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Welding consumables — Rods, wires and deposits for tungsten inert gas welding of non-alloy and fine-grain steels — Classification

Produits consommables pour le soudage — Baguettes et fils pour dépôts par soudage TIG des aciers non alliés et des aciers à grains fins — 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 636 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 636:1989), which has been technically revised.

Introduction

This International Standard provides a classification for the designation of rods and wires in terms of their chemical composition and, where required, in terms of the yield strength, tensile strength and elongation 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 strengths, selection of consumable should be made by reference to column 3 of Table 1A or Table 1B.

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

The classification according to system A is mainly based on EN 1668:1997, *Welding consumables — Rods, wires and deposits for tungsten inert gas welding of non alloy and fine grain 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 — Rods, wires and deposits for tungsten inert gas welding of non-alloy and fine-grain steels — Classification

1 Scope

This International Standard specifies requirements for classification of rods and wires in the as-welded condition and in the post-weld heat-treated condition for tungsten inert gas welding of non-alloy and fine grain steels with a minimum yield strength of up to 500 MPa or a minimum tensile strength of up to 570 MPa.

This International Standard is a combined specification providing classification utilizing a system based upon the yield strength and the average impact energy of 47 J of all-weld metal, or utilizing a system based upon the tensile strength and the average impact energy of 27 J of all-weld metal.

1) Paragraphs and tables which carry the suffix letter “A” are applicable only to rods and wires classified to the system based upon the yield strength and the average impact energy of 47 J of all-weld metal in accordance with this International Standard.

2) Paragraphs and tables which carry the suffix letter “B” are applicable only to rods and wires classified to the system based upon the tensile strength and the average impact energy of 27 J of all-weld metal in accordance with this International Standard.

3) Paragraphs and tables which have neither the suffix letter “A” nor the suffix letter “B” are applicable to all rods and wires classified in accordance with this International Standard.

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 markings*

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

ISO 14175, *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 — Testing methods — Part 1: Test methods for all-weld metal test specimens in steel, nickel and nickel alloys*

3 Classification

Classification designations are based upon two approaches to indicate the tensile properties and the impact properties of the all-weld metal obtained with rods or wires. The two designation approaches include additional designators for some other classification requirements, but not all, as will be clear from the following sections. In most cases, a given commercial product can be classified to the classification requirements in both systems. Then either or both classification designations can be used for the product.

Rods or wires shall be classified according to their chemical composition in accordance with Table 3A or Table 3B.

3A Classification by yield strength and 47 J impact energy

The classification is divided into four parts:

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

2) the second part gives a symbol indicating the strength and elongation of the all-weld metal (see Table 1A);

3) the third part gives a symbol indicating the impact properties of all-weld metal (see Table 2);

4) the fourth part gives a symbol indicating the chemical composition of the rods or wires used (see Table 3A).

3B Classification by tensile strength and 27 J impact energy

The classification is divided into four parts:

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

2) the second part gives a symbol indicating the strength and elongation of the all-weld metal in either the as-welded or post-weld heat-treated condition (see Table 1B);

3) the third part gives a symbol indicating the impact properties of all-weld metal in the same condition as specified for the tensile strength (see Table 2). The letter “U” after this designator indicates that the deposit meets an average optional requirement of 47 J at the designated Charpy test temperature;

4) the fourth part gives a symbol indicating the chemical composition of the rods or wires used (see Table 3B).

4 Symbols and requirements

4.1 Symbol for the product/process

The symbol of weld deposit by the tungsten inert gas welding process shall be the letter “W” placed at the beginning of the designation.

The symbol of rods or wires for the tungsten inert gas welding shall be the letter “W” placed at the beginning of the rod or wire designation.

4.2 Symbol for strength and elongation of all-weld metal

4.2A Classification by yield strength and 47 J impact energy

The symbol in Table 1A indicates yield strength, tensile strength and elongation of the all-weld metal in the as-welded condition determined in accordance with Clause 6.

