defined in 4.1A, 4.2 and 4.3A.

b) Optional section

This section includes the symbols for the weld metal recovery, the type of current and the welding positions for which the electrode is suitable, i.e. the symbols defined in 4.4A and Table 5A.

The full designation (compulsory and optional sections) shall be used on packages and in the manufacturer's literature and data sheets.

3B Classification according to alloy type

The classification includes all-weld metal properties obtained with a covered electrode as given below. The classification is based on an electrode diameter of 4 mm for mechanical properties, with the exception of testing for welding position and for chemical analysis of the weld metal.

The classification is divided into four parts:

1) the first part gives a symbol indicating the product/process to be identified (see 4.1B);
2) the second part gives a symbol indicating the chemical composition of all-weld metal (see Table 2);
3) the third part gives a symbol indicating the welding position (See Table 5B);
4) the fourth part gives a symbol indicating the type of electrode covering. This also serves to define the type of current which can be used with the electrode classified (see 4.3B).

In classifying welding electrodes to ISO 3581-B, the symbols for all four parts – product/process, alloy type, welding position and type of electrode covering, as defined in 4.1B, 4.2, 4.3 and Table 5B – are compulsory.

The full designation shall be used on packages and in manufacturer's literature and data sheets.

NOTE The composition of the core wire, which may be substantially different from the weld metal composition, is not considered a classification criterion.

4 Symbols and requirements

NOTE See Annex A for examples of classifications in both systems.

4.1 Symbol for the product/process

4.1A Classification according to nominal composition

The symbol for the covered electrode used in the manual metal arc welding process for stainless and heat-resisting steels in accordance with ISO 3581-A shall be the letter E.

4.1B Classification according to alloy type

The symbol for the covered electrode used in the manual metal arc welding process for stainless and heat-resisting steels in accordance with ISO 3581-B shall be the letters ES. The initial letter "E" indicates a covered electrode; the letter "S" indicates stainless and heat-resisting steels.

4.2 Symbol for the chemical composition of all-weld metal

The symbol in Table 2 indicates the chemical composition of all-weld metal determined in accordance with Clause 5. The all-weld metal obtained with the covered electrodes in Table 2, in accordance with Clause 6, shall also fulfil the mechanical property requirements for that electrode as specified in Table 3.

4.3 Symbol for type of electrode covering [1)]

The type of covering of the electrodes determines, to a large extent, usability characteristics of the electrode and properties of the weld metal.

4.3A Classification according to nominal composition

Two symbols are used to describe the type of covering:

B denotes a basic covering;

R denotes a rutile based covering.

4.3B Classification according to alloy type

Three symbols are used to define the type of covering on the electrode:

5 denotes a basic covering, intended for d.c. welding;

6 denotes a rutile based coating, intended for d.c. or a.c. welding (except that position and coating type - 46 is d.c.);

7 denotes a modified rutile based coating containing a considerable amount of silica, intended for d.c. or a.c. welding (except that position and coating type - 47 is d.c.).

1) See Annex A for information on coating types.

