BRITISH STANDARD

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Welding consumables — Solid wires, solid wire-flux and tubular cored electrode-flux combinations for submerged arc welding of non alloy and fine grain steels — Classification

The European Standard EN 756:2004 has the status of a British Standard

ICS 25.160.20

National foreword

This British Standard is the official English language version of EN 756:2004. It supersedes BS EN 756:1996 which is withdrawn.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 international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

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Welding consumables - Solid wires, solid wire-flux and tubular cored electrode-flux combinations for submerged arc welding of non alloy and fine grain steels - Classification

Produits consommables pour le soudage - Fils pleins, couples fils pleins-flux et fils fourrés-flux pour le soudage à l'arc sous flux des aciers non alliés et à grains fins - Classification

Schweißzusätze - Massivdrähte, Fülldrähte und Drahtpulver-Kombinationen zum Unterpulverschweißen von unlegierten Stählen und Feinkornbaustählen - Einteilung

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Contents

Foreword

This document (EN 756:2004) has been prepared by Technical Committee CEN/TC 121 “Welding”, the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by September 2004, and conflicting national standards shall be withdrawn at the latest by September 2004.

This document supersedes EN 756:1995.

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Introduction

This standard proposes a classification in order to designate solid wire electrodes by chemical analyses and solid wire-flux combinations in terms of the yield strength, tensile strength and elongation and impact properties of the all-weld metal. Tubular cored electrode-flux combinations are designated by the chemical composition; yield strength, tensile strength and elongation and impact properties of the all-weld metal. The ratio of yield to tensile strength of weld metal is generally higher than that of parent metal. Users should note that matching weld metal yield strength to parent metal yield strength will not necessarily ensure that the weld metal tensile strength matches that of the parent material. Where the application requires matching tensile strength, therefore, selection of the consumable should be made by reference to column 3 of Table 1.

Although combinations of electrodes and fluxes supplied by individual companies may have the same grading, the individual electrodes and fluxes from different companies are not interchangeable unless verified according to this standard.

It should be noted that the mechanical properties of all-weld metal test specimens used to classify the electrode-flux combinations will vary from those obtained in production joints because of differences in welding procedures such as electrode size and parent metal chemical composition.

1 Scope

This standard specifies requirements for classification of electrode-flux combinations and all-weld metal in the as-welded condition for submerged arc welding of non alloy and fine grain steels with a minimum yield strength of up to 500 MPa. Classification can be made with solid wire electrodes or tubular cored electrodes. One flux may be classified with different electrodes. The solid wire electrode is also classified separately based on its chemical composition. Fluxes for the single and two run techniques are classified on the basis of the two run technique.

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 European Standards only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN ISO 544, *Welding consumables – Technical delivery conditions for welding filler materials – Type of product, dimensions, tolerances and markings (ISO 544:2003).*

EN 760, *Welding consumables – Fluxes for submerged arc welding – Classification.*

EN 1597-1, *Welding consumables - Test methods - Part 1: Test piece for all-weld metal test specimens in steel, nickel and nickel alloys.*

EN 1597-2, *Welding consumables - Test methods - Part 2: Preparation of test piece for single-run and two-run technique test specimens in steel.*

EN ISO 6847, *Welding consumables - Deposition of a weld metal pad for chemical analysis (ISO 6847:2000).*

EN ISO 13916, *Welding – Guidance on the 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 manufacturer's specific electrode-flux combination as given below. A solid wire electrode may be separately classified with the symbol for its chemical composition in Table 5.

The classification is divided into five parts:

1) The first part gives a symbol indicating the process to be identified.

2) The second part gives a symbol indicating strength and elongation of all-weld metal for multi run technique or the strength of the parent material used in classification for the two run technique.

3) The third part gives a symbol indicating impact properties of the all-weld metal or the two run welded joint.

4) The fourth part gives a symbol indicating the type of flux used.

5) The fifth part gives a symbol indicating the chemical composition of the solid wire electrode used or the chemical composition of the all-weld metal deposited by a tubular cored electrode-flux combination.

4 Symbols and requirements

4.1 Symbol for the process

The symbol for a solid wire electrode and/or an electrode-flux combination used in the submerged arc welding process shall be the letter S.

4.2 Symbol for the tensile properties

4.2.1 Multi run technique

The symbol in Table 1 indicates yield strength, tensile strength and elongation of the all-weld metal in the as-welded condition determined in accordance with 5.1.

