INTERNATIONAL STANDARD

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Arc welding and cutting — Nonconsumable tungsten electrodes — Classification

Soudage et coupage à l'arc — Électrodes non consommables en tungstène — Classification

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Foreword

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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 6848 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 3, *Welding consumables*.

This second edition cancels and replaces the first edition (ISO 6848:1984), which has been technically revised.

Introduction

Tungsten electrodes are used in a variety of welding and allied processes, including tungsten inert gas welding, plasma arc welding and cutting, plasma spraying, and atomic hydrogen welding. In contrast to most other welding electrodes, tungsten electrodes are not intended to become part of the weld deposit. Nevertheless, the chemical composition of a tungsten electrode has an important effect on its range of usage in welding and allied processes. Therefore, tungsten electrodes are classified according to their chemical composition.

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 national standards bodies can be found at www.iso.org.

Arc welding and cutting — Nonconsumable tungsten electrodes — Classification

1 Scope

This International Standard specifies requirements for classification of nonconsumable tungsten electrodes for inert gas shielded arc welding, and for plasma welding, cutting and thermal spraying.

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*

3 Classification

Classification of a tungsten electrode is based upon its chemical composition.

4 Symbols and requirements

4.1 Symbol for the product/process

The symbol for gas shielded tungsten arc processes is the letter W.

4.2 Symbol for the chemical composition

The symbol for the chemical composition of the tungsten electrode is the chemical symbol for the principal oxide additive followed by digits indicating the nominal mass percent of the oxide additive multiplied by 10. If there is no additive, the symbol is the letter P. Table 1 lists the composition requirements for the various classifications. Compositions not listed in Table 1 shall be symbolized by the letters WG, followed by the chemical symbol and digits for the major oxide additive, according to the principle used for the other compositions given in Table 1.

5 Chemical analysis

Chemical analysis shall be performed on specimens of the electrode being classified. Any analytical technique may be used but, in cases of dispute, reference shall be made to established published methods.

6 Retests

If any test fails to meet the requirement, that test shall be repeated twice. The results of both retests shall meet the requirements. Specimens for retesting may be taken from the original test assembly or from a new test assembly. For chemical analysis, retests need only be 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.

7 Marking

In accordance with Table 1, tungsten electrodes shall be marked on the basis of their chemical composition, with one colour ring near one end of the electrode. The width of the colour ring shall be at least 3 mm. Alternatively, tungsten electrodes may have their classification symbols marked on the surface of the electrode near at least one end of the electrode.

Table 1 — Chemical composition requirements for tungsten electrodes

Classification symbol	Chemical composition requirements				Colour code, RGB colour value and colour sample[a]
	Oxide addition		Impurities, mass percent	Tungsten, mass percent	
	Principal oxide	Mass percent			
WP	None	N.A.[b]	0,5 max.	99,5 min.	Green #008000
WCe 20	CeO_2	1,8 to 2,2	0,5 max.	Balance	Grey #808080
WLa 10	La_2O_3	0,8 to 1,2	0,5 max.	Balance	Black #000000
WLa 15	La_2O_3	1,3 to 1,7	0,5 max.	Balance	Gold #FFD700
WLa 20	La_2O_3	1,8 to 2,2	0,5 max.	Balance	Blue #0000FF
WTh 10	ThO_2	0,8 to 1,2	0,5 max.	Balance	Yellow #FFFF00
WTh 20	ThO_2	1,7 to 2,2	0,5 max.	Balance	Red #FF0000

Table 1 (*continued*)

Classification symbol	Chemical composition requirements				Colour code, RGB colour value and colour sample[a]
	Oxide addition		Impurities, mass percent	Tungsten, mass percent	
	Principal oxide	Mass percent			
WTh 30	ThO_2	2,8 to 3,2	0,5 max.	Balance	Violet #EE82EE
WZr 3	ZrO_2	0,15 to 0,50	0,5 max.	Balance	Brown #A52A2A
WZr 8	ZrO_2	0,7 to 0,9	0,5 max.	Balance	White #FFFFFF

[a] RGB colour values and colour samples can be found at the following website: http://msdn.microsoft.com/library/default.asp?url=/workshop/author/dhtml/reference/colors/colors.asp

[b] N.A. = Not applicable.

8 Standard sizes and tolerances

8.1 Electrode diameters

Standard electrode diameters and tolerances are given in Table 2. Other diameters and tolerances may be as agreed between supplier and purchaser.

Table 2 — Standard electrode diameters and tolerances

Diameter mm	Tolerance mm
0,25	± 0,02
0,30	± 0,02
0,50	± 0,05
1,0	± 0,05
1,5	± 0,05
1,6	± 0,05
2,0	± 0,05
2,4	± 0,1
2,5	± 0,1
3,0	± 0,1
3,2	± 0,1
4,0	± 0,1
4,8	± 0,1
5,0	± 0,1
6,3	± 0,1
6,4	± 0,1
8,0	± 0,1
10,0	± 0,1

8.2 Electrode lengths

Standard electrode lengths and tolerances are given in Table 3. Other lengths and tolerances may be as agreed between supplier and purchaser.

Table 3 — Standard electrode lengths and tolerances

Length mm	Tolerance mm
50	± 1,5
75	+ 2,5 – 1,0
150	+ 4 – 1
175	+ 6 – 1
300	+ 8 – 1
450	+ 8 – 1
600	+ 13 – 1

8.3 Electrode straightness

Electrodes shall not deviate from straight by more than 0,5 mm over any 100 mm of length or less.