4.2B Classification by tensile strength and 27 J impact energy

The symbol in Table 1B indicates yield strength, tensile strength and elongation of the all-weld metal in the as-welded condition or in the post-weld heat-treated condition determined in accordance with Clause 6.

Table 1A — Symbol for strength and elongation of all-weld metal

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}) is used when yielding occurs, otherwise the 0,2 % proof strength ($R_{p0,2}$) is used.

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

Table 1B — Symbol for strength and elongation of all-weld metal

Symbol[a]	Minimum yield strength[b] MPa	Tensile strength MPa	Minimum elongation[c] %
43X	330	430 to 600	20
49X	390	490 to 670	18
55X	460	550 to 740	17
57X	490	570 to 770	17

[a] X is "A" or "P". Where "A" indicates testing in the as-welded condition and "P" indicates testing in the post-weld heat-treated condition.

[b] For yield strength the lower yield (R_{eL}) is used when yielding occurs, otherwise the 0,2 % proof strength ($R_{p0,2}$) is used.

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

4.3 Symbol for impact properties of all-weld metal

4.3A Classification by yield strength and 47 J impact energy

The symbol in Table 2 indicates the temperature at which an impact energy of 47 J is achieved under the conditions given in Clause 6. Three test specimens shall be tested. Only one individual value may be lower than 47 J but not lower than 32 J.

4.3B Classification by tensile strength and 27 J impact energy

The symbol in Table 2 indicates the temperature at which an impact energy of 27 J is achieved in the as-welded condition or in the post-weld heat-treated condition under the conditions given in Clause 6. Five test specimens shall be tested. The lowest and highest values obtained shall be disregarded. Two of the three remaining values shall be greater than the specified 27 J level, one of the three may be lower but shall not be less than 20 J. The average of the three remaining values shall be at least 27 J. Three test specimens shall be tested when the optional supplemental designator "U" is used to indicate that the weld deposit will meet a minimum impact energy of 47 J at the test temperature. The impact value shall be determined by the average of the three test specimens. The average of the three values shall be 47 J or greater.

Table 2 — Symbol for impact properties of all-weld metal

Symbol	Temperature for minimum average impact energy of 47 J [a] or 27 J [b] °C
Z	No requirements
A [a] or Y [b]	+ 20
0	0
2	− 20
3	− 30
4	− 40
5	− 50
6	− 60
7	− 70
8	− 80
9	− 90
10	− 100

[a] Classification by yield strength and 47 J impact energy.

[b] Classification by tensile strength and 27 J impact energy.

4.4 Symbol for the chemical composition of rods or wires

The symbol in Table 3A or Table 3B indicates the chemical composition of the rods or wires and includes an indication of characteristic alloying elements.

Table 3A — Symbol for chemical composition (classification by yield strength and 47 J impact energy)

Symbol	**Chemical composition** (percentage mass fraction) [a, b]										
	C	**Si**	**Mn**	**P**	**S**	**Ni**	**Cr**	**Mo**	**V**	**Al**	**Ti + Zr**
W0	Any agreed analysis not specified in this standard										
W2Si	0,06 to 0,14	0,50 to 0,80	0,90 to 1,30	0,025	0,025	0,15	0,15	0,15	0,03	0,02	0,15
W3Si1	0,06 to 0,14	0,70 to 1,00	1,30 to 1,60	0,025	0,025	0,15	0,15	0,15	0,03	0,02	0,15
W4Si1	0,06 to 0,14	0,80 to 1,20	1,60 to 1,90	0,025	0,025	0,15	0,15	0,15	0,03	0,02	0,15
W2Ti	0,04 to 0,14	0,40 to 0,80	0,90 to 1,40	0,025	0,025	0,15	0,15	0,15	0,03	0,05 to 0,20	0,05 to 0,25
W3Ni1	0,06 to 0,14	0,50 to 0,90	1,00 to 1,60	0,020	0,020	0,80 to 1,50	0,15	0,15	0,03	0,02	0,15
W2Ni2	0,06 to 0,14	0,40 to 0,80	0,80 to 1,40	0,020	0,020	2,10 to 2,70	0,15	0,15	0,03	0,02	0,15
W2Mo	0,08 to 0,12	0,30 to 0,70	0,90 to 1,30	0,020	0,020	0,15	0,15	0,40 to 0,60	0,03	0,02	0,15

