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**Welding consumables — Tubular-  
cored electrodes for gas-shielded  
and non-gas-shielded metal arc  
welding of nickel and nickel alloys —  
Classification**

*Produits consommables pour le soudage — Fils-électrodes fourrés  
pour soudage à l'arc avec ou sans gaz de protection 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](http://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](http://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](http://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 second edition cancels and replaces the first edition (ISO 12153:2011), which has been technically revised.

The main changes are as follows:

- dated references updated to the latest editions;
- the chemistries of a number of classifications revised in [Table 1](#);
- a new alloy symbol, Ni 6023 (numerical), NiCr13Mo13W3 (chemical) added in [Table 1](#), [Table 2](#) and [Table A.1](#);
- a restricted numerical alloy symbol Ni 6117R and chemistry added to [Table 1](#);
- the minimum elongation for Ni 1013 revised in [Table 2](#);
- [Table A.1](#) updated to reflect the above changes and provide missing data.

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](http://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>.

# Welding consumables — Tubular-cored electrodes for gas-shielded and non-gas-shielded metal arc welding of nickel and nickel alloys — Classification

## 1 Scope

This document specifies requirements for the classification of tubular-cored electrodes for metal arc welding with or without a gas shield of nickel and nickel alloys. 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 6947, *Welding and allied processes — Welding positions*

ISO 14175, *Welding consumables — Gases and gas mixtures for fusion welding and allied processes*

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

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

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

Tubular-cored electrodes shall be classified according to the chemical composition of the all-weld metal as given in [Table 1](#) and the mechanical properties of the all-weld metal listed in [Table 2](#).

The classification designation is divided into five parts:

- a) the first part gives a symbol indicating the product or process to be identified;
- b) the second part gives a symbol indicating the chemical composition of the all-weld metal;
- c) the third part gives a symbol indicating the type of electrode core;



Table 1 (continued)

Numerical	Alloy symbols Chemical	Chemical composition (% by mass) <sup>a,b</sup>													Oth- ers <sup>d</sup>	
		C	Mn	Fe	Si	Cu	Ni	Co	Al	Ti	Cr	Nb <sup>c</sup>	Mo	V		W
Ni 6002	NiCr22Fe18Mo	0,05 to 0,15	1,0	17,0 to 20,0	1,0	0,5	≥45,0	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 6012	NiCr22Mo9	0,03	1,0	3,5	0,7	0,5	≥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	≥49,0	2,5	—	—	20,0 to 22,5	—	12,5 to 14,5	0,35	2,5 to 3,5	P 0,03
Ni 6023	NiCr13Mo13W3	0,10	1,0 to 3,0	4,0 to 7,0	0,50	0,5	≥58,0	1,0	—	—	12,0 to 14,5	1,0	12,0 to 14,0	0,35	2,0 to 3,5	P 0,03 S 0,03
Ni 6059	NiCr23Mo16	0,02	1,0	1,5	0,2	0,5	≥56,0	—	—	—	22,0 to 24,0	—	15,0 to 16,5	—	—	—
Ni 6275	NiCr15Mo16Fe5W3	0,10	1,0	4,0 to 7,0	1,0	0,5	≥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	≥50,0	2,5	—	—	14,5 to 16,5	—	15,0 to 17,0	0,35	3,0 to 4,5	P 0,03 S 0,03
Ni 6455	NiCr16Mo15Ti	0,02	1,5	3,0	0,2	0,5	≥56,0	2,0	—	0,7	14,0 to 18,0	—	14,0 to 17,0	—	0,5	—
Ni 6456	NiCr16Mo10Nb	0,10	5,0 to 8,0	10,0	0,8	0,5	≥58,0	—	—	1,0	15,0 to 18,0	1,5 to 3,0	9,0 to 11,0	—	—	—
Ni 6625	NiCr22Mo9Nb	0,10	0,50	5,0	0,50	0,5	≥58,0	—	—	0,40	20,0 to 23,0	3,15 to 4,15	8,0 to 10,0	—	—	—
Ni 6686	NiCr21Mo16W4	0,02	1,0	5,0	0,3	0,5	≥49,0	—	—	0,3	19,0 to 23,0	—	15,0 to 17,0	—	3,0 to 4,4	—

**Nickel-chromium-cobalt-molybdenum**

<sup>a</sup> Unless otherwise stated, single values are maxima.

