British Standard

BRITISH STANDARD

BS EN
1600 : 1997

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

The European Standard EN 1600 : 1997 has the status of a British Standard

ICS 25.160.20

National foreword

This British Standard is the English language version of EN 1600 : 1997. It supersedes BS 2926 : 1984, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee WEE/39, Welding consumables, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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

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

Schweißzusätze — Umhüllte Stabelektroden zum Lichtbogenhandschweißen von nichtrostenden und hitzebeständigen Stählen — Einteilung

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European Committee for Standardization
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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 121, Welding, the secretariat of which is held by DS.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 1998, and conflicting national standards shall be withdrawn at the latest by February 1998.

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Contents

Introduction

This standard proposes a classification in order to designate covered electrodes in terms of the chemical composition of the all-weld metal.

It should be noted that the mechanical properties of all-weld metal test specimens used to classify the electrodes will vary from those obtained in production joints because of differences in welding procedure such as electrode diameter, width of weave, welding position and material composition.

1 Scope

This standard specifies requirements for classification of covered electrodes based on the all-weld metal in the as welded or heat treated conditions for manual metal arc welding of stainless and heat resisting steels.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 759	*Welding consumables — Technical delivery conditions for welding filler metals including type of product, dimensions, tolerances and marking*
EN 1597-1	*Welding consumables — Test methods — Part 1: Test assembly for all-weld metal test specimens in steel, nickel and nickel alloys*
EN 1597-3	*Welding consumables — Test methods — Part 3: Classification testing of positional capability of welding consumables in a fillet weld*
EN 22401	*Covered electrodes — Determination of the efficiency, metal recovery and deposition coefficient* (ISO 2401 : 1972)
EN ISO 13916	*Welding — Guide for measurement of preheating temperature, interpass temperature and preheat maintenance temperature* (ISO 13916:1996)
ISO 31-0 : 1992	*Quantities and units — Part 0: General principles*

3 Classification

The classification includes all-weld metal properties obtained with a covered electrode as given below. The classification is based on the electrode diameter 4 mm with the exception of the testing for welding position which is based on diameter 3,2 mm.

The classification is divided into five parts:

1) the first part gives a symbol indicating the product/process to be identified;

2) the second part gives a symbol indicating the chemical composition of all-weld metal;

3) the third part gives a symbol indicating the type of electrode covering;

4) the fourth part gives a symbol indicating the weld metal recovery and the type of current;

5) the fifth part gives a symbol indicating the welding position.

In order to facilitate the use of this standard, the classification 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. the symbols defined in **4.1**, **4.2** and **4.3**;

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 **4.4** and **4.5**.

The full designation (see clause **8**) shall be used on packages and in the manufacturer's literature and data sheets.

4 Symbols and requirements

4.1 Symbol for the product/process

The symbol for the covered electrode used in the manual metal arc welding process shall be the letter E.

4.2 Symbol for the chemical composition of all-weld metal

The symbol in table 1 indicates the chemical composition of all-weld metal determined in accordance with clause **6**. The all-weld metal obtained with the covered electrodes in table 1 in accordance with clause **5** shall also fulfil the mechanical property requirements specified in table 2.

Table 1. Symbol for chemical composition of all-weld metal

Alloy symbol	Chemical composition in % (*m/m*) [1)2)3)]								
	C	Si	Mn	P[4)]	S[4)]	Cr	Ni[5)]	Mo[5)]	Other elements[5)]
Martensitic/ferritic									
13	0,12	1,0	1,5	0,030	0,025	11,0 to 14,0	—	—	—
13 4	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	—
17	0,12	1,0	1,5	0,030	0,025	16,0 to 18,0	—	—	—
Austenitic									
19 9	0,08	1,2	2,0	0,030	0,025	18,0 to 21,0	9,0 to 11,0	—	—
19 9 L	0,04	1,2	2,0	0,030	0,025	18,0 to 21,0	9,0 to 11,0	—	—
19 9 Nb	0,08	1,2	2,0	0,030	0,025	18,0 to 21,0	9,0 to 11,0	—	Nb[6)]
19 12 2	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	—
19 12 3 L	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	—
19 12 3 Nb	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	Nb[6)]
19 13 4 N L[7)]	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	N 0,20
Austenitic-ferritic. High corrosion resistance									
22 9 3 N L[8)]	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	N 0,08 to 0,20
25 7 2 N L	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	N 0,20
25 9 3 Cu N L[8)]	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	N 0,10 to 0,25; Cu 1,5 to 3,5
25 9 4 N L[8)]	0,04	1,2	2,5	0,030	0,025	24,0 to 27,0	8,0 to 10,5	2,5 to 4,5	N 0,20 to 0,30; Cu 1,5; W 1,0
Fully austenitic. High corrosion resistance									
18 15 3 L[7)]	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	—
18 16 5 N L[4)]	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	N 0,20
20 25 5 Cu N L[7)]	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	Cu 1,0 to 2,0; N 0,25
20 16 3 Mn N L[7)]	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	N 0,20
25 22 2 N L[7)]	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	N 0,20
27 31 4 Cu L[7)]	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	Cu 0,6 to 1,5

