INTERNATIONAL STANDARD

ISO 14172

Third edition
2015-09-15

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

Reference number
ISO 14172:2015(E)

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Foreword

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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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 44, *Welding and allied processes*, Subcommittee SC 3, *Welding consumables*.

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 these bodies can be found at www.iso.org.

This third edition cancels and replaces the second edition (ISO 14172:2008), which has been technically revised.

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

1 Scope

This International Standard prescribes requirements for the classification of nickel and nickel-alloy covered electrodes for manual metal arc welding and overlaying. It includes those compositions in which the nickel content exceeds that of any other element.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 15792-1:2000, *Welding consumables — Test methods — Part 1: Test methods for all-weld metal test specimens in steel, nickel and nickel alloys*. Amended by ISO 15792-1:2000/Amd 1:2011.

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

3 Classification

A covered electrode shall be classified in accordance with the chemical composition of the all-weld metal as given in Table 1 and the mechanical properties listed in Table 2. The symbol for the classification is divided into two parts:

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

b) the second part gives a symbol indicating the chemical composition of the all-weld metal.

4 Symbols and requirements

4.1 Symbol for the product/process

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

4.2 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

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),

10 indicates significant molybdenum addition without significant chromium addition (nickel-molybdenum 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.

4.3 Rounding procedure

For purposes of determining compliance with the requirements of this International Standard, the actual test values obtained shall be subject to ISO 80000-1:2009, B.3, 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. If an arithmetic average value is to be compared to the requirements of this International Standard, rounding shall be done only after calculating the arithmetic average. If the test method cited in Clause 2 contains instructions for rounding that conflict with the instructions of this International Standard, the rounding requirements of the test method standard shall apply. The rounded results shall fulfil the requirements of the appropriate table for the classification under test.

5 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; but, in case of dispute, reference shall be made to established published methods.

6 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 15792-1:2000 with 4,0 mm electrodes. The minimum tensile properties shall be in accordance with Table 2.

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

Alloy symbol		Chemical composition % (by mass)[a]														
Numerical symbol	Chemical symbol	C	Mn	Fe	Si	Cu	Ni[b]	Co	Al	Ti	Cr	Nb[c]	Mo	V	W	Notes[d, e]
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	—	1,0	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 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	—	—	—	0,02P 0,02S
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	0,5	8,0 to 11,0	0,8	—	min. 55,0	—	1,5 to 2,2	0,3	24,0 to 26,0	—	—	—	—	0,15Y
Ni 6045	NiCr27Fe23Si	0,05 to 0,20	2,5	21,0 to 025,0	2,5 to 3,0	0,30	min. 38,0	1,0	0,30	—	26,0 to 29,0	—	—	—	—	0,04P 0,03S
Ni 6062	NiCr15Fe8Nb	0,08	3,5	11,0	0,8	0,5	min. 62,0	—	—	—	13,0 to 17,0	0,5 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 6094	NiCr14Fe4NbMo	0,15	1,0 to 4,5	12,0	0,8	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	0,8	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	—	—	—	0,03P 0,015S

Table 1 *(continued)*

Alloy symbol		Chemical composition % (by mass)[a]														
Numerical symbol	**Chemical symbol**	C	Mn	Fe	Si	Cu	Ni[b]	Co	Al	Ti	Cr	Nb[c]	Mo	V	W	Notes[d, e]
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 6152	NiCr30Fe9Nb	0,05	5,0	7,0 to 12,0	0,8	0,5	min. 50,0	—	0,5	0,5	28,0 to 31,5	1,0 to 2,5	0,5	—	—	F
Ni 6182	NiCr15Fe6Mn	0,10	5,0 to 10,0	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
Ni 6333	NiCr25Fe16Co-Mo3W	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	—	—	—	—	0,15Y
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 to7,5	—	—	
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	0,8	0,5	min. 60,0	—	—	—	0,5 to 3,5	—	17,0 to 20,0	—	2,0 to 4,0	
Ni 1009	NiMo20WCu	0,10	1,5	7,0	0,8	0,3 to 1,3	min. 62,0	—	—	—	—	—	18,0 to 22,0	—	2,0 to 4,0	
Ni 1062	NiMo24Cr8Fe6	0,02	1,0	4,0 to 7,0	0,7	—	min. 60,0	—	—	—	6,0 to 9,0	—	22,0 to 26,0	—	—	