Table 2 — Chemical composition requirements

Symbol classification by		Chemical composition [a, b] %										
nominal composition[c,d,e] (ISO 3581-A)	**alloy type**[e,f] (ISO 3581-B)	C	Si	Mn	P	S	Cr	Ni	Mo	Cu	Nb + Ta	N
—	409Nb	0,12	1,00	1,00	0,040	0,030	11,0 to 14,0	0,60	0,75	0,75	0,50 to 1,50	—
13	(410)	0,12	1,0	1,5	0,030	0,025	11,0 to 14,0	0,60	0,75	0,75	—	—
(13)	410	0,12	0,90	1,0	0,04	0,03	11,0 to 14,0	0,70	0,75	0,75	—	—
13 4	(410NiMo)	0,06	1,0	1,5	0,030	0,025	11,0 to 14,5	3,0 to 5,0	0,4 to 1,0	0,75	—	—
(13 4)	410NiMo	0,06	0,90	1,0	0,04	0,03	11,0 to 12,5	4,0 to 5,0	0,40 to 0,70	0,75	—	—
17	(430)	0,12	1,0	1,5	0,030	0,025	16,0 to 18,0	0,60	0,75	0,75	—	—
(17)	430	0,10	0,90	1,0	0,04	0,03	15,0 to 18,0	0,6	0,75	0,75	—	—
—	430Nb	0,10	1,00	1,00	0,040	0,030	15,0 to 18,0	0,60	0,75	0,75	0,50 to 1,50	—
19 9	(308)	0,08	1,2	2,0	0,030	0,025	18,0 to 21,0	9,0 to 11,0	0,75	0,75	—	—
(19 9)	308	0,08	1,00	0,5 to 2,5	0,04	0,03	18,0 to 21,0	9,0 to 11,0	0,75	0,75	—	—
19 9 H	(308H)	0,04 to 0,08	1,2	2,0	0,03	0,025	18,0 to 21,0	9,0 to 11,0	0,75	0,75	—	—
(19 9 H)	308H	0,04 to 0,08	1,00	0,5 to 2,5	0,04	0,03	18,0 to 21,0	9,0 to 11,0	0,75	0,75	—	—
19 9 L	(308L)	0,04	1,2	2,0	0,030	0,025	18,0 to 21,0	9,0 to 11,0	0,75	0,75	—	—
(19 9 L)	308L	0,04	1,00	0,5 to 2,5	0,04	0,03	18,0 to 21,0	9,0 to 12,0	0,75	0,75	—	—
(20 10 3)	308Mo	0,08	1,00	0,5 to 2,5	0,04	0,03	18,0 to 21,0	9,0 to 12,0	2,0 to 3,0	0,75	—	—
—	308LMo	0,04	1,00	0,5 to 2,5	0,04	0,03	18,0 to 21,0	9,0 to 12,0	2,0 to 3,0	0,75	—	—
—	349[g]	0,13	1,00	0,5 to 2,5	0,04	0,03	18,0 to 21,0	8,0 to 10,0	0,35 to 0,65	0,75	0,75 to 1,20	—
19 9 Nb	(347)	0,08	1,2	2,0	0,030	0,025	18,0 to 21,0	9,0 to 11,0	0,75	0,75	8 × C to 1,1	—
(19 9 Nb)	347	0,08	1,00	0,5 to 2,5	0,04	0,03	18,0 to 21,0	9,0 to 11,0	0,75	0,75	8 × C to 1,00	—
—	347L	0,04	1,00	0,5 to 2,5	0,040	0,030	18,0 to 21,0	9,0 to 11,0	0,75	0,75	8 × C to 1,00	—
19 12 2	(316)	0,08	1,2	2,0	0,030	0,025	17,0 to 20,0	10,0 to 13,0	2,0 to 3,0	0,75	—	—
(19 12 2)	316	0,08	1,00	0,5 to 2,5	0,04	0,03	17,0 to 20,0	11,0 to 14,0	2,0 to 3,0	0,75	—	—
(19 12 2)	316H	0,04 to 0,08	1,00	0,5 to 2,5	0,04	0,03	17,0 to 20,0	11,0 to 14,0	2,0 to 3,0	0,75	—	—
(19 12 3 L)	316L	0,04	1,00	0,5 to 2,5	0,04	0,03	17,0 to 20,0	11,0 to 14,0	2,0 to 3,0	0,75	—	—

Table 2 (*continued*)