Table 1 — Symbol for tensile properties by multi run technique

Symbol	Minimum yield strength [a] MPa	Tensile strength MPa	Minimum elongation [b] %
35	355	440 to 570	22
38	380	470 to 600	20
42	420	500 to 640	20
46	460	530 to 680	20
50	500	560 to 720	18

[a] For yield strength the lower yield (R_{eL}) shall be used when yielding occurs, otherwise the 0,2 % proof strength ($R_{pO,2}$) shall be used.

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

4.2.2 Two-run technique

The symbol indicates strength of the welded joint in relation to strength of the parent material used in two-run welding tests satisfactorily completed in accordance with 5.2.

Table 2 — Symbol for the tensile properties by two-run technique

Symbol	Minimum parent material yield strength MPa	Minimum tensile strength of the welded joint MPa
2T	275	370
3T	355	470
4T	420	520
5T	500	600

4.3 Symbol for the impact properties of all-weld metal or two-run weldment

The symbol in Table 3 indicates the temperature at which an average impact energy of 47 J is achieved under conditions given in clause 5. Three specimens shall be tested. Only one individual value may be lower than 47 J but not lower than 32 J. When an electrode-flux combination has been classified for a certain temperature, it automatically covers any higher temperature in Table 3.

Table 3 — Symbol for the impact properties of all-weld metal or two-run welded joint

Symbol	Temperature for minimum average impact energy of 47 J °C
Z	no requirements
A	+ 20
0	0
2	- 20
3	- 30
4	- 40
5	- 50
6	- 60
7	- 70
8	- 80

4.4 Symbol for the type of welding flux

The symbol in Table 4 indicates the welding flux as described in EN 760.

Table 4 — Symbol for the type of welding flux

Type of flux	Symbol
Manganese-silicate	MS
Calcium-silicate	CS
Zirconium-silicate	ZS
Rutile-silicate	RS
Aluminate-rutile	AR
Aluminate-basic	AB
Aluminate-silicate	AS
Aluminate-fluoride-basic	AF
Fluoride-basic	FB
Any other type	Z

4.5 Symbol for the chemical composition of solid wire electrodes or the all-weld metal deposited by a tubular cored electrode-flux combinations

The symbol in Table 5 indicates the chemical composition of the solid wire electrode and includes an indication of characteristic alloying elements.

The symbol in Table 6 indicates the chemical composition of the all-weld metal deposited by a tubular cored electrode-flux combination carried out according to Table 7.

The chemical composition of the weld metal is dependent on the chemical composition of the solid wire electrode or tubular cored electrode and the metallurgical behaviour of the flux (see EN 760).

Table 5 — Chemical composition of solid wire electrodes for submerged arc welding

