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Welding consumables — Fluxes for submerged arc welding and electroslag welding — Classification

Produits consommables pour le soudage — Flux pour le soudage à l'arc sous flux et le soudage sous laitier — Classification

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

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

This third edition cancels and replaces the second edition (ISO 14174:2012), which has been technically revised. The main changes compared to the previous edition are as follows:

— Subclause 5.4.3 now clarifies burn-out;

— ISO 18724 has been added to Clause 2;

— Table 3 has been expanded;

— Table 5 for flux class 2, welding current and voltage have been revised;

— an example of a Z option has been added;

— information on IIW Round robin testing of fluxes has been added to Annex B and as a bibliographical reference;

— Clause B.16 has been corrected to include CaF_2 (to align with EN 760).

Any feedback, question or request for official interpretation related to any aspect of this document should be directed to the Secretariat of ISO/TC 44/SC 3 via your national standards body. A complete listing of these bodies can be found at www.iso.org/members.html. Official interpretations, where they exist, are available from this page: https://committee.iso.org/sites/tc44/home/interpretation.html.

Welding consumables — Fluxes for submerged arc welding and electroslag welding — Classification

1 Scope

This document specifies requirements for classification of fluxes for submerged arc welding and electroslag welding for joining and overlay welding using wire electrodes, tubular cored electrodes, and strip electrodes.

NOTE This document was based on EN 760:1996.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3690, *Welding and allied processes — Determination of hydrogen content in arc weld metal*

ISO 14171, *Welding consumables — Solid wire electrodes, tubular cored electrodes and electrode/flux combinations for submerged arc welding of non alloy and fine grain steels — Classification*

ISO 14343, *Welding consumables — Wire electrodes, strip electrodes, wires and rods for arc welding of stainless and heat resisting steels — Classification*

ISO 18274, *Welding consumables — Solid wire electrodes, solid strip electrodes, solid wires and solid rods for fusion welding of nickel and nickel alloys — Classification*

ISO 80000-1:2009, *Quantities and units — Part 1: General* Corrected by ISO 80000-1:2009/Cor 1:2011

3 Terms and definitions

No terms and definitions are listed in this document.

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

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

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

4 Classification

Fluxes for submerged arc welding and electroslag welding for joining and overlay welding are granular, fusible products of mainly mineral origin, which are manufactured by various methods. Fluxes influence the chemical composition and the mechanical properties of the weld metal.

The classification of the fluxes is divided into seven parts:

1) the first part gives a symbol indicating the product/process (see 5.1);

2) the second part gives a symbol indicating the method of manufacture (see 5.2);

3) the third part gives a symbol indicating the type of flux, characteristic chemical constituents (see Table 1);

4) the fourth part gives a symbol indicating the applications, flux class (see 5.4);

5) the fifth part gives a symbol indicating the metallurgical behaviour (see 5.5);

6) the sixth part gives a symbol indicating the type of current (see 5.6);

7) the seventh part gives a symbol indicating the diffusible hydrogen content of deposited weld metal (see Table 6) — only applicable for class 1 fluxes.

The classification is divided into two sections.

a) the compulsory section, which includes the symbols for process, method of manufacture, characteristic chemical constituents, and applications, i.e. the symbols defined in 5.1, 5.2, 5.3 and 5.4.

b) the optional section, which includes the symbols for the metallurgical behaviour, type of current, and diffusible hydrogen, i.e. the symbols defined in 5.5, 5.6 and 5.7.

5 Symbols

5.1 Symbol for the product/process

The symbol for the flux used in submerged arc welding for joining and overlay welding shall be the letter S and for the flux used in electroslag welding for joining and overlay welding shall be the letters ES.

5.2 Symbol for method of manufacture

The symbol below indicates the method of manufacture:

— F: fused flux;

— A: agglomerated flux;

— M: mixed flux.

Fused fluxes are made by melting and granulating. Agglomerated fluxes are bound, granular mixtures of finer raw materials. Mixed fluxes comprise all fluxes which, after fusing or agglomerating, are mixed with one or more additional components or fluxes.

For particle size requirements in marking, see Clause 6.