Symbol classification by		Chemical composition [a, b] %										
nominal composition[c,d,e] (ISO 3581-A)	**alloy type**[e,f] (ISO 3581-B)	C	Si	Mn	P	S	Cr	Ni	Mo	Cu	Nb + Ta	N
19 12 3 L	(316L)	0,04	1,2	2,0	0,030	0,025	17,0 to 20,0	10,0 to 13,0	2,5 to 3,0	0,75	—	—
—	316LCu	0,04	1,00	0,5 to 2,5	0,040	0,030	17,0 to 20,0	11,0 to 16,0	1,20 to 2,75	1,00 to 2,50	—	—
—	317	0,08	1,00	0,5 to 2,5	0,04	0,03	18,0 to 21,0	12,0 to 14,0	3,0 to 4,0	0,75	—	—
—	317L	0,04	1,00	0,5 to 2,5	0,04	0,03	18,0 to 21,0	12,0 to 14,0	3,0 to 4,0	0,75	—	—
19 12 3 Nb	(318)	0,08	1,2	2,0	0,030	0,025	17,0 to 20,0	10,0 to 13,0	2,5 to 3,0	0,75	8 × C to 1,1	—
(19 12 3 Nb)	318	0,08	1,00	0,5 to 2,5	0,04	0,03	17,0 to 20,0	11,0 to 14,0	2,0 to 3,0	0,75	6 × C to 1,00	—
19 13 4 N L	—	0,04	1,2	1,0 to 5,0	0,030	0,025	17,0 to 20,0	12,0 to 15,0	3,0 to 4,5	0,75	—	0,20
—	320	0,07	0,60	0,5 to 2,5	0,04	0,03	19,0 to 21,0	32,0 to 36,0	2,0 to 3,0	3,0 to 4,0	8 × C to 1,00	—
—	320LR	0,03	0,30	1,5 to 2,5	0,020	0,015	19,0 to 21,0	32,0 to 36,0	2,0 to 3,0	3,0 to 4,0	8 × C to 0,40	—
22 9 3 N L	(2209)	0,04	1,2	2,5	0,030	0,025	21,0 to 24,0	7,5 to 10,5	2,5 to 4,0	0,75	—	0,08 to 0,20
(22 9 3 N L)	2209	0,04	1,00	0,5 to 2,0	0,04	0,03	21,5 to 23,5	7,5 to 10,5	2,5 to 3,5	0,75	—	0,08 to 0,20
25 7 2 N L[d]	—	0,04	1,2	2,0	0,035	0,025	24,0 to 28,0	6,0 to 8,0	1,0 to 3,0	0,75	—	0,20
25 9 3 Cu N L	(2593)	0,04	1,2	2,5	0,030	0,025	24,0 to 27,0	7,5 to 10,5	2,5 to 4,0	1,5 to 3,5	—	0,10 to 0,25
25 9 4 N L[d, h]	(2593)	0,04	1,2	2,5	0,030	0,025	24,0 to 27,0	8,0 to 11,0	2,5 to 4,5	1,5	—	0,20 to 0,30
—	2553	0,06	1,0	0,5 to 1,5	0,04	0,03	24,0 to 27,0	6,5 to 8,5	2,9 to 3,9	1,5 to 2,5	—	0,10 to 0,25
(25 9 3 Cu N L)	2593	0,04	1,0	0,5 to 1,5	0,04	0,03	24,0 to 27,0	8,5 to 10,5	2,9 to 3,9	1,5 to 3,0	—	0,08 to 0,25
18 15 3 L	—	0,04	1,2	1,0 to 4,0	0,030	0,025	16,5 to 19,5	14,0 to 17,0	2,5 to 3,5	0,75	—	—
18 16 5 N L[d]	—	0,04	1,2	1,0 to 4,0	0,035	0,025	17,0 to 20,0	15,5 to 19,0	3,5 to 5,0	0,75	—	0,20
20 25 5 Cu N L	(385)	0,04	1,2	1,0 to 4,0	0,030	0,025	19,0 to 22,0	24,0 to 27,0	4,0 to 7,0	1,0 to 2,0	—	0,25
20 16 3 Mn N L[d]	—	0,04	1,2	5,0 to 8,0	0,035	0,025	18,0 to 21,0	15,0 to 18,0	2,5 to 3,5	0,75	—	0,20
25 22 2 N L	—	0,04	1,2	1,0 to 5,0	0,030	0,025	24,0 to 27,0	20,0 to 23,0	2,0 to 3,0	0,75	—	0,20
27 31 4 Cu L	—	0,04	1,2	2,5	0,030	0,025	26,0 to 29,0	30,0 to 33,0	3,0 to 4,5	0,6 to 1,5	—	—
18 8 Mn[d]	—	0,20	1,2	4,5 to 7,5	0,035	0,025	17,0 to 20,0	7,0 to 10,0	0,75	0,75	—	—
18 9 Mn Mo[d]	(307)	0,04 to 0,14	1,2	3,0 to 5,0	0,035	0,025	18,0 to 21,5	9,0 to 11,0	0,5 to 1,5	0,75	—	—

Table 2 (*continued*)