Symbol	Chemical composition (%) (m/m) [a b c]								
	C	Si	Mn	P	S	Mo	Ni	Cr	Cu
SZ	any other agreed composition								
S1	0,05 to 0,15	0,15	0,35 to 0,60	0,025	0,025	0,15	0,15	0,15	0,30
S2	0,07 to 0,15	0,15	0,80 to 1,30	0,025	0,025	0,15	0,15	0,15	0,30
S3	0,07 to 0,15	0,15	1,30 to 1,75	0,025	0,025	0,15	0,15	0,15	0,30
S4	0,07 to 0,15	0,15	1,75 to 2,25	0,025	0,025	0,15	0,15	0,15	0,30
S1Si	0,07 to 0,15	0,15 to 0,40	0,35 to 0,60	0,025	0,025	0,15	0,15	0,15	0,30
S2Si	0,07 to 0,15	0,15 to 0,40	0,80 to 1,30	0,025	0,025	0,15	0,15	0,15	0,30
S2Si2	0,07 to 0,15	0,40 to 0,60	0,80 to 1,30	0,025	0,025	0,15	0,15	0,15	0,30
S3Si	0,07 to 0,15	0,15 to 0,40	1,30 to 1,85	0,025	0,025	0,15	0,15	0,15	0,30
S4Si	0,07 to 0,15	0,15 to 0,40	1,85 to 2,25	0,025	0,025	0,15	0,15	0,15	0,30
S1Mo	0,05 to 0,15	0,05 to 0,25	0,35 to 0,60	0,025	0,025	0,45 to 0,65	0,15	0,15	0,30
S2Mo	0,07 to 0,15	0,05 to 0,25	0,80 to 1,30	0,025	0,025	0,45 to 0,65	0,15	0,15	0,30
S3Mo	0,07 to 0,15	0,05 to 0,25	1,30 to 1,75	0,025	0,025	0,45 to 0,65	0,15	0,15	0,30
S4Mo	0,07 to 0,15	0,05 to 0,25	1,75 to 2,25	0,025	0,025	0,45 to 0,65	0,15	0,15	0,30
S2Ni1	0,07 to 0,15	0,05 to 0,25	0,80 to 1,30	0,020	0,020	0,15	0,80 to 1,20	0,15	0,30
S2Ni1,5	0,07 to 0,15	0,05 to 0,25	0,80 to 1,30	0,020	0,020	0,15	1,20 to 1,80	0,15	0,30
S2Ni2	0,07 to 0,15	0,05 to 0,25	0,80 to 1,30	0,020	0,020	0,15	1,80 to 2,40	0,15	0,30
S2Ni3	0,07 to 0,15	0,05 to 0,25	0,80 to 1,30	0,020	0,020	0,15	2,80 to 3,70	0,15	0,30
S2Ni1Mo	0,07 to 0,15	0,05 to 0,25	0,80 to 1,30	0,020	0,020	0,45 to 0,65	0,80 to 1,20	0,20	0,30
S3Ni1,5	0,07 to 0,15	0,05 to 0,25	1,30 to 1,70	0,020	0,020	0,15	1,20 to 1,80	0,20	0,30
S3Ni1Mo	0,07 to 0,15	0,05 to 0,25	1,30 to 1,80	0,020	0,020	0,45 to 0,65	0,80 to 1,20	0,20	0,30
S3Ni1,5Mo	0,07 to 0,15	0,05 to 0,25	1,20 to 1,80	0,020	0,020	0,30 to 0,50	1,20 to 1,80	0,20	0,30
S2Ni1Cu	0,08 to 0,12	0,15 to 0,35	0,70 to 1,20	0,020	0,020	0,15	0,65 to 0,90	0,40	0,40 to 0,65
S3Ni1Cu	0,05 to 0,15	0,15 to 0,40	1,20 to 1,70	0,025	0,025	0,15	0,60 to 1,20	0,15	0,30 to 0,60

a Finished product chemical composition, Cu inclusive of copper coating, Al ≤ 0,030 %.

b Single values shown in the Table mean 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 6 — Chemical composition of the all-weld metal deposited by a tubular cored electrode-flux combination

Symbol	Chemical composition % (m/m)[a b c]			
	Mn	Ni	Mo	Cu
T2	1,4	-	-	0,3
T3	1,4 to 2,0	-	-	0,3
T2Mo	1,4	-	0,3 to 0,6	0,3
T3Mo	1,4 to 2,0	-	0,3 to 0,6	0,3
T2Ni1	1,4	0,6 to 1,2	-	0,3
T2Ni1,5	1,6	1,2 to 1,8	-	0,3
T2Ni2	1,4	1,8 to 2,6	-	0,3
T2Ni3	1,4	2,6 to 3,8	-	0,3
T3Ni1	1,4 to 2,0	0,6 to 1,2	-	0,3
T2Ni1Mo	1,4	0,6 to 1,2	0,3 to 0,6	0,3
T2Ni1Cu	1,4	0,8 to 1,2	-	0,3 to 0,6
TZ	any other agreed composition			

[a] If not specified Mo ≤ 0,2 %, Ni ≤ 0,5 %, Cr ≤ 0,2 %, V ≤ 0,08 %, Nb ≤ 0,05 %, C 0,03 % to 0,15 %, Si ≤ 0,8 %, S ≤ 0,025 %, P ≤ 0,025 %.

[b] Single values shown in the Table mean 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.

5 Mechanical tests

5.1 Multi run technique

Tensile and impact tests and any required retests shall be carried out on weld metal in the as-welded condition using an all-weld metal test assembly type 3 according to EN 1597-1 using 4,0 mm or 3,2 mm (3,0 mm; 2,8 mm) diameter electrodes which ever is the larger size being supplied.

Welding conditions (single electrode welding) and details of the test assembly shall be selected from Table 7.

Preheating is not required; welding may start from room temperature.

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 interpass temperature indicated in Table 7. If, after any pass, the interpass temperature is exceeded, the test assembly shall be cooled in air to a temperature within the indicated range.