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

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

Table 3B — Symbol for chemical composition (classification by tensile strength and 27 J impact energy)

Symbol	Chemical composition (percentage mass fraction) [a, b, c]											
	C	Si	Mn	P	S	Ni	Cr	Mo	V	Cu	Al	Ti + Zr
W0	Any agreed analysis not specified in this standard											
W2	0,07	0,40 to 0,70	0,90 to 1,40	0,025	0,035	—	—	—	—	0,50	0,05 to 0,15	Ti: 0,05 to 0,15 Zr: 0,02 to 0,12
W3	0,06 to 0,15	0,45 to 0,75	0,90 to 1,40	0,025	0,035	—	—	—	—	0,50	–	—
W4	0,07 to 0,15	0,65 to 0,85	1,00 to 1,50	0,025	0,035	—	—	—	—	0,50	—	—
W6	0,06 to 0,15	0,80 to 1,15	1,40 to 1,85	0,025	0,035	—	—	—	—	0,50	—	—
W12	0,02 to 0,15	0,55 to 1,00	1,25 to 1,90	0,030	0,030	—	—	—	—	0,50	—	—
W16	0,02 to 0,15	0,40 to 1,00	0,90 to 1,60	0,030	0,030	—	—	—	—	0,50	—	—
W1M3	0,12	0,30 to 0,70	1,30	0,025	0,025	0,20	—	0,40 to 0,65	—	0,35	—	—
W2M3	0,12	0,30 to 0,70	0,60 to 1,40	0,025	0,025	—	—	0,40 to 0,65	—	0,50	—	—
W2M31	0,12	0,30 to 0,90	0,80 to 1,50	0,025	0,025	—	—	0,40 to 0,65	—	0,50	—	—
W2M32	0,05	0,30 to 0,90	0,80 to 1,40	0,025	0,025	—	—	0,40 to 0,65	—	0,50	—	—
W3M1T	0,12	0,40 to 1,00	1,40 to 2,10	0,025	0,025	—	—	0,10 to 0,45	—	0,50	—	Ti: 0,02 to 0,30
W3M3	0,12	0,60 to 0,90	1,10 to 1,60	0,025	0,025	—	—	0,40 to 0,65	—	0,50	—	—
W4M3	0,12	0,30	1,50 to 2,00	0,025	0,025	—	—	0,40 to 0,65	—	0,50	—	—
W4M31	0,05 to 0,15	0,50 to 0,80	1,60 to 2,10	0,025	0,025	—	—	0,40 to 0,65	—	0,40	—	—
W4M3T	0,12	0,50 to 0,80	1,60 to 2,20	0,025	0,025	—	—	0,40 to 0,65	—	0,50	—	Ti: 0,02 to 0,30

Table 3B (*continued*)