5.3 Symbol for type of flux, characteristic chemical constituents

The symbols in Table 1 indicate the type of flux in accordance with the characteristic chemical constituents. Elemental analysis shall be performed on representative samples of the flux. Any suitable analytical technique may be used, but in cases of dispute reference shall be made to established methods. Based on the elemental analysis of the flux, the characteristic chemical constituents of the flux can be determined.

Examples of such determinations are shown in Annex A and descriptions of flux types are given in Annex B.

5.4 Symbol for applications, flux class

5.4.1 General

A given flux may carry more than one class as specified in 5.4.2 to 5.4.5.

5.4.2 Flux class 1

These are fluxes for submerged arc welding of non-alloy and fine grain steels, high-strength steels, creep-resisting steels, and atmospheric corrosion-resisting steels.

In general, the fluxes do not contain alloying elements, other than Mn and Si, thus the weld metal analysis is predominantly influenced by the composition of the wire/strip electrode and metallurgical reactions. The fluxes are suitable for joint welding and/or overlay welding. In the case of joint welding, some fluxes can be applied for both multi-run and single-run and/or two-run technique.

In the flux designation, the digit 1 indicates class 1.

5.4.3 Flux classes 2 and 2B

These are fluxes for joint welding of stainless and heat-resisting steels and/or nickel and nickel alloys and corrosion-resistant overlay welding[1)]. Fluxes of these classes can contain alloying elements compensating for the burn-out (elements lost to the slag).

In the flux designation, the digit 2 is used to indicate class 2 fluxes mainly suited for joint welding, but which can also be used for strip cladding. 2B is used for fluxes especially designed for strip cladding.

5.4.4 Flux class 3

These are fluxes mainly for hard-facing overlay welding by transfer of alloying elements from the flux, such as C, Cr or Mo.

In the flux designation, the digit 3 indicates class 3.

5.4.5 Flux class 4

These are other fluxes for which classes 1 to 3 are not applicable, e.g. fluxes for copper alloys.

In the flux designation, the digit 4 indicates class 4.

Table 1 — Symbol for type of flux, characteristic chemical constituents[a,b]

Symbol (description)	Characteristic chemical constituents	Limit of constituent % (by mass)
MS	$MnO + SiO_2$	≥50
(Manganese-silicate)	CaO	≤15
CS	$CaO + MgO + SiO_2$	≥55
(Calcium-silicate)	CaO + MgO	≥15
CG	CaO + MgO	5 to 50
(Calcium-magnesium)	CO_2	≥2
	Fe	≤10
CB	CaO + MgO	30 to 80
(Calcium-magnesium basic)	CO_2	≥2
	Fe	≤10

a Calculations can be made as shown in Annex A.

b A description of the characteristics of each of the types of flux is given in Annex B.

c Fluxes for which the chemical composition is not listed shall be symbolized by the letter Z. The chemical composition ranges are not specified and it is possible that two fluxes with the same Z classification are not interchangeable.

1) Not all fluxes suitable for use with stainless steel filler metal are also suitable for nickel and nickel alloy filler metal.

Table 1 *(continued)*

Symbol (description)	Characteristic chemical constituents	Limit of constituent % (by mass)
CG-I (Calcium-magnesium with iron)	CaO + MgO CO_2 Fe	5 to 45 ≥2 15 to 60
CB-I (Calcium-magnesium basic with iron)	CaO + MgO CO_2 Fe	10 to 70 ≥2 15 to 60
GS (Magnesium-silicate)	$MgO + SiO_2$ Al_2O_3 $CaO + CaF_2$	≥42 ≤20 ≤14
ZS (Zirconium-silicate)	$ZrO_2 + SiO_2 + MnO$ ZrO_2	≥45 ≥15
RS (Rutile-silicate)	$TiO_2 + SiO_2$ TiO_2	≥50 ≥20
AR (Aluminate-rutile)	$Al_2O_3 + TiO_2$	≥40
BA (Basic-alumina)	$Al_2O_3 + CaF_2 + SiO_2$ CaO SiO_2	≥55 ≥8 ≤20
AAS (Acid-aluminium-silicate)	$Al_2O_3 + SiO_2$ $CaF_2 + MgO$	≥50 ≥20
AB (Aluminate-basic)	$Al_2O_3 + CaO + MgO$ Al_2O_3 CaF_2	≥40 ≥20 ≤22
AS (Aluminate-silicate)	$Al_2O_3 + SiO_2 + ZrO_2$ $CaF_2 + MgO$ ZrO_2	≥40 ≥30 ≥5
AF (Aluminate-fluoride-basic)	$Al_2O_3 + CaF_2$	≥70
FB (Fluoride-basic)	$CaO + MgO + CaF_2 + MnO$ SiO_2 CaF_2	≥50 ≤20 ≥15
Z[c]	Any other agreed composition	