Symbol classification by		Chemical composition [a, b] %										
nominal composition[c,d,e] (ISO 3581-A)	**alloy type**[e,f] (ISO 3581-B)	C	Si	Mn	P	S	Cr	Ni	Mo	Cu	Nb + Ta	N
(18 9 Mn Mo)	307	0,04 to 0,14	1,00	3,30 to 4,75	0,04	0,03	18,0 to 21,5	9,0 to 10,7	0,5 to 1,5	0,75	—	—
20 10 3	(308Mo)	0,10	1,2	2,5	0,030	0,025	18,0 to 21,0	9,0 to 12,0	1,5 to 3,5	0,75	—	—
23 12 L	(309L)	0,04	1,2	2,5	0,030	0,025	22,0 to 25,0	11,0 to 14,0	0,75	0,75	—	—
(23 12 L)	309L	0,04	1,00	0,5 to 2,5	0,04	0,03	22,0 to 25,0	12,0 to 14,0	0,75	0,75	—	—
(22 12)	309	0,15	1,00	0,5 to 2,5	0,04	0,03	22,0 to 25,0	12,0 to 14,0	0,75	0,75	—	—
23 12 Nb	(309Nb)	0,10	1,2	2,5	0,030	0,025	22,0 to 25,0	11,0 to 14,0	0,75	0,75	8 × C to 1,1	—
—	309LNb	0,04	1,00	0,5 to 2,5	0,040	0,030	22,0 to 25,0	12,0 to 14,0	0,75	0,75	0,70 to 1,00	—
(23 12 Nb)	309Nb	0,12	1,00	0,5 to 2,5	0,04	0,03	22,0 to 25,0	12,0 to 14,0	0,75	0,75	0,70 to 1,00	—
—	309Mo	0,12	1,00	0,5 to 2,5	0,04	0,03	22,0 to 25,0	12,0 to 14,0	2,0 to 3,0	0,75	—	—
23 12 2 L	(309LMo)	0,04	1,2	2,5	0,030	0,025	22,0 to 25,0	11,0 to 14,0	2,0 to 3,0	0,75	—	—
(23 12 2 L)	309LMo	0,04	1,00	0,5 to 2,5	0,04	0,03	22,0 to 25,0	12,0 to 14,0	2,0 to 3,0	0,75	—	—
29 9 [d]	(312)	0,15	1,2	2,5	0,035	0,025	27,0 to 31,0	8,0 to 12,0	0,75	0,75	—	—
(29 9)	312	0,15	1,00	0,5 to 2,5	0,04	0,03	28,0 to 32,0	8,0 to 10,5	0,75	0,75	—	—
16 8 2	(16-8-2)	0,08	0,60	2,5	0,030	0,025	14,5 to 16,5	7,5 to 9,5	1,5 to 2,5	0,75	—	—
(16 8 2)	16-8-2	0,10	0,60	0,5 to 2,5	0,03	0,03	14,5 to 16,5	7,5 to 9,5	1,0 to 2,0	0,75	—	—
25 4	—	0,15	1,2	2,5	0,030	0,025	24,0 to 27,0	4,0 to 6,0	0,75	0,75	—	—
—	209[i]	0,06	1,00	4,0 to 7,0	0,04	0,03	20,5 to 24,0	9,5 to 12,0	1,5 to 3,0	0,75	—	0,10 to 0,30
—	219	0,06	1,00	8,0 to 10,0	0,04	0,03	19,0 to 21,5	5,5 to 7,0	0,75	0,75	—	0,10 to 0,30
—	240	0,06	1,00	10,5 to 13,5	0,04	0,03	17,0 to 19,0	4,0 to 6,0	0,75	0,75	—	0,10 to 0,30
22 12	(309)	0,15	1,2	2,5	0,030	0,025	20,0 to 23,0	10,0 to 13,0	0,75	0,75	—	—
25 20	(310)	0,06 to 0,20	1,2	1,0 to 5,0	0,030	0,025	23,0 to 27,0	18,0 to 22,0	0,75	0,75	—	—
(25 20)	310	0,08 to 0,20	0,75	1,0 to 2,5	0,03	0,03	25,0 to 28,0	20,0 to 22,5	0,75	0,75	—	—
25 20 H	(310H)	0,35 to 0,45	1,2	2,5	0,030	0,025	23,0 to 27,0	18,0 to 22,0	0,75	0,75	—	—
(25 20 H)	310H	0,35 to 0,45	0,75	1,0 to 2,5	0,03	0,03	25,0 to 28,0	20,0 to 22,5	0,75	0,75	—	—

Table 2 (*continued*)

Symbol classification by		Chemical composition [a, b] %										
nominal composition[c,d,e] (ISO 3581-A)	**alloy type**[e,f] (ISO 3581-B)	C	Si	Mn	P	S	Cr	Ni	Mo	Cu	Nb + Ta	N
—	310Nb	0,12	0,75	1,0 to 2,5	0,03	0,03	25,0 to 28,0	20,0 to 22,0	0,75	0,75	0,70 to 1,00	—
—	310Mo	0,12	0,75	1,0 to 2,5	0,03	0,03	25,0 to 28,0	20,0 to 22,0	2,0 to 3,0	0,75	—	—
18 36	(330)	0,25	1,2	2,5	0,030	0,025	14,0 to 18,0	33,0 to 37,0	0,75	0,75	—	—
(18 36)	330	0,18 to 0,25	1,00	1,0 to 2,5	0,04	0,03	14,0 to 17,0	33,0 to 37,0	0,75	0,75	—	—
—	330H	0,35 to 0,45	1,00	1,0 to 2,5	0,04	0,03	14,0 to 17,0	33,0 to 37,0	0,75	0,75	—	—
—	383	0,03	0,90	0,5 to 2,5	0,02	0,02	26,5 to 29,0	30,0 to 33,0	3,2 to 4,2	0,6 to 1,5	—	—
(20 25 5 Cu N L)	385	0,03	0,90	1,0 to 2,5	0,03	0,02	19,5 to 21,5	24,0 to 26,0	4,2 to 5,2	1,2 to 2,0	—	—
—	630	0,05	0,75	0,25 to 0,75	0,04	0,03	16,00 to 16,75	4,5 to 5,0	0,75	3,25 to 4,00	0,15 to 0,30	—

[a] Single values shown in this table are maximum values.