<sup>b</sup> Phosphorus 0,020 % (by mass) max., sulfur 0,015 % (by mass) max. unless otherwise stated.

<sup>c</sup> Up to 20 % (by mass) of the amount of Nb can be replaced by Ta.

<sup>d</sup> Total unspecified elements shall not exceed 0,5 % (by mass).

<sup>e</sup> Symbols with R have more restricted chemical compositions than symbols without R. Symbols with R meet the requirements of symbols without R but not vice versa.

<sup>f</sup> Consumables for which the chemical composition is not listed shall be symbolized similarly and prefixed by the letter "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)

Numerical	Alloy symbols Chemical	Chemical composition (% by mass) <sup>a,b</sup>													Oth- ers <sup>d</sup>	
		C	Mn	Fe	Si	Cu	Ni	Co	Al	Ti	Cr	Nb <sup>c</sup>	Mo	V		W
Ni 6117	NiCr22Co12Mo	0,05 to 0,15	2,5	5,0	0,75	0,5	≥45,0	9,0 to 15,0	—	—	21,0 to 26,0	1,0	8,0 to 10,0	—	—	P 0,03
Ni 6117 <sup>e</sup>	NiCr22Co12Mo	0,05 to 0,15	0,3 to 2,5	5,0	0,75	0,5	≥45,0	9,0 to 15,0	—	—	21,0 to 26,0	1,0	8,0 to 10,0	—	—	P 0,03
Ni 6617	NiCr22Co12MoAlTi	0,05 to 0,15	2,5	5,0	0,75	0,5	≥45,0	9,0 to 15,0	0,6	1,5	21,0 to 26,0	1,0	8,0 to 10,0	—	—	—
Z <sup>f</sup>		Any other agreed composition														

<sup>a</sup> Unless otherwise stated, single values are maxima.

<sup>b</sup> Phosphorus 0,020 % (by mass) max., sulfur 0,015 % (by mass) max. unless otherwise stated.

<sup>c</sup> Up to 20 % (by mass) of the amount of Nb can be replaced by Ta.

<sup>d</sup> Total unspecified elements shall not exceed 0,5 % (by mass).

<sup>e</sup> Symbols with R have more restricted chemical compositions than symbols without R. Symbols with R meet the requirements of symbols without R but not vice versa.

<sup>f</sup> Consumables for which the chemical composition is not listed shall be symbolized similarly and prefixed by the letter "Z". The chemical composition ranges are not specified and it is possible that two electrodes with the same Z classification are not interchangeable.