Table 1 *(continued)*

Alloy symbol		Chemical composition % (by mass)[a]														
Numerical symbol	**Chemical symbol**	C	Mn	Fe	Si	Cu	Ni[b]	Co	Al	Ti	Cr	Nb[c]	Mo	V	W	Notes[d, e]
Ni 1066	NiMo28	0,02	2,0	2,2	0,2	0,5	min. 64,5	1,0	—	—	1,0	—	26,0 to 30,0	—	1,0	
Ni 1067	NiMo30Cr	0,02	2,0	1,0 to 3,0	0,2	0,5	min. 62,0	3,0	—	—	1,0 to 3,0	—	27,0 to 32,0	—	3,0	
Ni 1069	NiMo28Fe4Cr	0,02	1,0	2,0 to 5,0	0,7	—	min. 65,0	1,0	0,5	—	0,5 to 1,5	—	26,0 to 30,0	—	—	
Nickel-Chromium-Molybdenum																
Ni 6002	NiCr22Fe18Mo	0,05 to 0,15	1,0	17,0 to 20,0	1,0	0,5	min. 45,0	0,5 to 2,5	—	—	20,0 to 23,0	—	8,0 to 10,0	—	0,2 to 1,0	
Ni 6007	NiCr22Fe20Mo-6Cu2Nb2Mn	0,05	1,0 to 2,0	18,0 to 21,0	1,0	1,5 to 02,5	min. 37,0	2,5	—	—	21,0 to 23,5	1,75 to 2,50	5,5 to 7,5	—	1,0	0,04P 0,03S
Ni 6012	NiCr22Mo9	0,03	1,0	3,5	0,7	0,5	min. 58,0	—	0,4	0,4	20,0 to 23,0	1,5	8,5 to 10,5	—	—	
Ni 6022	NiCr21Mo13W3	0,02	1,0	2,0 to 6,0	0,2	0,5	min. 49,0	2,5	—	—	20,0 to 22,5	—	12,5 to 14,5	0,4	2,5 to 3,5	
Ni 6024	NiCr26Mo14	0,02	0,5	1,5	0,2	0,5	min. 55,0	—	—	—	25,0 to 27,0	—	13,5 to 15,0	—	—	
Ni 6030	NiCr29Mo5Fe15W2	0,03	1,5	13,0 to 17,0	1,0	1,0 to 2,4	min. 36,0	5,0	—	—	28,0 to 31,5	0,3 to 1,5	4,0 to 6,0	—	1,5 to 4,0	
Ni 6058	NiCr22Mo20	0,02	1,5	1,5	0,2	0,5	min. 51,0	0,3	0,4	—	20,0 to 23,0	—	19,0 to 21,0	—	0,3	
Ni 6059	NiCr23Mo16	0,02	1,0	1,5	0,2	—	min. 56,0	—	—	—	22,0 to 24,0	—	15,0 to 16,5	—	—	
Ni 6200	NiCr23Mo16Cu2	0,02	1,0	3,0	0,2	1,3 to 1,9	min. 45,0	2,0	—	—	20,0 to 24,0	—	15,0 to 17,0	—	—	
Ni 6205	NiCr25Mo16	0,02	0,5	5,0	0,3	2,0	min. 50,0	—	0,4	—	22,0 to 27,0	—	13,5 to 16,5	—	—	
Ni 6275	NiCr15Mo16Fe5W3	0,10	1,0	4,0 to 7,0	1,0	0,5	min. 50,0	2,5	—	—	14,5 to 16,5	—	15,0 to 18,0	0,4	3,0 to 4,5	
Ni 6276	NiCr15Mo15Fe6W4	0,02	1,0	4,0 to 7,0	0,2	0,5	min. 50,0	2,5	—	—	14,5 to 16,5	—	15,0 to 17,0	0,4	3,0 to 4,5	