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

[c] Covered electrodes not listed in this table, but those which the user wishes to classify to this system, can be similarly symbolized and prefixed with the letter Z.

[d] The sum of P and S may not exceed 0,050 %, except for 25 7 2 N L; 18 16 5 N L; 20 16 3 Mn N L; 18 8 Mn; 18 9 Mn Mo and 29 9.

[e] A designation in parentheses [e.g., (308L) or (19 9 L)] indicates a near match in the other designation system, but not an exact match. The correct designation for a given composition range is the one not in parentheses. A given product, by having a more restricted chemical composition that fulfils both sets of designation requirements, may be assigned both designations independently.

[f] Analysis shall be made for the elements for which specific values are shown in this table. If, however, the presence of other elements is indicated in the course of routine analysis, further analysis shall be made in order to determine that the total of these other elements, iron excepted, is not present in excess of 0,50 %.

[g] Vanadium shall be from 0,10 % to 0,30 %; titanium shall be 0,15 % maximum; tungsten shall be from 1,25 % to 1,75 %.

[h] Tungsten shall be 1,0 % maximum.

[i] Vanadium shall be from 0,10 % to 0,30 %.

Table 3 — Mechanical property requirements

Nominal composition (ISO 3581-A)	Alloy symbol (ISO 3581-B)	Minimum proof strength $R_{p0,2}$ MPa	Minimum tensile strength R_m MPa	Minimum elongation [a] %	Post weld heat treatment
—	409Nb	—	450	13	b
13	(410)	250	450	15	c
(13)	410	—	450	15	d
13 4	(410NiMo)	500	750	15	e
(13 4)	410NiMo	—	760	10	f
17	(430)	300	450	15	g
(17)	430	—	450	15	b
—	430Nb	—	450	13	b
19 9	(308)	350	550	30	none
(19 9)	308	—	550	30	none
19 9 H	(308H)	350	550	30	none
(19 9 H)	308H	—	550	30	none
19 9 L	(308L)	320	510	30	none
(19 9 L)	308L	—	510	30	none
—	308Mo	—	550	30	none
—	308LMo	—	520	30	none
—	349	—	690	23	none
19 9 Nb	(347)	350	550	25	none
(19 9 Nb)	347	—	520	25	none
—	347L	—	510	25	none
19 12 2	(316)	350	550	25	none
(19 12 2)	316	—	520	25	none
—	316H	—	520	25	none
19 12 3 L	(316L)	320	510	25	none
(19 12 3 L)	316L	—	490	25	none
—	316LCu	—	510	25	none
—	317	—	550	20	none
—	317L	—	510	20	none
19 12 3 Nb	(318)	350	550	25	none
(19 12 3 Nb)	318	—	550	20	none
19 13 4 N L	—	350	550	25	none
—	320	—	550	28	none

Table 3 (*continued*)

Nominal composition (ISO 3581-A)	Alloy symbol (ISO 3581-B)	Minimum proof strength $R_{p0,2}$ MPa	Minimum tensile strength R_m MPa	Minimum elongation[a] %	Post weld heat treatment
—	320LR	—	520	28	none
22 9 3 N L	(2209)	450	550	20	none
(29 9 3 N L)	2209	—	690	15	none
25 7 2 N L	—	500	700	15	none
25 9 3 Cu N L	—	550	620	18	none
25 9 4 N L	—	550	620	18	none
—	2553	—	760	13	none
—	2593	—	760	13	none
18 15 3 L	—	300	480	25	none
18 16 5 N L	—	300	480	25	none
20 25 5 Cu N L	—	320	510	25	none
20 16 3 Mn N L	—	320	510	25	none
25 22 2 N L	—	320	510	25	none
27 31 4 Cu L	—	240	500	25	none
18 8 Mn	—	350	500	25	none
18 9 Mn Mo	(307)	350	500	25	none
(18 9 Mn Mo)	307	—	590	25	none
20 10 3	—	400	620	20	none
—	309	—	550	25	none
23 12 L	(309L)	320	510	25	none
(23 12 L)	309L	—	510	25	none
23 12 Nb	(309Nb)	350	550	25	none
(23 12 Nb)	309Nb	—	550	25	none
—	309Mo	—	550	25	none
23 12 2 L	(309LMo)	350	550	25	none
(23 12 2 L)	309LMo	—	510	25	none
—	309LNb	—	510	25	none
29 9	(312)	450	650	15	none
(29 9)	312	—	660	15	none
16 8 2	(16-8-2)	320	510	25	none
(16 8 2)	16-8-2	—	520	25	none
25 4	—	400	600	15	none