**Table 2 — Mechanical properties of the all-weld metal**

Numerical symbol	Chemical symbol	Minimum yield strength $R_{p0,2}$ MPa	Minimum tensile strength $R_m$ MPa	Minimum elongation $5d$ %
<b>Nickel-copper</b>				
Ni 4060	NiCu30Mn3Ti	200	480	27
Ni 4061	NiCu27Mn3NbTi	200	480	27
<b>Nickel-chromium</b>				
Ni 6082	NiCr20Mn3Nb	360	550	22
Ni 6083	NiCr20Mn6Fe4Nb	360	600	27
<b>Nickel-molybdenum</b>				
Ni 1013	NiMo17Cr7W	400	690	22
<b>Nickel-chromium-iron</b>				
Ni 6062	NiCr15Fe8Nb	360	550	22
Ni 6133	NiCr16Fe12NbMo	360	550	22
Ni 6182	NiCr15Fe6Mn	360	550	22
Ni 6152	NiCr30Fe9Nb	360	550	27
<b>Nickel-chromium-molybdenum</b>				
Ni 6002	NiCr22Fe18Mo	380	620	22
Ni 6012	NiCr22Mo9	410	650	22
Ni 6022	NiCr21Mo13W3	350	690	22
Ni 6023	NiCr13Mo13W3	300	690	22
Ni 6059	NiCr23Mo16	350	690	22
Ni 6275	NiCr15Mo16Fe5W3	400	690	22
Ni 6276	NiCr15Mo15Fe6W4	400	690	22
Ni 6455	NiCr16Mo15Ti	300	690	22
Ni 6456	NiCr16Mo10Nb	400	690	27
Ni 6625	NiCr22Mo9Nb	420	690	22
Ni 6686	NiCr21Mo16W4	350	690	27
<b>Nickel-chromium-cobalt-molybdenum</b>				
Ni 6117	NiCr22Co12Mo	400	620	22
Ni 6617	NiCr22Co12MoAlTi	400	620	22

**Table 3 — Symbol for the type of electrode core**

Symbol	Characteristics
B	Basic
R	Rutile, slow-freezing slag
P	Rutile, fast-freezing slag
M	Metal powder
U	Self-shielding
Z	Other types

**Table 4 — Symbol for the welding positions**

Symbol	Welding position (in accordance with ISO 6947)
1	PA, PB, PC, PD, PE, PF, PG
2	PA, PB, PC, PD, PE, PF
3	PA, PB
4	PA
5	PA, PB, PG
<b>Key</b>	
PA flat position	
PB horizontal vertical position	
PC horizontal position	
PD horizontal overhead position	
PE overhead position	
PF vertical up position	
PG vertical down position	

## 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 tubular-cored electrodes in accordance with [Table 1](#), shall be determined using a test assembly in accordance with ISO 15792-1:2020, type 1.3 using 1,2 mm or, if this diameter is not manufactured, the next larger diameter manufactured. The minimum tensile properties shall be in accordance with [Table 2](#).

The total number of runs, the number of runs per layer and the total number of layers shall be as given in [Table 5](#).

## 8 Rounding procedure

For the purposes of determining conformity with the requirements of this document, the actual test values obtained shall be subjected to the rounding rules of ISO 80000-1:2009, Annex B, 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 with the requirements of this document, rounding shall be done only after calculating the average. In cases where the testing standard cited in [Clause 2](#) contains instructions for rounding that conflict with the instructions of this document, the rounding requirements of the testing standard shall apply. The rounded results shall fulfil the requirements of the appropriate table for the classification under test.

**Table 5 — Layer sequence**

Diameter mm	ISO 15792-1:2020 test assembly type	Passes per layer		Total number of layers
		First layer	Other layers	
< 1,2	1.3	1 to 3	2 to 4 <sup>a</sup>	8 to 12
1,2	1.3	1 to 3	2 to 4 <sup>a</sup>	5 to 9
1,4; 1,6; 2,0	1.3	1 to 3	2 to 4 <sup>a</sup>	5 to 8
2,4; 3,2	1.3	1 or 2	1 to 3 <sup>b</sup>	4 to 7
<sup>a</sup> Final layer may have five passes.				
<sup>b</sup> Final layer may have four passes.				

## 9 Retest

If any test fails to meet the requirement, it shall be repeated twice. The results of both retests shall meet the requirement. Specimens for the retest may be taken from the original test assembly or from a new test assembly. For chemical analysis, retests need be only 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 the 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 the proper prescribed procedures. In such cases, the requirement for doubling the number of test specimens does not apply.

## 10 Technical delivery conditions

Technical delivery conditions shall meet the requirements of ISO 544 and ISO 14344.

## 11 Example of designation

The designation of tubular-cored electrodes shall follow the principles given in the following example.

