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

Produits consommables pour le soudage — Fils-électrodes pleins, feuillets pleins, fils pleins et baguettes pleines pour le soudage par fusion du nickel et des alliages de nickel — 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.

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of 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 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*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 121, *Welding and allied processes*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 18274:2010), which has been technically revised.

The main changes are as follows:

- new restricted alloy symbols, commonly used in the USA, added to [Table 1](#) and [Table C.1](#);
- alloy symbols updated in [Table 1](#) and [Table C.1](#);
- a new EXAMPLE 4 added to [Clause 11](#) for a Z classification.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html. Official interpretations of ISO/TC 44 documents, where they exist, are available from this page: <https://committee.iso.org/sites/tc44/home/interpretation.html>.

Introduction

For nickel welding consumables, there is no unique relationship between the product form, for example:

- solid wire electrode;
- solid strip electrode;
- solid wire;
- solid rod;

and the welding process used, for example:

- gas-shielded metal arc welding;
- gas tungsten arc welding;
- plasma arc welding;
- submerged arc welding;
- strip overlay welding;
- laser welding;
- other welding processes.

Consequently, solid wire electrodes, solid strip electrodes, solid wires or solid rods can be classified on the basis of any of these product forms and can be used, as appropriate, for more than one of these processes (see also [Annex B](#)).

The International Organization for Standardization (ISO) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent.

ISO takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has assured ISO that he/she is willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with ISO. Information may be obtained from the patent database available at www.iso.org/patents.

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

1 Scope

This document specifies requirements for classification of solid wire electrodes, solid strip electrodes, solid wires and solid rods for fusion welding of nickel and nickel alloys. The classification of the solid wire electrodes, solid strip electrodes, solid wires and solid rods is based on their chemical composition. It includes those compositions in which the nickel content exceeds that of any other element.

The principles of this document can be applied to metal powders for cladding, hard facing and additive manufacturing.

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 544, *Welding consumables — Technical delivery conditions for filler materials and fluxes — Type of product, dimensions, tolerances and markings*

ISO 14344, *Welding consumables — Procurement of filler materials and fluxes*

ISO 80000-1:2009, *Quantities and units — Part 1: General*

3 Terms and definitions

No terms and definitions are listed in this document.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

4 Classification

The symbol for the classification is divided into two parts:

- a) the first part indicates the product form, being solid wire electrode, solid strip electrode, solid wire or solid rod, see [5.1](#);
- b) the second part gives a numerical symbol indicating the chemical composition of the solid wire electrode, solid strip electrode, solid wire or solid rod, see [Table 1](#).

5 Symbols and requirements

5.1 Symbols for the product form

The symbol for the solid wire electrode, solid wire or solid rod shall be “S”.

The symbol for the solid strip electrode shall be “B”.

NOTE One product form can be used for more than one welding process.

5.2 Symbol for the chemical composition

The initial symbol “Ni” in [Table 1](#) identifies the welding consumable as a nickel base alloy. The following four digits indicate the chemical composition of the solid wire electrode, solid strip electrode, solid wire or solid rod, determined under conditions given in [Clause 6](#). The first digit is an indicator of the alloy group as follows:

- 1, significant molybdenum addition without significant chromium addition (nickel-molybdenum alloys);
- 2, no significant alloy addition;
- 4, significant copper addition (nickel-copper alloys);
- 5, significant copper additions with aluminium and titanium for precipitation hardening;
- 6, significant chromium addition, with iron less than 25 % (mass fraction) (nickel-chromium-iron and nickel-chromium-molybdenum alloys);
- 7, same as 6, but with aluminium and titanium for precipitation hardening;
- 8, significant chromium addition, with iron more than 25 % (mass fraction) (nickel-iron-chromium alloys);
- 9, an alloy that is precipitation hardenable.

The remaining digits indicate the alloy composition of the welding consumable. The basis of the system of designation is described in [Annex A](#). A description of common uses of each welding consumable alloy is given in [Annex B](#).

NOTE 1 In addition, the chemical symbol can be used.

NOTE 2 Corresponding national classifications are shown in [Annex C](#), [Table C.1](#).