Table 3 (*continued*)

Nominal composition (ISO 3581-A)	Alloy symbol (ISO 3581-B)	Minimum proof strength $R_{p0,2}$ MPa	Minimum tensile strength R_m MPa	Minimum elongation [a] %	Post weld heat treatment
—	209	—	690	15	none
—	219	—	620	15	none
—	240	—	690	25	none
22 12	—	350	550	25	none
25 20	(310)	350	550	20	none
(25 20)	310	—	550	25	none
25 20 H	(310H)	350	550	10 [h]	none
(25 20 H)	310H	—	620	8	none
—	310Nb	—	550	23	none
—	310Mo	—	550	28	none
18 36	(330)	350	510	10 [h]	none
(18 36)	330	—	520	23	none
—	330H	—	620	8	none
—	383	—	520	28	none
—	385	—	520	28	none
—	630	—	930	6	[i]

NOTE All-weld metal can have elongation and toughness lower than those of the parent metal.

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

[b] 760 °C to 790 °C for 2 h. Furnace cooling at a rate not exceeding 55 °C/h down to 595 °C then air cooling to ambient.

[c] 840 °C to 870 °C for 2 h. Furnace cooling down to 600 °C then air cooling.

[d] 730 °C to 760 °C for 1 h. Furnace cooling at a rate not exceeding 110 °C/h down to 315 °C then air cooling to ambient.

[e] 580 °C to 620 °C for 2 h. Air cooling.

[f] 595 °C to 620 °C for 1 h. Air cool to ambient.

[g] 760 °C to 790 °C for 2 h, furnace cooling down to 600°C then air cooling.

[h] These electrodes have high carbon in the all-weld metal for service at high temperatures. Room temperature elongation has little relevance to such applications.

[i] 1 025 °C to 1 050 °C for 1 h. Air cool to ambient, followed by precipitation hardening at 610 °C to 630 °C for 4 h then air cool to ambient.

4.4 Symbol for effective electrode efficiency and type of current

4.4A Classification according to nominal composition

The symbol in Table 4A indicates effective electrode efficiency, determined in accordance with ISO 2401, with the type of current shown in Table 4A.

4.4B Classification according to alloy type

No specific symbol is used to indicate effective electrode efficiency in this classification system. Type of current is included in the coating type, as given in 4.3B.

Table 4A – Symbol for effective electrode efficiency and type of current
(classification according to nominal composition)

Symbol	Effective electrode efficiency %	Type of current [a]
1	⩽ 105	a.c. and d.c.
2	⩽ 105	d.c.
3	> 105 but ⩽ 125	a.c. and d.c.
4	> 105 but ⩽ 125	d.c.
5	> 125 but ⩽ 160	a.c. and d.c.
6	> 125 but ⩽ 160	d.c.
7	> 160	a.c. and d.c.
8	> 160	d.c.

[a] In order to demonstrate operability on alternating current, tests shall be carried out with load voltages higher than 65 V (a.c. means alternating current; d.c. means direct current).

4.5 Symbol for welding position

The symbols for welding position, determined in accordance with the fillet weld test in ISO 15792-3, shall be as shown in Table 5A or in Table 5B.

Table 5A — Symbol for welding position
(classification according to nominal composition)

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

[a] Positions are defined in ISO 6947.
PA = Flat position
PB = Horizontal vertical position
PD = Horizontal overhead position
PF = Vertical up position
PG = Vertical down position

Table 5B — Symbol for welding position
(classification according to alloy type)

Symbol	Welding positions [a]
-1	PA, PB, PD, PF
-2	PA, PB
-4	PA, PB, PD, PF, PG

[a] Positions are defined in ISO 6947.
PA = Flat position
PB = Horizontal vertical position
PD = Horizontal overhead position
PF = Vertical up position
PG = Vertical down position

5 Chemical analysis

Chemical analysis is performed on any suitable all-weld metal test specimen. In case of dispute, the test specimen specified in ISO 6847 shall be used. The test results shall meet the requirements of Table 2 for the classification under test.

Any analytical technique may be used, but in case of dispute reference shall be made to established published methods.

6 Mechanical property tests

6.1 General

Tensile tests and any required retests shall be carried out in the condition specified in Table 3 (as-welded or after post-weld heat treatment). An all-weld metal test assembly type 1.3 shall be prepared in accordance with ISO 15792-1, using welding conditions described in 6.2 and 6.3.

6.2 Preheat and interpass temperatures

The preheat and interpass temperatures shall be selected for the appropriate type of weld metal as shown in Table 6A or in Table 6B.