Table 1. Symbol for chemical composition of all-weld metal *(continued)*

Alloy symbol	Chemical composition in % *(m/m)* [1)2)3)]								
	C	Si	Mn	P[4)]	S[4)]	Cr	Ni[5)]	Mo[5)]	Other elements[5)]
Special types									
18 8 Mn[7)]	0,20	1,2	4,5 to 7,5	0,035	0,025	17,0 to 20,0	7,0 to 10,0	—	—
18 9 Mn Mo	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	—
20 10 3	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	—
23 12 L	0,04	1,2	2,5	0,030	0,025	22,0 to 25,0	11,0 to 14,0	—	—
23 12 Nb	0,10	1,2	2,5	0,030	0,025	22,0 to 25,0	11,0 to 14,0	—	Nb[6)]
23 12 2 L	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	—
29 9	0,15	1,2	2,5	0,035	0,025	27,0 to 31,0	8,0 to 12,0	—	—
Heat resisting types									
16 8 2	0,08	1,0	2,5	0,030	0,025	14,5 to 16,5	7,5 to 9,5	1,5 to 2,5	—
19 9 H	0,04 to 0,08	1,2	2,0	0,030	0,025	18,0 to 21,0	9,0 to 11,0	—	—
25 4	0,15	1,2	2,5	0,030	0,025	24,0 to 27,0	4,0 to 6,0	—	—
22 12	0,15	1,2	2,5	0,030	0,025	20,0 to 23,0	10,0 to 13,0	—	—
25 20 [7)]	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	—	—
25 20 H[7)]	0,35 to 0,45	1,2	2,5	0,030	0,025	23,0 to 27,0	18,0 to 22,0	—	—
18 36 [7)]	0,25	1,2	2,5	0,030	0,025	14,0 to 18,0	33,0 to 37,0	—	—

[1)] Single values shown in the table are maximum values.

[2)] Covered electrodes not listed in the table shall be symbolized similarly and prefixed by the letter Z.

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

[4)] 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.

[5)] If not specified: Mo < 0,75 %, Cu < 0,75 % and Ni < 0,60 %.

[6)] Nb min. 8 × % C, max. 1,1 %; up to 20 % of the amount of Nb can be replaced by Ta.

[7)] The all-weld metal is in most cases fully austenitic and therefore can be susceptable to microfissuring and solidification cracks. The occurrence of cracking is reduced by increasing the weld metal manganese level and in recognition of this the manganese range is extended for a number of the grades.

[8)] Electrodes under this symbol are usually selected for specific properties and may not be directly interchangeable.

Table 2. Mechanical properties of all-weld metal

Alloy symbol	Minimum proof strength $R_{p0.2}$ N/mm^2	Minimum tensile strength R_m N/mm^2	Minimum elongation [1] A %	Post weld heat treatment
13	250	450	15	[2]
13 4	500	750	15	[3]
17	300	450	15	[4]
19 9	350	550	30	None
19 9 L	320	510	30	
19 9 Nb	350	550	25	
19 12 2	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	None
25 7 2 N L	500	700	15	
25 9 3 Cu N L	550	620	18	
25 9 4 N L	550	620	18	
18 15 3 L	300	480	25	None
18 16 5 N L	300	480	25	
20 25 5 Cu N L	320	510	25	
20 16 3 Mn N L	320	510	25	
25 22 2 N L	320	510	25	
27 31 4 Cu L	240	500	25	
18 8 Mn	350	500	25	None
18 9 Mn Mo	350	500	25	
20 10 3	400	620	20	
23 12 L	320	510	25	
23 12 Nb	350	550	25	
23 12 2 L	350	550	25	
29 9	450	650	15	
16 8 2	320	510	25	None
19 9 H	350	550	30	
25 4	400	600	15	
22 12	350	550	25	
25 20	350	550	20	
25 20 H	350	550	10[5]	
18 36	350	550	10[5]	

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

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

[3] 580 °C to 620 °C for 2 h, air cooling.

[4] 760 °C to 790 °C for 2 h, furnace cooling down to 600 °C then air cooling.

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

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

4.3 Symbol for type of electrode covering

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

Two symbols are used to describe the type of covering:

– R rutile covering;

– B basic covering.