**EXAMPLE** A basic tubular-cored electrode for gas-shielded metal arc welding (B) (T) with mixed shielding gas (M21), weldable in all positions except the position PG (2), which gives a nickel-based weld metal (Ni) with the chemical composition 67 % (by mass) Ni, 15 % (by mass) Cr, 7 % (by mass) Mn, 2 % (by mass) Nb, and all the other requirements for the alloy Ni 6182 in accordance with [Tables 1](#) and [2](#), is designated:

**ISO 12153 — T Ni 6182 B M21 2**

or

**ISO 12153 — T Ni 6182 (NiCr15Fe6Mn) B M21 2**

where

ISO 12153	is the number of this document;
T	indicates tubular-cored electrode for metal arc welding (see <a href="#">5.1</a> );
Ni 6182	indicates the chemical composition of the all-weld metal (see <a href="#">Table 1</a> );
NiCr15Fe6Mn	is the optional chemical symbol of the tubular-cored electrode (see <a href="#">Table 1</a> );
B	indicates basic slag (see <a href="#">Table 3</a> );
M21	indicates mixed gas in accordance with ISO 14175 (see <a href="#">5.4</a> );
2	indicates welding positions PA, PB, PC, PD, PE, PF (see <a href="#">Table 4</a> ).

## Annex A (informative)

### Corresponding national specifications

[Table A.1](#) relates classifications in this document to those in some national standards. The all-weld metal chemical composition ranges specified in the national standards will possibly not be the same as those in this document in all respects and reference should be made to relevant standards for comparison. The table is for information only. It is based on data available at the time of publication.

**Table A.1 — Corresponding AWS classifications**

Numerical symbol	Chemical symbol	Alloy type AWS A5.34	Traditional AWS A5.34 classification
<b>Nickel-copper</b>			
Ni 4060	NiCu30Mn3Ti	—	—
Ni 4061	NiCu27Mn3NbTi	—	—
<b>Nickel-chromium</b>			
Ni 6082	NiCr20Mn3Nb	TNi 6082-XY	ENiCr3Tx-y
Ni 6083	NiCr20Mn6Fe4Nb	—	—
<b>Nickel-molybdenum</b>			
Ni 1013	NiMo17Cr7W	TNi 1013-XY	ENiMo13Tx-y
<b>Nickel-chromium-iron</b>			
Ni 6062	NiCr15Fe8Nb	TNi 6062-XY	ENiCrFe1Tx-y
Ni 6133	NiCr16Fe12NbMo	TNi 6133-XY	ENiCrFe2Tx-y
Ni 6182	NiCr15Fe6Mn	TNi 6182-XY	ENiCrFe3Tx-y
Ni 6152	NiCr30Fe9Nb	—	—
<b>Nickel-chromium-molybdenum</b>			
Ni 6002	NiCr22Fe18Mo	TNi 6002-XY	ENiCrMo2Tx-y
Ni 6012	NiCr22Mo9	—	—
Ni 6022	NiCr21Mo13W3	TNi 6022-XY	ENiCrMo10Tx-y
Ni 6023	NiCr13Mo13W3	TNi 6023-XY	ENiCrMo23Tx-y
Ni 6059	NiCr23Mo16	—	—
Ni 6275	NiCr15Mo16Fe5W3	—	—
Ni 6276	NiCr15Mo15Fe6W4	TNi 6276-XY	ENiCrMo4Tx-y
Ni 6455	NiCr16Mo15Ti	—	—
Ni 6456	NiCr16Mo10Nb	—	—
Ni 6625	NiCr22Mo9Nb	TNi 6625-XY	ENiCrMo3Tx-y
Ni 6686	NiCr21Mo16W4	—	—
<b>Nickel-chromium-cobalt-molybdenum</b>			
Ni 6117	NiCr22Co12Mo	TNi 6117-XY	ENiCrCoMo1Tx-y
Ni 6617	NiCr22Co12MoAlTi	—	—