[a] Calculations can be made as shown in Annex A.

[b] A description of the characteristics of each of the types of flux is given in Annex B.

[c] Fluxes for which the chemical composition is not listed shall be symbolized by the letter Z. The chemical composition ranges are not specified and it is possible that two fluxes with the same Z classification are not interchangeable.

5.5 Symbol for metallurgical behaviour

5.5.1 General

The metallurgical behaviour of a flux is characterized by the contribution (pick-up and/or burn-out) of alloying elements. Concerning fluxes for joining, the contribution is the difference between the chemical composition of the all-weld metal deposit and the composition of the specified electrode. Concerning fluxes for overlay welding, the contribution is the difference between the chemical composition of the deposited weld metal of the last bead/layer and the chemical composition of the specified wire/strip electrode.

5.5.2 Metallurgical behaviour, flux class 1

For determining the pick-up and burn-out behaviour, a wire electrode ISO 14171-A – S2 or ISO 14171-B – SU22 shall be used in accordance with 5.5.6. The pick-up or burn-out of the elements Si and Mn shall be stated in this sequence.

The symbols in Table 2 indicate the metallurgical behaviour of a welding flux class 1.

Table 2 — Symbol for metallurgical behaviour of class 1 fluxes

Metallurgical behaviour	Symbol	Contribution from flux on all-weld metal % (by mass)
Burn-out [a]	1	>0,7
	2	0,5 to 0,7
	3	0,3 to 0,5
	4	0,1 to 0,3
Neutral	5	0,0 to 0,1
Pick-up	6	0,1 to 0,3
	7	0,3 to 0,5
	8	0,5 to 0,7
	9	>0,7

[a] For Si, symbols 1, 2, 3 and 4 are not used.

5.5.3 Metallurgical behaviour, flux classes 2 and 2B

For determining the pick-up or burn-out behaviour, wire or strip electrodes shall be selected in accordance with Table 3 and shall be used in accordance with 5.5.6.

The pick-up or burn-out of the elements C, Si, Cr, and Nb shall be stated in this sequence. If the flux adds other elements, these shall be indicated by stating the corresponding chemical symbols (e.g. Ni, Mo) immediately after the symbols for C, Si, Cr, and Nb.

The symbols in Table 4 indicate the metallurgical behaviour for class 2 and class 2B fluxes.

Table 3 — Electrodes used for determination of metallurgical behaviour for class 2 and class 2B fluxes

Product/ process	Class	Electrode to be used			
		ISO 14343-A[a]	ISO 14343-B[a]	ISO 18274 (numerical)	ISO 18274 (chemical)
S	2	S 19 9 L	SS308L	N/A	N/A
ES	2	S 19 9 L	SS308L	N/A	N/A
S	2B	B 19 9 L	BS 308L	N/A	N/A
ES	2B	B 19 9 L	BS 308L	N/A	N/A
S	2	N/A	N/A	S Ni 6625	S NiCr22Mo9Nb
ES	2	N/A	N/A	S Ni 6625	S NiCr22Mo9Nb
S	2B	N/A	N/A	B Ni 6625	S NiCr22Mo9Nb
ES	2B	N/A	N/A	B Ni 6625	S NiCr22Mo9Nb

[a] To determine carbon burn-out, electrodes with minimum 0,04 % (by mass) C shall be used. To determine niobium burn-out, 19 9 Nb/347 electrodes shall be used.

N/A Not applicable.

