
Welding consumables — Covered electrodes for manual metal arc welding of nickel and nickel alloys — Classification

*Produits consommables pour le soudage — Électrodes enrobées
pour le soudage manuel à l'arc du nickel et des alliages de nickel —
Classification*





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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Contents

	Page
Foreword	iv
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Classification	1
5 Symbols and requirements	2
5.1 Symbol for the product or process.....	2
5.2 Symbol for the chemical composition of the all-weld metal.....	2
6 Chemical analysis	2
7 Mechanical properties of the all-weld metal	2
8 Rounding procedure	2
9 Retests	11
10 Technical delivery conditions	11
11 Designation	11
Annex A (informative) System for designation of welding consumables	13
Annex B (informative) Description and uses of welding consumables	14
Annex C (informative) Corresponding national classifications	20
Bibliography	23

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 document 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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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 fourth edition cancels and replaces the third edition (ISO 14172:2015), which has been technically revised.

The main changes are as follows:

- updated to latest style including foreword;
- aligned with ISO 18274 where possible;
- updated references;
- rounding procedure is now [Clause 8](#);
- revised the chemical compositions for a number of chemical compositions in [Table 1](#);
- added new alloys in [Table 1](#);
- updated corresponding entries in other parts of the document;
- new Example 2 added;
- added Chinese alloys to [Table C.1](#)

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.

Welding consumables — Covered electrodes for manual metal arc welding of nickel and nickel alloys — Classification

1 Scope

This document prescribes requirements for the classification of nickel and nickel-alloy covered electrodes for manual metal arc welding and overlaying. The classification of the covered electrodes is based on the chemical composition of their deposited all-weld metal. It includes those compositions in which the nickel content exceeds that of any other element.

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 6847, *Welding consumables — Deposition of a weld metal pad for chemical analysis*

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

ISO 15792-1:2020, *Welding consumables — Test methods — Part 1: Test methods for all-weld metal test specimens in steel, nickel and nickel alloys*

ISO 80000-1:2022, *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

A covered electrode shall be classified in accordance with the chemical composition of the all-weld metal as given in [Table 1](#). The required mechanical properties for the classification's all-weld metal are listed in [Table 2](#).

The symbol for the classification is divided into two parts:

- a) the first part gives a symbol indicating the product or process to be used;
- b) the second part gives a symbol indicating the chemical composition of the all-weld metal.

5 Symbols and requirements

5.1 Symbol for the product or process

The symbol for covered electrodes used for manual metal arc welding shall be the letter “E”.

NOTE Corresponding national classifications are shown in [Annex C](#).

5.2 Symbol for the chemical composition of the all-weld metal

The symbol for the chemical composition of the all-weld metal shall comprise “Ni” plus four digits, as shown in [Table 1](#). The first digit is an indicator of the class of alloy deposited, where:

- 1 indicates significant molybdenum addition without significant chromium addition (nickel-molybdenum alloys);
- 2 indicates no significant alloy addition;
- 4 indicates significant copper addition (nickel-copper alloys);
- 6 indicates significant chromium addition, with iron less than 25 % (nickel-chromium-iron and nickel-chromium-molybdenum alloys);
- 8 indicates significant chromium addition, with iron more than 25 % (nickel-iron-chromium alloys).

The remaining digits indicate the particular alloy deposited. The basis of the system of designation is described in [Annex A](#).

NOTE In addition, the chemical symbol can be used.

6 Chemical analysis

Chemical analysis shall be performed on any suitable all-weld metal test specimen. In case of dispute, the test specimen specified in ISO 6847 shall be used. The test results shall meet the requirements of [Table 1](#) for the classification under test. Any analytical technique can be used; however, in case of dispute, reference shall be made to established published methods.

7 Mechanical properties of the all-weld metal

Mechanical properties are not part of the designation, but they are required for classification. The mechanical properties of the all-weld metal, deposited using covered electrodes in accordance with [Table 1](#), shall be determined using a test assembly type 1,3 in accordance with ISO 15792-1:2020, with 4,0 mm electrodes. The minimum tensile properties shall be in accordance with [Table 2](#).

8 Rounding procedure

Actual test values obtained shall be subject to ISO 80000-1:2022, B.3, Rule A. If the measured values are obtained by equipment calibrated in units other than those of this document, the measured values shall be converted to the units of this document before rounding. If an average value is to be compared to the requirements of this document, rounding shall be done only after calculating the average. The rounded results shall fulfil the requirements of the appropriate table for the classification under test.