Table 1 *(continued)*

Alloy symbol		Chemical composition % (by mass)[a]														
Numerical symbol	**Chemical symbol**	C	Mn	Fe	Si	Cu	Ni[b]	Co	Al	Ti	Cr	Nb[c]	Mo	V	W	Notes[d, e]
Ni 6452	NiCr19Mo15	0,025	2,0	1,5	0,4	0,5	min. 56,0	—	—	—	18,0 to 20,0	0,4	14,0 to 16,0	0,4	—	
Ni 6455	NiCr16Mo15Ti	0,02	1,5	3,0	0,2	0,5	min. 56,0	2,0	—	0,7	14,0 to 18,0	—	14,0 to 17,0	—	0,5	
Ni 6620	NiCr14Mo7Fe	0,10	2,0 to 4,0	10,0	1,0	0,5	min. 55,0	—	—	—	12,0 to 17,0	0,5 to 2,0	5,0 to 9,0	—	1,0 to 2,0	
Ni 6625	NiCr22Mo9Nb	0,10	2,0	7,0	0,8	0,5	min. 55,0	—	—	—	20,0 to 23,0	3,0 to 4,2	8,0 to 10,0	—	—	
Ni 6627	NiCr21MoFeNb	0,03	2,2	5,0	0,7	0,5	min. 57,0	—	—	—	20,5 to 22,5	1,0 to 2,8	8,8 to 10,0	—	0,5	
Ni 6650	NiCr20Fe14Mo11WN	0,03	0,7	12,0 to 15,0	0,6	0,5	min. 44,0	1,0	0,5	—	19,0 to 22,0	0,3	10,0 to 13,0	—	1,0 to 2,0	0,15 N 0,02 S
Ni 6686	NiCr21Mo16W4	0,02	1,0	5,0	0,3	0,5	min. 49,0	—	—	0,3	19,0 to 23,0	—	15,0 to 17,0	—	3,0 to 4,4	
Ni 6985	NiCr22Mo7Fe19	0,02	1,0	18,0 to 21,0	1,0	1,5 to 2,5	min. 45,0	5,0	—	—	21,0 to 23,5	1,0	6,0 to 8,0	—	1,5	
Nickel-Chromium-Cobalt-Molybdenum																
Ni 6117	NiCr22Co12Mo	0,05 to 0,15	3,0	5,0	1,0	0,5	min. 45,0	9,0 to 15,0	1,5	0,6	20,0 to 26,0	1,0	8,0 to 10,0	—	—	

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

[b] 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.

[c] Up to 20 % of the niobium content can be tantalum.

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

[e] Phosphorus 0,020 max., sulfur 0,015 max. unless otherwise stated.

[f] Boron 0,005 % max., Zr 0,020 %.

Table 2 — Minimum tensile properties of the all-weld metal

Numerical symbol	Minimum 0,2 % proof strength MPa	Minimum tensile strength MPa	Minimum elongation $5d^a$ %
Nickel			
Ni 2061	200	410	18
Nickel-Copper			
Ni 4060; Ni 4061	200	480	27
Nickel-Chromium			
Ni 6082	360	600	22
Ni 6172	550	760	Not available
Ni 6231	350	620	18
Nickel-Chromium-Iron			
Ni 6025	400	650	15
Ni 6045	240	620	18
Ni 6062	360	550	27
Ni 6093; Ni 6094; Ni 6095	360	650	18
Ni 6132	360	550	27
Ni 6133; Ni 6152; Ni 6182	360	550	27
Ni 6333	360	550	18
Ni 6701; Ni 6702	450	650	8
Ni 6704	400	690	12
Ni 8025; Ni 8165	240	550	22
Nickel-Molybdenum			
Ni 1001; Ni 1004	400	690	22
Ni 1008; Ni 1009	360	650	22
Ni 1062	360	550	18
Ni 1066	400	690	22
Ni 1067	350	690	22
Ni 1069	360	550	20
Nickel-Chromium-Molybdenum			
Ni 6002	380	650	18
Ni 6007	Not available	620	18
Ni 6012	410	650	22
Ni 6022; Ni 6024	350	690	22
Ni 6030	350	585	22
Ni 6058	450	830	18
Ni 6059	350	690	22
Ni 6200; Ni 6275; Ni 6276	400	690	22
Ni 6205; Ni 6452	350	690	22
Ni 6455	300	690	22
Ni 6620	350	620	32

[a] Elongation determined from gauge length equal to five times gauge diameter, 5*d*.