Symbol	Chemical composition (percentage mass fraction) [a, b, c]											
	C	Si	Mn	P	S	Ni	Cr	Mo	V	Cu	Al	Ti + Zr
WN1	0,12	0,20 to 0,50	1,25	0,025	0,025	0,60 to 1,00	—	0,35	—	0,35	—	—
WN2	0,12	0,40 to 0,80	1,25	0,025	0,025	0,80 to 1,10	0,15	0,35	0,05	0,35	—	—
WN3	0,12	0,30 to 0,80	1,20 to 1,60	0,025	0,025	1,50 to 1,90	—	0,35	—	0,35	—	—
WN5	0,12	0,40 to 0,80	1,25	0,025	0,025	2,00 to 2,75	—	—	—	0,35	—	—
WN7	0,12	0,20 to 0,50	1,25	0,025	0,025	3,00 to 3,75	—	0,35	—	0,35	—	—
WN71	0,12	0,40 to 0,80	1,25	0,025	0,025	3,00 to 3,75	—	—	—	0,35	—	—
WN9	0,10	0,50	1,40	0,025	0,025	4,00 to 4,75	—	0,35	—	0,35	—	—
WNCC	0,12	0,60 to 0,90	1,00 to 1,65	0,030	0,030	0,10 to 0,30	0,50 to 0,80	—	—	0,20 to 0,60	—	—
WNCC1	0,12	0,20 to 0,40	0,40 to 0,70	0,030	0,030	0,50 to 0,80	0,50 to 0,80	—	—	0,30 to 0,75	—	—
WNCCT	0,12	0,60 to 0,90	1,00 to 1,65	0,030	0,030	0,10 to 0,30	0,50 to 0,80	—	—	0,20 to 0,60	—	Ti: 0,02 to 0,30
WNCCT1	0,12	0,50 to 0,80	1,20 to 1,80	0,030	0,030	0,10 to 0,40	0,50 to 0,80	0,02 to 0,30	—	0,20 to 0,60	—	Ti: 0,02 to 0,30
WNCCT2	0,12	0,50 to 0,90	1,10 to 1,70	0,030	0,030	0,40 to 0,80	0,50 to 0,80	—	—	0,20 to 0,60	—	Ti: 0,02 to 0,30
WN1M2T	0,12	0,60 to 1,00	1,70 to 2,30	0,025	0,025	0,40 to 0,80	—	0,20 to 0,60	—	0,50	—	Ti: 0,02 to 0,30
WN1M3	0,12	0,20 to 0,80	1,00 to 1,80	0,025	0,025	0,30 to 0,90	—	0,40 to 0,65	—	0,50	—	—
WN2M3	0,12	0,30	1,10 to 1,60	0,025	0,025	0,80 to 1,20	—	0,40 to 0,65	—	0,50	—	—

[a] The total amount of the elements (excluding iron) which are not shown in this table shall not exceed 0,50 %.

[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 according to ISO 31-0:1992, Annex B, Rule A.

5 Mechanical tests

5A Classification by yield strength and 47 J impact energy

Tensile and impact tests and any required retests shall be carried out in the as-welded condition using an all-weld metal test assembly type 1,3 in accordance with ISO 15792-1:2000 using 2,4 mm diameter rods or wires and welding conditions as described below in 5.1A and 5.2A.

5B Classification by tensile strength and 27 J impact energy

Tensile and impact tests shall be carried out in the as-welded condition or in the post-weld heat-treated condition using an all-weld metal test assembly type 1,3 in accordance with ISO 15792-1:2000 using 2,4 mm diameter rods or wires and welding conditions as described below in 5.1B and 5.2B.

5.1 Preheating and interpass temperatures

5.1A Classification by yield strength and 47 J impact energy

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 ISO 13916).

The interpass temperature shall not exceed 250 °C. If, after any pass, this interpass temperature is exceeded, the test assembly shall be cooled in air to a temperature below that limit.

5.1B Classification by tensile strength and 27 J impact energy

Preheating and interpass temperatures shall be selected for the appropriate weld metal type from Table 4B. The interpass temperature shall be measured using temperature indicator crayons, surface thermometers or thermocouples (see ISO 13916).

Welding shall continue until the assembly has reached a maximum interpass temperature (165 °C). If, after any pass, this interpass temperature is exceeded, the test assembly shall be cooled in air to a temperature within that range. If below interpass temperature, reheat into interpass range.

Table 4B — Preheating and interpass temperatures

Symbol	Preheat temperature °C	Interpass temperature °C
W0	As agreed between purchaser and supplier	
W2, W3, W4, W6, W12, W16	Room temperature	150 ± 15
W1M3, W2M3, W2M31, W2M32, W3M1T, W3M3, W4M3, W4M31, W4M3T, WN1, WN2, WN3, WN5, WN7, WN71, WN9, WNCC, WNCC1, WNCCT, WNCCT1, WNCCT2, WN1M2T, WN1M3, WN2M3	min. 100	