Table 1 — Symbols and all-weld metal chemical composition requirements

Alloy symbol ^a		Chemical composition % (by mass) ^b															W	V	Mo	Nb ^d	Cr	Ti	Al	Ni ^c	Cu	Si	Fe	Mn	C	Chemical symbol	Numerical symbol	Notes ^{e, f}
Nickel																																
Ni 2061	NiTi3	0,10	0,7	0,7	1,2	0,2	min. 92,0	—	1,0	1,0 to 4,0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—			
Nickel-copper																																
Ni 4060	NiCu30Mn3Ti	0,15	4,0	2,5	1,5	27,0 to 34,0	min. 62,0	—	0,75	1,0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—			
Ni 4061	NiCu27Mn3NbTi	0,15	4,0	2,5	1,3	24,0 to 31,0	min. 62,0	—	1,0	1,5	—	3,0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—			
Nickel-chromium																																
Ni 6056	NiCr27Nb3	0,05	2,5 to 4,5	2,0 to 3,0	0,50	0,3	59,0 min.	0,10	0,6	0,40	26,0 to 28,0	2,0 to 3,6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0,02 P			
Ni 6082	NiCr20Mn3Nb	0,10	2,0 to 6,0	4,0	0,8	0,5	min. 63,0	—	—	0,5	18,0 to 22,0	1,5 to 3,0	2,0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—			
Ni 6172	NiCr50Nb	0,10	1,5	1,0	1,0	0,25	min. 41,0	—	—	—	48,0 to 52,0	1,0 to 2,5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0,02 P 0,02 S			
Ni 6231	NiCr22W14Mo	0,05 to 0,10	0,3 to 1,0	3,0	0,3 to 0,7	0,5	min. 45,0	5,0	0,5	0,1	20,0 to 24,0	—	1,0 to 3,0	—	—	—	—	—	—	—	—	—	—	—	—	—	13,0 to 15,0	—	—			
Nickel-chromium-iron																																
Ni 6025	NiCr25Fe10AlY	0,10 to 0,25	1,0	8,0 to 11,0	1,0	—	min. 55,0	1,0	1,5 to 2,2	0,4	24,0 to 26,0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0,15 Y			
Ni 6045	NiCr27Fe23Si	0,05 to 0,20	2,5	21,0 to 25,0	2,5 to 3,0	0,30	min. 38,0	1,0	0,30	—	26,0 to 29,0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0,04 P 0,03 S			
Ni 6055	NiCr30Mo4Nb3	0,05	1,0	rem	0,7	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	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—			

^a Symbols with B generally have more restrictive chemical compositions and are typically used in Pacific Rim countries.

^b Single values for all elements except nickel are maxima. Two values shown indicate minimum and maximum limits for a range.

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

^d Up to 20 % of the niobium content can be tantalum.

^e The total of unspecified elements shall not exceed 0,5 %, excluding cobalt and tantalum.

^f Phosphorus 0,020 max., sulfur 0,015 max. unless otherwise stated.

Boron 0,005 % max., Zr 0,020 %.

Consumables for which the chemical composition is not listed in the table may be symbolized similarly and prefixed by the letter Z. The chemical composition ranges are not specified and therefore two electrodes with the same Z-classification may not be interchangeable.

Table 1 (continued)

Alloy symbol ^a		Chemical composition % (by mass) ^b														Notes ^{e,f}
Numerical symbol	Chemical symbol	C	Mn	Fe	Si	Cu	Ni ^c	Co	Al	Ti	Cr	Nb ^d	Mo	V	W	Notes ^{e,f}
Ni 6062	NiCr15Fe8NbMo	0,08	3,5	11,0	0,7	0,5	min. 62,0	—	—	—	13,0 to 17,0	1,5 to 4,0	—	—	—	—
Ni 6093	NiCr15Fe8NbMo	0,20	1,0 to 5,0	12,0	1,0	0,5	min. 60,0	—	—	—	13,0 to 17,0	1,0 to 3,5	1,0 to 3,5	—	—	—
Ni 6093B	NiCr15Fe8NbMo	0,20	1,0 to 3,5	12,0	1,0	0,5	min. 60,0	—	—	—	13,0 to 17,0	1,0 to 3,5	1,0 to 3,5	—	—	—
Ni 6094	NiCr14Fe4NbMo	0,15	1,0 to 4,5	12,0	0,7	0,5	min. 55,0	—	—	—	12,0 to 17,0	0,5 to 3,0	2,5 to 5,5	—	1,5	—
Ni 6095	NiCr15Fe8NbMoW	0,20	1,0 to 3,5	12,0	0,7	0,5	min. 55,0	—	—	—	13,0 to 17,0	1,0 to 3,5	1,0 to 3,5	—	1,5 to 3,5	—
Ni 6132	NiCr15Fe9Nb	0,08	3,5	11,0	0,75	0,50	min. 62,0	—	—	—	13,0 to 17,0	1,5 to 4,0	—	—	—	0,03 P
Ni 6133	NiCr16Fe12NbMo	0,10	1,0 to 3,5	12,0	0,8	0,5	min. 62,0	—	—	—	13,0 to 17,0	0,5 to 3,0	0,5 to 2,5	—	—	—
Ni 6133B	NiCr16Fe12NbMo	0,10	1,0 to 3,5	12,0	0,7	0,5	min. 62,0	—	—	—	13,0 to 17,0	0,5 to 3,0	0,5 to 2,5	—	—	0,03 P 0,02 S
Ni 6152	NiCr30Fe9Nb	0,05	5,0	7,0 to 12,0	0,7	0,5	min. 50,0	—	0,5	0,5	28,0 to 31,5	1,0 to 2,5	0,5	—	—	g
Ni 6182	NiCr15Fe6Mn	0,10	5,0 to 10,5	10,0	1,0	0,5	min. 60,0	—	—	1,0	13,0 to 17,0	1,0 to 3,5	—	—	—	*0,3 max. Ta where specified