Table 1 — Symbols and chemical composition requirements for solid wire electrodes, solid strip electrodes, solid wires and solid rods

Alloy symbols		Chemical composition, % (mass fraction) ^a													
Numerical ^b	Chemical	C	Mn	Fe	Si	Cu	Ni ^c	Co	Al	Ti	Cr	Nb ^d	Mo	W	Others ^{e, f}
Nickel															
Ni 2061	NiTi3	0,15	1,0	1,0	0,7	0,25	≥ 92,0	—	1,5	2,0 to 3,5	—	—	—	—	P 0,03
Ni 2061B	(NiTi3)	0,15	1,0	1,0	0,7	0,25	≥ 93,0	—	1,5	2,0 to 3,5	—	—	—	—	P 0,03
Nickel-copper															
Ni 4060	NiCu30Mn3Ti	0,15	4,0	2,5	1,2	28,0 to 32,0	62,0 to 69,0	—	1,2	1,5 to 3,0	—	0,3	—	—	—
Ni 4061	NiCu30Mn3Nb	0,15	4,0	2,5	1,25	28,0 to 32,0	≥ 60,0	—	1,0	1,0	—	3,0	—	—	—
Ni 5504	NiCu25Al3Ti	0,25	1,5	2,0	1,0	≥ 20,0	63,0 to 70,0	—	2,0 to 4,0	0,3 to 1,0	—	—	—	—	P 0,03
Nickel-chromium															
Ni 6072	NiCr44Ti	0,01 to 0,10	0,20	0,50	0,20	0,50	≥ 52,0	—	—	0,3 to 1,0	42,0 to 46,0	—	—	—	—
Ni 6073	NiCr38AlNbTi	0,03	0,50	1,0	0,30	0,30	≥ 63,0	1,0	0,75 to 1,20	0,25 to 0,75	36,0 to 39,0	0,25 to 1,00	0,50	—	P 0,02 B 0,003 Zr 0,02
Ni 6076	NiCr20	0,08 to 0,15	1,0	2,00	0,30	0,50	≥ 75,0	—	0,4	0,15 to 0,50	19,0 to 21,0	—	—	—	P 0,03
Ni 6082	NiCr20Mn3Nb	0,10	2,5 to 3,5	3,0	0,5	0,5	≥ 67,0	—	—	0,7	18,0 to 22,0	2,0 to 3,0	—	—	P 0,03
^a Single values for all elements are maxima except where the ≥ sign is used.															
^b Symbols with B have more restricted chemical compositions than symbols without R. Symbols with R meet the requirements of symbols without R but not vice versa.															
^c Up to 1 % (mass fraction) of the nickel content can be cobalt unless otherwise specified. For certain applications, lower cobalt levels can required and should be agreed between contracting parties.															
^d Up to 20 % (mass fraction) of the niobium content can be tantalum.															
^e The total of unspecified elements shall not exceed 0,5 % (mass fraction).															
^f Phosphorus 0,020 % (mass fraction) maximum and sulfur 0,015 % (mass fraction) maximum unless otherwise stated.															
^g Ag ≤ 0,000 5 % (mass fraction), B ≤ 0,020 % (mass fraction), Bi ≤ 0,000 1 % (mass fraction), Pb ≤ 0,002 0 % (mass fraction), Zr ≤ 0,15 % (mass fraction).															
^h Consumables for which the chemical composition is not listed shall be symbolized similarly and prefixed by the letters Ni Z. The chemical composition ranges are not specified and it is possible that two electrodes with the same Z-classification are not interchangeable.															

Table 1 (continued)

Alloy symbols		Chemical composition, % (mass fraction) ^a													
Numerical ^b	Chemical	C	Mn	Fe	Si	Cu	Ni ^c	Co	Al	Ti	Cr	Nb ^d	Mo	W	Others ^{e,f}
Ni 6699	NiCr29Al	0,005 to 0,10	0,5	2,5	0,50	0,50	≥ 60	—	1,9 to 3,0	0,60	26,0 to 30,0	0,50	—	—	Zr 0,10 N 0,05 S 0,01 B 0,008
Nickel-chromium-iron															
Ni 6002	NiCr21Fe18Mo9	0,05 to 0,15	1,0	17,0 to 20,0	1,0	0,5	≥ 44,0	0,5 to 2,5	—	—	20,5 to 23,0	—	8,0 to 10,0	0,2 to 1,0	P 0,04 S 0,03
Ni 6025	NiCr25Fe10AlY	0,15 to 0,25	0,5	8,0 to 11,0	0,5	0,1	≥ 59,0	1,0	1,8 to 2,4	0,1 to 0,2	24,0 to 26,0	—	—	—	Y 0,05 to 0,12 Zr 0,01 to 0,10
Ni 6030	NiCr30Fe15Mo5W	0,03	1,5	13,0 to 17,0	0,8	1,0 to 2,4	≥ 36,0	5,0	—	—	28,0 to 31,5	0,3 to 1,5	4,0 to 6,0	1,5 to 4,0	P 0,04 S 0,02
Ni 6043	NiCr30Fe9Nb2	0,04	3,0	7,0 to 12,0	0,5	0,30	≥ 54,0	—	0,50	0,5	28,0 to 31,5	1,0 to 2,5	0,50	—	—
Ni 6045	NiCr28Fe23Si3	0,05 to 0,12	1,0	21,0 to 25,0	2,5 to 3,0	0,3	≥ 40,0	1,0	0,30	—	26,0 to 29,0	—	—	—	P 0,020 S 0,010
Ni 6052	NiCr30Fe9	0,04	1,0	7,0 to 11,0	0,5	0,3	≥ 54,0	—	1,1	1,0	28,0 to 31,5	0,10	0,5	—	Al + Ti < 1,5
Ni 6054	NiCr29Fe9	0,04	1,0	7,0 to 11,0	0,50	0,30	≥ 51,0	0,12	1,10	1,0	28,0 to 31,5	0,5 to 1,0	0,50	—	P 0,02

^a Single values for all elements are maxima except where the ≥ sign is used.