Table 6A — Preheat and interpass temperatures
(classification according to nominal composition)

Alloy symbol	Type of weld metal	Preheat and interpass temperature °C
13 17	Martensitic and ferritic chromium steel	200 to 300
13 4	Soft martensitic stainless steel	100 to 180
All others	Austenitic and duplex ferritic-austenitic stainless steel	150 max.

Table 6B — Preheat and interpass temperatures
(classification according to alloy type)

Alloy symbol	Type of weld metal	Preheat and interpass temperature °C
410	Martensitic and ferritic chromium stainless steel	200 to 300
409 Nb 430 430 Nb		150 to 260
410 NiMo 630	Soft martensitic stainless steel	100 to 260
All others	Austenitic and duplex ferritic-austenitic stainless steel	150 max.

The interpass temperature shall be measured using temperature indicating crayons, surface thermometers or thermocouples (see ISO 13916) measured at the mid-point of the assembly approximately 25 mm from the groove edge.

The interpass temperature shall not exceed the temperature indicated in the applicable Table 6A or Table 6B. If, after any pass, the interpass temperature is exceeded, the test assembly shall be cooled in air to a temperature below that limit.

6.3 Pass sequence

For a 4 mm diameter electrode and test plate type 1.3 (ISO 15792-1:2000), the pass sequence shall be two passes per layer. The number of layers shall be limited to the range 7 to 9.

The direction of welding to complete a pass shall not vary. Each pass shall be welded with a welding current of 70 % to 90 % of the maximum current recommended by the manufacturer.

Regardless of the type of covering, welding shall be performed with alternating current when both alternating current and direct current are recommended and with direct current with electrode positive when only direct current is recommended.

7 Fillet weld test

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

7A Classification according to nominal composition

The fillet weld test requirements are specified in Table 7A. The test plate thickness, t, shall be 10 mm to 12 mm, the test plate length, l, shall be 250 mm and the test plate width, w, shall be 50 mm.

7B Classification according to alloy type

The fillet weld test plate thickness, t, and required test results are specified in Table 7B. The test plate length, l, shall be 250 mm and the test plate width, w, shall be 50 mm.

Table 7A — Fillet weld test requirements
(classification according to nominal composition)

ISO 3581-A symbol for position	ISO 3581-A symbol for coating type	Test position	Electrode size mm	Fillet theoretical throat mm	Maximum leg length difference mm	Maximum convexity mm
1 or 2	R or B	PB	6,0	5,0 min.	2,0	3,0
1 or 2	R B	PF	4,0	4,5 max. 5,5 max.	Not specified	2,0
1 or 2	R B	PD	4,0	4,5 max. 5,5 max.	1,5 2,0	2,5 3,0
3	R or B	PB	6,0	5,0 min.	2,0	3,0
4	R or B	Not required	Not required	Not specified	Not specified	Not specified
5	R B	PB	6,0 5,0	4,5 min.	1,5	2,5
5	R B	PD	4,0	4,5 max. 5,5 max.	1,5 2,0	2,5 3,0
5	R or B	PG	5,0	5,0 min.	Not specified	1,5 [a]

[a] Maximum concavity.

Table 7B — Fillet weld test plate thickness and test results required
(classification according to alloy type)

ISO 3581-B symbols for position and coating type	Electrode diameter mm	Type of current	Nominal plate thickness *t* mm	Test position	Fillet size (length of leg) mm	Maximum leg length difference mm	Maximum convexity mm
-15	4,0	d.c.+	6 or 8 or 10	PF	8,0 max.	Not specified	2,0
	4,0		6 or 8 or 10	PB and PD	6,0 min.	1,5	1,5
	4,8 or 5,0		10	PB	8,0 min.	1,5	2,0
	5,6 or 6,0 or 6,4		10	PB	10,0 min.	2,0	2,0
-16	4,0	a.c.	6 or 8 or 10	PF	8,0 max.	Not specified	2,0
	4,0		6 or 8 or 10	PB and PD	6,0 min.	1,5	1,5
	4,8 or 5,0		10	PB	8,0 min.	1,5	2,0
	5,6 or 6,0 or 6,4		10	PB	10,0 min.	2,0	2,0
-17	4,0	a.c.	6 or 8 or 10	PF	12,0 max.	Not specified	2,0
	4,0		6 or 8 or 10	PB and PD	8,0 min.	1,5	1,5
	4,8 or 5,0		10	PB	8,0 min.	1,5	2,0
	5,6 or 6,0 or 6,4		10	PB	10,0 min.	2,0	2,0
-25	4,0	d.c.+	10 or 12	PB	8,0 min.	1,5	1,5
	4,8 or 5,0				8,0 min.	1,5	2,0
	5,6 or 6,0 or 6,4				10,0 min.	2,0	2,0
-26 or -27	4,0	a.c.	10 or 12	PB	8,0 min.	1,5	1,5
	4,8 or 5,0				8,0 min.	1,5	2,0
	5,6 or 6,0 or 6,4				10,0 min.	2,0	2,0
-45, -46 or -47	2,4 or 2,5	d.c.+	6 or 8 or 10	PG	5,0 min.	Not specified	2,0 [a]
	3,0 or 3,2			PG	6,0 min.		3,0 [a]
	4,0			PG	8,0 min.		4,0 [a]
	4,8 or 5,0			PG	10,0 min.		5,0 [a]

[a] Maximum concavity.