NOTE. A description of the characteristics of each of the types of covering is given in annex A.

4.4 Symbol for weld metal recovery and type of current

The symbol in table 3 indicates weld metal recovery, determined in accordance with EN 22401 with the type of current shown in table 3.

Table 3. Symbol for weld metal recovery and type of current

Symbol	Weld metal recovery %	Type of current[1)2)]
1	≤ 105	a.c. and d.c.
2	≤ 105	d.c.
3	> 105 ≤ 125	a.c. and d.c.
4	> 105 ≤ 125	d.c.
5	> 125 ≤ 160	a.c. and d.c.
6	> 125 ≤ 160	d.c.
7	> 160	a.c. and d.c.
8	> 160	d.c.

[1)] In order to demonstrate operability on alternating current tests shall be carried out with a no load voltage not higher than 65 V.

[2)] a.c. means alternating current; d.c. means direct current.

4.5 Symbol for welding position

The symbol below for welding positions indicates the positions for which the electrode is tested in accordance with EN 1597-3:

1) all positions;

2) all positions, except vertical down;

3) flat butt weld, flat fillet weld, horizontal vertical fillet weld;

4) flat butt weld, flat fillet weld;

5) vertical down and positions according to symbol 3.

5 Mechanical tests

5.1 General

Tensile tests and any required retests shall be carried out in the condition specified in table 2 (as-welded or after post weld heat treatment) using an all-weld metal test assembly type 3 in accordance with EN 1597-1 and welding conditions as described in **5.2** and **5.3**.

5.2 Preheating and interpass temperatures

Preheating and interpass temperatures shall be selected for the appropriate type of weld metal in table 4.

Table 4. Preheating and interpass temperatures

Alloy symbol as given in table 1	Type of weld metal	Preheating and interpass temperatures °C
13 17	Martensitic and ferritic chromium steel	200 to 300
13 4	Soft martensitic stainless steel	100 to 180
All others	Austenitic and austenitic — ferritic stainless steel	max. 150

The interpass temperature shall be measured using temperature indicator crayons, surface thermometers or thermocouples, see EN ISO 13916.

The interpass temperature shall not exceed the temperature indicated in table 4. If, after any pass, the interpass temperature is exceeded, the test assembly shall be cooled in air to a temperature below that limit.

5.3 Pass sequence

The pass sequence shall be as indicated in table 5.

The direction of welding to complete a layer consisting of two passes shall not vary, but the direction of welding of layers shall be alternated. Each pass shall be welded with a welding current of 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.

Table 5. Pass sequence

Electrode diameter mm	Split weave		
	Layer No.	Passes per layer	Number of layers
4,0	1 to top	2	7 to 9

6 Chemical analysis

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

NOTE. See annex B.

7 Technical delivery conditions

Technical delivery conditions shall meet the requirements in EN 759.

8 Designation

The designation of the covered electrode shall follow the principle given in the example below:

Example:

A covered electrode for manual metal arc welding deposits weld metal with a chemical composition 19 % Cr, 12 % Ni and 2 % Mo (19 12 2) of table 1. The electrode has a rutile covering (R) and can be used with alternating current or direct current and with a metal recovery of 120 % (3) in flat butt and flat fillet welds (4).

The designation will be:

covered electrode EN 1600 — E 19 12 2 R 3 4

Compulsory section:

covered electrode EN 1600 — E 19 12 2 R

where:

EN 1600	= standard number;
E	= covered electrode/manual metal arc welding (see **4.1**);
19 12 2	= chemical composition of all-weld metal (see table 1);
R	= type of electrode covering (see **4.3**);
3	= recovery and type of current (see table 3);
4	= welding position (see **4.5**).

Annex A (informative)
Description of types of electrode covering

A.1 Rutile covered electrodes

The covering of this type contains as an essential component titanium dioxide, in most cases as rutile, varying amounts of silicates, and small quantities of carbonates and fluorides.

Electrodes with rutile covering are suitable for direct and alternating current. They are easy to strike and to restrike and have a stable arc. The surface of the weld is smooth and finely rippled, the slag removal is good.

A.2 Basic covered electrodes

The covering of this type contains large quantities of both carbonates and fluorides.

Electrodes with basic covering are usually suitable only for direct current, electrode positive.

Annex B (informative)
Bibliography

B.1 *Handbuch für das Eisenhüttenlaboratorium*, VdEh, Düsseldorf

B.2 BS 6200-3 *Sampling and analysis of iron, steels and other ferrous metals – Part 3: Methods of analysis*

B.3 CR 10261 ECISS Information Circular 11, Iron and Steel, *Review of available methods of chemical analysis*

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