^b Symbols with B have more restricted chemical compositions than symbols without R. Symbols with R meet the requirements of symbols without R but not vice versa.

^c Up to 1 % (mass fraction) of the nickel content can be cobalt unless otherwise specified. For certain applications, lower cobalt levels can required and should be agreed between contracting parties.

^d Up to 20 % (mass fraction) of the niobium content can be tantalum.

^e The total of unspecified elements shall not exceed 0,5 % (mass fraction).

^f Phosphorus 0,020 % (mass fraction) maximum and sulfur 0,015 % (mass fraction) maximum unless otherwise stated.

^g Ag ≤ 0,000 5 % (mass fraction), B ≤ 0,020 % (mass fraction), Bi ≤ 0,000 1 % (mass fraction), Pb ≤ 0,002 0 % (mass fraction), Zr ≤ 0,15 % (mass fraction).

^h Consumables for which the chemical composition is not listed shall be symbolized similarly and prefixed by the letters Ni Z. The chemical composition ranges are not specified and it is possible that two electrodes with the same Z-classification are not interchangeable.

Table 1 (continued)

Alloy symbols		Chemical composition, % (mass fraction) ^a													
Numerical ^b	Chemical	C	Mn	Fe	Si	Cu	Ni ^c	Co	Al	Ti	Cr	Nb ^d	Mo	W	Others ^{e,f}
Ni 6054B	(NiCr29Fe9)	0,04	1,0	7,0 to 11,0	0,50	0,30	≥ 51,0	0,12	1,10	1,0	28,0 to 31,5	0,5 to 1,0	0,50	—	P 0,02 Al + Ti 1,5 B 0,005 Zr 0,02
Ni 6055	NiCr29Fe5Mo4Nb3	0,03	1,0	14,4	0,50	0,30	52,0 to 62,0	0,10	0,50	0,50	28,5 to 31,0	2,1 to 4,0	3,0 to 5,0	—	P 0,02 B 0,003 Zr 0,02
Ni 6056	NiCr27Fe2Nb2	0,020 to 0,055	2,5 to 3,5	1,0 to 3,0	0,50	0,3	≥ 61,0	0,10	0,60	0,10 to 0,40	26,0 to 28,0	2,0 to 2,8	—	—	P 0,02
Ni 6062	NiCr15Fe8Nb	0,08	1,0	6,0 to 10,0	0,3	0,5	≥ 70,0	—	—	—	14,0 to 17,0	1,5 to 3,0	—	—	P 0,03
Ni 6176	NiCr16Fe6	0,05	0,5	5,5 to 7,5	0,5	0,1	≥ 76,0	0,05	—	—	15,0 to 17,0	—	—	—	—
Ni 6601	NiCr23Fe15Al	0,10	1,0	20,0	0,5	1,0	58,0 to 63,0	—	1,0 to 1,7	—	21,0 to 25,0	—	—	—	P 0,03
Ni 6693	NiCr29Fe4Al3	0,15	1,0	2,5 to 6,0	0,5	0,5	≥ 53,0	—	2,5 to 4,0	1,0	27,0 to 31,0	0,5 to 2,5	—	—	P 0,03 S 0,01
Ni 6701	NiCr36Fe7Nb	0,35 to 0,50	0,5 to 2,0	7,0	0,5 to 2,0	—	42,0 to 48,0	—	—	—	33,0 to 39,0	0,8 to 1,8	—	—	—
Ni 6975	NiCr25Fe13Mo6	0,03	1,0	10,0 to 17,0	1,0	0,7 to 1,2	47,0 to 52,0	—	—	0,70 to 1,50	23,0 to 26,0	—	5,0 to 7,0	—	P 0,03 S 0,03

^a Single values for all elements are maxima except where the ≥ sign is used.

^b Symbols with B have more restricted chemical compositions than symbols without R. Symbols with R meet the requirements of symbols without R but not vice versa.

^c Up to 1 % (mass fraction) of the nickel content can be cobalt unless otherwise specified. For certain applications, lower cobalt levels can required and should be agreed between contracting parties.

^d Up to 20 % (mass fraction) of the niobium content can be tantalum.

^e The total of unspecified elements shall not exceed 0,5 % (mass fraction).