8 Retests

If any test fails to meet the requirements, that test shall be repeated twice. The results of both retests shall meet the requirements. 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 specified in ISO 544 and ISO 14344.

10 Examples of designation

The designation of covered electrodes shall follow the principles given in the respective examples in 10.1A and 10.1B.

10.1A Classification according to nominal composition

EXAMPLE 1A:

A covered electrode (E) for manual metal arc welding deposits weld metal with a chemical composition 19 % Cr, 12 % Ni and 2 % Mo (19 12 2) in Table 2. The electrode has a rutile covering (R) and can be used with alternating current or direct current and with an effective electrode efficiency of 120 % (3) in flat butt and flat fillet welds (4) is designated as follows:

ISO 3581-A - E 19 12 2 R 3 4

Compulsory section:

ISO 3581-A - E 19 12 2 R

where

ISO 3581	is the standard number, with A indicating classification according to nominal composition;
E	is the covered electrode for manual metal arc welding (see 4.1A);
19 12 2	is the chemical composition of all-weld metal (see Table 2);
R	is the type of electrode covering (see 4.3A);
3	is for use with a.c. or d.c. and effective electrode efficiency of 120 % (see Table 4A);
4	is for flat butt and flat fillet welds (see Table 5A).

10.1B Classification according to alloy type

EXAMPLE 1B:

A covered electrode (E) for manual metal arc welding of stainless and heat-resisting steels (S) deposits weld metal with a chemical composition 19 % Cr, 12 % Ni and 2 % Mo (a type 316) in Table 2. The electrode has a rutile covering (6), and can be used with alternating current or direct current electrode positive, and may be used for welding flat butt and flat fillet welds (2) is designated as follows:

ISO 3581-B - ES316-26

where

ISO 3581	is the standard number, with B indicating classification according to alloy type;
ES	is the covered electrode for manual metal arc welding of stainless and heat-resisting steel (see 4.1B);
316	is the chemical composition of all-weld metal (see Table 2);
2	is the positions in which welding may be carried out (see Table 5B);
6	is the type of electrode covering (see 4.3B).

Annex A
(informative)

Types of covering

The flux covering, sometimes referred to as coating, on a manual metal arc electrode can vary quite dramatically from one classification to another. Both classification approaches referenced in this International Standard use symbols to indicate the major ingredients in the flux. A brief description of each, with the major characteristics, is given below.

A.1A Classification according to nominal composition

Under this approach there are two symbols used to designate the flux system of the electrode covering.

A.1.1A Basic covering, represented by a B

This indicates a covering containing large quantities of basic minerals or chemicals, such as limestone (calcium carbonate), dolomite (calcium magnesium carbonate) and fluorspar (calcium fluoride). The electrodes can generally be used only with d.c. electrode positive.

A.1.2A Rutile covering, represented by an R

This indicates a covering with a large proportion of the mineral rutile, which is largely titanium dioxide (titania). Other chemicals and minerals that are easily ionized are also used. Electrodes using this flux system can be used with a.c. and d.c.

A.1B Classification according to alloy type

Under this approach there are three symbols used to designate the flux system of the electrode covering.

A.1.1B Basic covering, represented by a 5

This indicates a covering containing large quantities of basic minerals or chemicals, such as limestone (calcium carbonate), dolomite (calcium magnesium carbonate) and fluorspar (calcium fluoride). They can generally be used only with d.c. electrode positive.

A.1.2B Rutile covering, represented by a 6

This indicates a covering with a large proportion of the mineral rutile, which is largely titanium dioxide (titania). Other chemicals and minerals that are easily ionized are also used. Electrodes using this flux system can be used with a.c. and d.c.

A.1.3B Acid covering, represented by a 7

This indicates a modified rutile type covering where some of the titania has been replaced with silica. It is characterized by a highly fluid slag, and allows greater ease of use when using a drag technique. The arc tends more towards a spray transfer. It may be more difficult to weld in the vertical up position on thinner material.

NOTE Under approach A (classification according to nominal composition) no distinction is made between the rutile and acid coverings in approach B (classification according to alloy type).