Table 7 — Welding conditions for multi run single wire welding

Conditions [a]	Solid wire electrode diameter (mm)		Cored wire electrode diameter (mm)	
	2,8 to 3,2	4,0	3,0 to 3,2	4,0
Length of weld deposit (mm)	min. 350	min. 350	min. 350	min. 350
Type of current	direct current [b]			
Welding current (A)	440 ± 20	580 ± 20	480 ± 20	550 ± 20
Welding voltage (V)	27 ± 1	29 ± 1	30 ± 1	30 ± 1
Welding speed (mm/min)	400 ± 50	550 ± 50	450 ± 50	450 ± 50
Interpass temperature (°C) (no preheat)	150 ± 25	150 ± 25	150 ± 25	150 ± 25
Electrode extension (mm)	30 ± 5	30 ± 5	30 ± 5	30 ± 5

[a] If alternating current and direct current operations are claimed; test welding shall be carried out using alternating current only.

[b] Direct current welding polarity shall follow the recommendation of the manufacturer.

5.2 Two run technique

Tensile and impact tests and any required retests shall be carried out on weld metal in the as-welded condition using a test assembly type 4 according to EN 1597-2. Welding conditions shall be within the range recommended by the manufacturer and shall be recorded to demonstrate compliance with this standard.

6 Chemical analysis

Chemical analysis shall be performed on specimens of the solid wire electrode or on any suitable all-weld metal test specimen deposited by the electrode-flux combination. In case of dispute specimens in accordance with EN ISO 6847 shall be used. Any analytical technique can be used, but in case of dispute reference shall be made to established published methods.

NOTE See Bibliography.

7 Technical delivery conditions

Technical delivery conditions shall meet the requirements in EN ISO 544.

8 Designation

The designation of the solid wire electrode and the electrode-flux combination shall follow the principle given in the examples below:

EXAMPLE 1 A wire-flux combination for submerged arc welding for multi run technique deposits a weld metal with a minimum yield strength of 460 MPa (46) and a minimum average impact energy of 47 J at -30°C (3) produced with an aluminate-basic flux (AB) and a solid wire electrode S2 is designated:

Wire-flux combination EN 756 - S 46 3 AB S2

where:

EN 756 = standard number
S = submerged arc welding (see 4.1)
46 = tensile properties (see Table 1)
3 = impact properties (see Table 3)
AB = type of welding flux (see Table 4)
S2 = chemical composition (see Table 5)

EXAMPLE 2 A wire-flux combination for submerged arc welding using two run technique demonstrated in accordance with the manufacturer's recommendation in a parent metal with minimum yield strength 420 MPa (4T) achieving a weld metal with transverse tensile strength > 520 MPa and impact energy 47J at -20°C (2) with an aluminate-basic flux (AB) and a solid wire electrode S2Mo is designated:

Wire-flux combination EN 756 - S 4T 2 AB S2Mo

where:

EN 756 = standard number;
S = submerged arc welding (see 4.1)
4T = tensile properties (see Table 2)
2 = impact properties (see Table 3)
AB = type of welding flux (see Table 4)
S2Mo = chemical composition (see Table 5)

EXAMPLE 3 A solid wire electrode complying with the chemical requirement of S2Mo in Table 5 is designated:

Solid wire electrode EN 756 - S2Mo

EXAMPLE 4 A tubular cored electrode-flux combination for submerged arc welding for multi run technique deposits a weld metal with a minimum yield strength of 420 MPa (42) and a minimum average impact energy of 47 J at -20°C (2) produced with an aluminate-basic flux (AB) and the all-weld metal chemical composition T3Mo, is designated:

Tubular cored electrode-flux combination EN 756 - S 42 2 AB T3Mo

where:

EN 756 = standard number
S = submerged arc welding (see 4.1)
42 = tensile properties (see Table 1)
2 = impact properties (see Table 3)
AB = type of welding flux (see Table 4)
T3Mo = chemical composition (see Table 6)

Bibliography

Handbuch für das Eisenhüttenlaboratorium, VdEh, Düsseldorf.

BS 6200-3, *Sampling and analysis of iron, steel and other ferrous metals. Methods of analysis. Summary of methods.*

CR 10261, *ECISS Information Circular 11 - Iron and steel - Review of available methods of chemical analysis.*

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