9 Rounding-off procedure

For purposes of determining compliance with the requirements of this International Standard, the actual test values obtained shall be subjected to the rounding-off rules of ISO 31-0:1992, Annex B, Rule A. If the measured values are obtained by equipment calibrated in units other than those of this International Standard, the measured values shall be converted to the units of this International Standard before rounding off. If an average value is to be compared to the requirements of this International Standard, rounding-off shall be done only after calculating the average. In the case where the testing standard cited in the normative references of this International Standard contains instructions for rounding off that conflict with the instructions of this International Standard, the rounding-off requirements of the testing standard shall apply. The rounded-off results shall fulfill the requirements of the appropriate table for the classification under test.

10 Electrode quality

The electrode surface shall be free of impurities, undesirable films, foreign inclusions, slivers, cracks, scale and other defects. Electrodes shall be internally free of foreign inclusions or anything else that would adversely affect the operation of the electrode. Oxide additions shall be sufficiently uniformly distributed throughout the electrode so that the operation of the electrode is not adversely affected.

11 Packaging

11.1 Marking of packages

The following information, as a minimum, shall be legibly marked so as to be visible from the outside of each package:

a) the number of this International Standard, i.e., ISO 6848;

b) electrode classification symbol in accordance with Table 1;

c) electrode diameter;

d) electrode length;

e) net quantity of electrodes;

f) supplier's name and trade designation;

g) lot, control or heat number.

11.2 Packing

Tungsten electrodes shall be packed so that their surfaces are protected from all damage or staining when they are properly transported and stored.

Annex A
(informative)

Conditions of use

A.1 Influence of the type of current

A.1.1 General

The electric arc may be supplied with either direct current or alternating current. Table A.1 indicates which type of current is generally more suitable to the type of metal or alloy to be welded.

A.1.2 Direct current supply

The arc behaviour is different depending on whether the electrode is connected to the positive or negative terminal of the power source. With electrode positive (d.c.+) polarity, there is greater output heat at the electrode and less penetration of the work than with electrode negative (d.c.–) polarity. The current-carrying capacity of an electrode of a given size will therefore be lower with positive polarity than with negative polarity.

A.1.3 Alternating current supply

With alternating current (a.c.) supply, the current changes direction each half-cycle. The arc alternates between electrode positive polarity and electrode negative polarity. The current-carrying capacity of an electrode is then less than when it is used with electrode negative polarity, but greater than when it is used with electrode positive polarity.

Table A.1 — Suitability of current supply type

Type of metal or alloy to be welded	Direct current		Alternating current
	Electrode negative (–)	Electrode positive (+)	
Aluminium and its alloys (thickness ⩽ 2,5 mm)	Acceptable	Acceptable	Best
Aluminium and its alloys (thickness > 2,5 mm)	Acceptable	N.R.[a]	Best
Magnesium and its alloys	N.R.	Acceptable	Best
Non-alloy steels and low alloy steels	Best	N.R.	N.R.
Stainless steels	Best	N.R.	N.R.
Copper	Best	N.R.	N.R.
Bronze	Best	N.R.	Acceptable
Aluminium bronze	Acceptable	N.R.	Best
Silicon bronze	Best	N.R.	N.R.
Nickel and its alloys	Best	N.R.	Acceptable
Titanium and its alloys	Best	N.R.	Acceptable

[a] N.R. = Not recommended.

A.2 Arc amperage

The electrode size should be selected so that the current value is high enough for the arc to cover the whole area of the electrode tip, which is then heated up to a temperature approaching its melting temperature.

If the current is too low for the electrode size selected, the arc may be erratic and unstable, and tungsten particles may be ejected.

If, however, the current is too high, it will cause the electrode to overheat and its tip to melt. Drops of molten tungsten may fall into the weld, and the arc will become erratic and unstable. Table A.2 provides recommended current ranges depending on the type of power supply and electrode diameter. A high current value provides, in addition to a more stable arc, a higher concentration of heat, but this is limited depending on the conditions of use. An adequate degree of taper of the electrode tip with d.c.– polarity permits improvement of these conditions; e.g., the degree of taper of the electrode tip should be chosen according to the current used. A more obtuse angle is recommended at higher currents for a given electrode diameter.

Tungsten electrodes when used with alternating current or with direct current positive polarity will form a molten ball on the arcing end of the electrode. A pure tungsten electrode may produce tungsten inclusions in the weld when used on a.c. or d.c.+ without having accurate control of amperage and arc length. The use of zirconiated tungsten will alleviate this problem.

Many modern a.c. welding power supplies allow the balance between the d.c.+ and d.c.– portions of the current cycle to be varied. When the d.c.+ portion of the cycle is increased relative to the d.c.– portion, the recommended average current is decreased somewhat from the ranges given in Table A.2. Conversely, when the d.c.– portion is increased relative to the d.c.+ portion, the recommended average a.c. current is increased somewhat from the ranges given in Table A.2.

A.3 Further remarks

The choice of an electrode type and size and of the welding current is influenced by the type and thickness of the parent metal to be welded or cut. The capacity of tungsten electrodes to carry current is dependent upon a number of other factors, in particular, the type of equipment used (gas- or water-cooled), the extension of the electrode beyond the nozzle and the welding position used.

An electrode of a given size will have its greatest current-carrying capacity with direct current, electrode negative; less with alternating current, and still less with direct current, electrode positive.

Table A.2 lists some typical current values that may be used with argon shielding. However, the other factors mentioned above should be carefully considered before selecting an electrode for a specific application.