^f Phosphorus 0,020 % (mass fraction) maximum and sulfur 0,015 % (mass fraction) maximum unless otherwise stated.

^g Ag ≤ 0,000 5 % (mass fraction), B ≤ 0,020 % (mass fraction), Bi ≤ 0,000 1 % (mass fraction), Pb ≤ 0,002 0 % (mass fraction), Zr ≤ 0,15 % (mass fraction).

^h Consumables for which the chemical composition is not listed shall be symbolized similarly and prefixed by the letters Ni Z. The chemical composition ranges are not specified and it is possible that two electrodes with the same Z-classification are not interchangeable.

Table 1 (continued)

Alloy symbols		Chemical composition, % (mass fraction) ^a													
Numerical ^b	Chemical	C	Mn	Fe	Si	Cu	Ni ^c	Co	Al	Ti	Cr	Nb ^d	Mo	W	Others ^{e,f}
Ni 6985	NiCr22Fe20Mo7Cu2	0,01	1,0	18,0 to 21,0	1,0	1,5 to 2,5	≥ 40,0	5,0	—	—	21,0 to 23,5	0,50	6,0 to 8,0	1,5	P 0,04 S 0,03
Ni 7069	NiCr15Fe7Nb	0,08	1,0	5,0 to 9,0	0,50	0,50	≥ 70,0	—	0,4 to 1,0	2,0 to 2,7	14,0 to 17,0	0,70 to 1,20	—	—	P 0,03
Ni 7092	NiCr15Ti3Mn	0,08	2,0 to 2,7	8,0	0,3	0,5	≥ 67,0	—	—	2,5 to 3,5	14,0 to 17,0	—	—	—	P 0,03
Ni 7718	NiCr19Fe19Nb5Mo3	0,08	0,3	24,0	0,3	0,3	50,0 to 55,0	—	0,2 to 0,8	0,7 to 1,1	17,0 to 21,0	4,8 to 5,5	2,8 to 3,3	—	B 0,006 P 0,015
Ni 8025	NiFe30Cr29Mo	0,02	1,0 to 3,0	30,0	0,5	1,5 to 3,0	35,0 to 40,0	—	0,2	1,0	27,0 to 31,0	—	2,5 to 4,5	—	—
Ni 8034	NiFe29Cr27Mo6Cu	0,10	1,0 to 4,0	24,5 - 33,5	0,10	0,5 to 1,5	33,5 to 35,0	—	0,3	—	26,0 to 27,0	—	6,0 to 7,0	—	N 0,10 to 0,25
Ni 8065	NiFe30Cr21Mo3	0,05	1,0	≥ 22,0	0,5	1,5 to 3,0	38,0 to 46,0	—	0,2	0,6 to 1,2	19,5 to 23,5	—	2,5 to 3,5	—	P 0,03 S 0,03
Ni 8125	NiFe26Cr25Mo	0,02	1,0 to 3,0	30,0	0,5	1,5 to 3,0	37,0 to 42,0	—	0,2	1,0	23,0 to 27,0	—	3,5 to 7,5	—	—
Ni 8827	NiFe30Cr22Mo6	0,015	0,5 to 0,9	≥ 22,0	0,2 to 0,5	1,60 to 2,30	39,0 to 43,0	0,5	0,06 to 0,25	—	21,0 to 23,0	0,15	4,5 to 6,5	—	N 0,03; B 0,002 to 0,004 S 0,005
Ni 9946	NiCr21Fe15Mo3Nb3	0,005 to 0,040	1,0	28,0	0,5	1,5 to 3,0	45,0 to 55,0	—	0,01 to 0,70	0,5 to 2,5	19,5 to 23,0	2,5 to 4,5	3,0 to 4,0	—	P 0,03

^a Single values for all elements are maxima except where the ≥ sign is used.

^b Symbols with B have more restricted chemical compositions than symbols without R. Symbols with R meet the requirements of symbols without R but not vice versa.

^c Up to 1 % (mass fraction) of the nickel content can be cobalt unless otherwise specified. For certain applications, lower cobalt levels can required and should be agreed between contracting parties.

^d Up to 20 % (mass fraction) of the niobium content can be tantalum.

^e The total of unspecified elements shall not exceed 0,5 % (mass fraction).

^f Phosphorus 0,020 % (mass fraction) maximum and sulfur 0,015 % (mass fraction) maximum unless otherwise stated.

^g Ag ≤ 0,000 5 % (mass fraction), B ≤ 0,020 % (mass fraction), Bi ≤ 0,000 1 % (mass fraction), Pb ≤ 0,002 0 % (mass fraction), Zr ≤ 0,15 % (mass fraction).

^h Consumables for which the chemical composition is not listed shall be symbolized similarly and prefixed by the letters Ni Z. The chemical composition ranges are not specified and it is possible that two electrodes with the same Z-classification are not interchangeable.