5.5.4 Metallurgical behaviour, flux class 3

The pick-up of alloying elements shall be indicated by stating the corresponding chemical symbols (e.g. C, Cr, Mo) and approximate amount without the % symbol. For determining the pick-up behaviour a wire electrode, ISO 14171-A – S2 or ISO 14171-B – SU22, shall be used in accordance with 5.5.6.

5.5.5 Metallurgical behaviour, flux class 4

The pick-up of alloying elements shall be indicated by stating the corresponding chemical symbols.

Table 4 — Symbols for metallurgical behaviour for class 2 and class 2B fluxes

Metallurgical behaviour	Symbol	Contribution from flux on all-weld metal % (by mass)			
		C	Si	Cr	Nb
Burn-out	1	>0,020	>0,7	>2,0	>0,20
	2	symbol not used	0,5 to 0,7	1,5 to 2,0	0,15 to 0,20
	3	0,010 to 0,020	0,3 to 0,5	1,0 to 1,5	0,10 to 0,15
	4	symbol not used	0,1 to 0,3	0,5 to 1,0	0,05 to 0,10
Neutral	5	0,000 to 0,010	0,0 to 0,1	0,0 to 0,5	0,00 to 0,05
Pick-up	6	symbol not used	0,1 to 0,3	0,5 to 1,0	0,05 to 0,10
	7	0,010 to 0,020	0,3 to 0,5	1,0 to 1,5	0,10 to 0,15
	8	symbol not used	0,5 to 0,7	1,5 to 2,0	0,15 to 0,20
	9	>0,020	>0,7	>2,0	>0,20

5.5.6 Determination of symbols for metallurgical behaviour

For the determination of symbols for class 1 and 2 fluxes, a weld metal pad shall be prepared in accordance with Table 5. For class 3 and 4 fluxes, the weld pad shall be prepared as recommended by the manufacturer.

The surface oxide on the sampling portion of the specimen for chemical analysis shall be removed by machining or grinding. When taking chips from a milling, a shaping or a drilling machine, the use of cutting fluid shall be avoided. The specimen for chemical analysis shall be taken from the weld metal of the highest layer. The specimen shall not include the start or the crater.

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

Table 5 — Welding conditions for preparation of a weld metal pad

Product/process	S			ES
Flux class	1	2	2B	2B
Electrode dimension, mm	4,0	3,0	60 × 0,5	60 × 0,5
Runs per layer	2		1	
Number of layers	8		3	2
Length of weld deposit, mm	≥200			
Electrode extension, mm	30 ± 5	27 ± 3		
Type of current[a]	Direct current electrode positive (DCEP)			
Welding current, A	580 ± 20	480 ± 20	750 ± 25	1 250 ± 30
Welding voltage, V	29 ± 2	29 ± 2	28 ± 2	25 ± 2
Welding speed, mm/min	550 ± 50	500 ± 50	120 ± 10	160 ± 15
Interpass temperature, °C	150 ± 50	≤150		

[a] If AC only or AC and DC operations are claimed, the test welding shall be carried out using AC only (AC = alternating current; DC = direct current).

5.6 Symbol for type of current

The symbols below indicate the type of current (alternating or direct) for which the flux is suitable:

— DC is the symbol for direct current;

— AC is the symbol for alternating current.

Suitability for use with alternating current (AC) generally also implies suitability for use with direct current (DC).

5.7 Symbol for diffusible hydrogen content in deposited weld metal (class 1 fluxes only)

The symbols in Table 6 indicate the diffusible hydrogen content in deposited weld metal determined in accordance with the method specified in ISO 3690 using a wire electrode ISO 14171-A – S2 or ISO 14171-B – SU22.

Other methods of collection and measurement of the diffusible hydrogen can be used for testing provided they possess equal reproducibility with, and are calibrated against, the method specified in ISO 3690.

In cases of dispute, the method specified in ISO 3690 shall be used.

Table 6 — Symbol for diffusible hydrogen content in deposited weld metal

Symbol	Diffusible hydrogen content ml/100 g deposited weld metal maximum
H2	2
H4	4
H5	5
H10	10

If a diffusible hydrogen symbol is indicated, the manufacturer shall provide information on the recommended type of current and redrying conditions for achieving that hydrogen limit.