^a Symbols with B generally have more restrictive chemical compositions and are typically used in Pacific Rim countries.

^b Single values for all elements except nickel are maxima. Two values shown indicate minimum and maximum limits for a range.

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

^d Up to 20 % of the niobium content can be tantalum.

^e The total of unspecified elements shall not exceed 0,5 %, excluding cobalt and tantalum.

^f Phosphorus 0,020 max., sulfur 0,015 max. unless otherwise stated.

^g Boron 0,005 % max., Zr 0,020 %.

^h Consumables for which the chemical composition is not listed in the table may be symbolized similarly and prefixed by the letter Z. The chemical composition ranges are not specified and therefore two electrodes with the same Z-classification may not be interchangeable.

Table 1 (continued)

Alloy symbol ^a		Chemical composition % (by mass) ^b														Notes ^{e, f}
Numerical symbol	Chemical symbol	C	Mn	Fe	Si	Cu	Ni ^c	Co	Al	Ti	Cr	Nb ^d	Mo	V	W	
Ni 6182B	NiCr15Fe6Mn	0,10	5,0 to 9,5	10,0	1,0	0,5	min. 59,0	—	—	1,0	13,0 to 17,0	1,0 to 2,5	—	—	—	0,03 P *0,3 max. Ta where specified
Ni 6333	NiCr25Fe16CoMo3W	0,10	1,2 to 2,0	min. 16,0	0,8 to 1,2	0,5	44,0 to 47,0	2,5 to 3,5	—	—	24,0 to 26,0	—	2,5 to 3,5	—	2,5 to 3,5	—
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 6702	NiCr28Fe6W	0,35 to 0,50	0,5 to 1,5	6,0	0,5 to 2,0	—	47,0 to 50,0	—	—	—	27,0 to 30,0	—	—	—	4,0 to 5,5	—
Ni 6704	NiCr25Fe10Al3YC	0,15 to 0,30	0,5	8,0 to 11,0	0,8	—	min. 55,0	—	1,8 to 2,8	0,3	24,0 to 26,0	—	—	—	—	0,15 Y
Ni 8025	NiCr29Fe26Mo	0,06	1,0 to 3,0	30,0	0,7	1,5 to 3,0	35,0 to 40,0	—	0,1	1,0*	27,0 to 31,0	1,0	2,5 to 4,5	—	—	*or Nb
Ni 8165	NiFe30Cr25Mo	0,03	1,0 to 3,0	30,0	0,7	1,5 to 3,0	37,0 to 42,0	—	0,1	1,0	23,0 to 27,0	—	3,5 to 7,5	—	—	—
Nickel-molybdenum																
Ni 1001	NiMo28Fe5	0,07	1,0	4,0 to 7,0	1,0	0,5	min. 55,0	2,5	—	—	1,0	—	26,0 to 30,0	0,6	1,0	—
Ni 1004	NiMo25Cr3Fe5	0,12	1,0	4,0 to 7,0	1,0	0,5	min. 60,0	2,5	—	—	2,5 to 5,5	—	23,0 to 27,0	0,6	1,0	—
Ni 1008	NiMo19WCr	0,10	1,5	10,0	0,7	0,5	min. 60,0	—	—	—	0,5 to 3,5	—	17,0 to 20,0	—	2,0 to 4,0	—

^a Symbols with B generally have more restrictive chemical compositions and are typically used in Pacific Rim countries.

^b Single values for all elements except nickel are maxima. Two values shown indicate minimum and maximum limits for a range.

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^d Up to 20 % of the niobium content can be tantalum.

The total of unspecified elements shall not exceed 0,5 %, excluding cobalt and tantalum.

Phosphorus 0,020 max., sulfur 0,015 max. unless otherwise stated.

Boron 0,005 % max., Zr 0,020 %.

Consumables for which the chemical composition is not listed in the table may be symbolized similarly and prefixed by the letter Z. The chemical composition ranges are not specified and therefore two electrodes with the same Z-classification may not be interchangeable.