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**Welding consumables — Tubular cored  
electrodes for gas shielded metal arc  
welding of creep-resisting steels —  
Classification**

*Produits consommables pour le soudage — Fils-électrodes fourrés pour  
le soudage à l'arc avec gaz de protection des aciers résistant au  
fluage — 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.

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 17634 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 3, *Welding consumables*.

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## Introduction

This International Standard provides a classification system for tubular cored electrodes in terms of chemical composition of the all-weld metal, type of electrode core, type of shielding gas and welding position, or in terms of the tensile properties, chemical composition of the all-weld metal, usability characteristics of the electrodes, shielding gas and welding position. The ratio of proof to tensile strength of weld metal is generally higher than that of parent metal. Users should note that matching weld metal proof strength to parent metal proof strength will not necessarily ensure that the weld metal tensile strength matches that of the parent metal. Where the application requires matching tensile strength, therefore, selection of the consumable should be made by reference to column 4 of Table 2.

It should be noted that the mechanical properties of all-weld metal test specimens used to classify the tubular cored electrodes will vary from those obtained in production joints because of differences in welding procedure such as electrode size, width of weave, welding position and parent metal composition.

The classification according to system A is mainly based on EN 12071:1999, *Welding consumables — Tubular cored electrodes for gas shielded metal arc welding of creep-resisting steels — Classification*. The classification according to system B is mainly based upon standards used around the Pacific Rim.

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 which can be found at [www.iso.org](http://www.iso.org).

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# Welding consumables — Tubular cored electrodes for gas shielded metal arc welding of creep-resisting steels — Classification

## 1 Scope

This International Standard specifies requirements for classification of tubular cored electrodes used in the post-weld heat-treated condition for gas shielded metal arc welding of creep-resisting and low alloy elevated temperature steels. One tubular cored electrode can be tested and classified with different shielding gases.

This International Standard is a combined specification providing for classification utilizing a system based upon the chemical composition of all-weld metal or utilizing a system based upon the tensile strength, and the chemical composition of all-weld metal.

- 1) Paragraphs and tables which carry the suffix letter “A” are applicable only to tubular cored electrodes classified to the system based upon chemical composition, with requirements for the yield strength and the average impact energy of 47 J of all-weld metal in accordance with this International Standard.
- 2) Paragraphs and tables which carry the suffix letter “B” are applicable only to tubular cored electrodes classified to the system based upon the tensile strength and chemical composition of all-weld metal in accordance with this International Standard.
- 3) Paragraphs and tables which have neither the suffix letter “A” nor the suffix letter “B” are applicable to all tubular cored electrodes classified in accordance with this International Standard.

It is recognized that the operating characteristics of tubular cored electrodes can be modified by the use of pulsed current, but for the purposes of this International Standard, pulsed current is not used for determining the electrode classification.

## 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*

ISO 544, *Welding consumables — Technical delivery conditions for welding filler materials — Type of product, dimensions, tolerances and marking*

ISO 3690, *Welding and allied processes — Determination of hydrogen content in ferritic steel arc weld metal*

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

ISO 6947:1990, *Welds — Working positions — Definitions of angles of slope and rotation*

ISO 13916, *Welding — Guidance on the measurement of preheating temperature, interpass temperature and preheat maintenance temperature*

ISO 14175:1997, *Welding Consumables — Shielding gases for arc welding and cutting*

ISO 14344, *Welding and allied processes — Flux and gas shielded electrical welding processes — Procurement guidelines for consumables*

ISO 15792-1:2000, *Welding Consumables — Test methods — Part 1: Test methods for all-weld metal test specimens in steel, nickel and nickel alloys*

ISO 15792-3, *Welding Consumables — Test methods — Part 3: Classification testing of positional capacity and root penetration of welding consumables in a fillet weld*

### 3 Classification

Classification designations are based upon two approaches to indicate the chemical composition, the tensile properties and the impact properties of the all-weld metal obtained with a given electrode. The two designation approaches include additional designators for some other classification requirements, but not all, as will be clear from the following sections. In most cases, a given commercial product can be classified in both systems. Then either or both classification designations can be used for the product.

The classification includes all-weld metal properties obtained with a tubular cored electrode and appropriate shielding gas combination as given below. With the exception of the symbol for welding position which is based on ISO 15792-3, the classification is based on the tubular cored electrode size 1,2 mm, or if this is not manufactured, the next larger diameter manufactured.

#### 3.1A Classification by chemical composition

The classification is divided into six parts:

- 1) the first part (T) indicates a tubular cored electrode;
- 2) the second part gives a symbol indicating the chemical composition of all-weld metal (see Table 1);
- 3) the third part gives a symbol indicating the type of electrode core (see Table 3A);
- 4) the fourth part gives a symbol indicating the shielding gas (see 4.5 and 4.5A);
- 5) the fifth part gives a symbol indicating the welding position (see Table 4A);
- 6) the sixth part gives a symbol indicating the hydrogen content of deposited metal (see Table 5).

#### 3.1B Classification by tensile strength and chemical composition

The classification is divided into seven parts:

- 1) the first part (T) indicates a tubular cored electrode;
- 2) the second part gives a symbol indicating the strength and elongation of all-weld metal in the post-weld heat-treated condition (see Table 2);
- 3) the third part gives a symbol indicating the usability characteristics of the electrode (see Table 3B);
- 4) the fourth part gives a symbol indicating the welding position (see Table 4B);
- 5) the fifth part gives a symbol indicating the shielding gas (see 4.5 and 4.5B);
- 6) the sixth part gives a symbol indicating the chemical composition of all-weld metal (see Table 1);
- 7) the seventh part gives a symbol indicating the hydrogen content of deposited metal (see Table 5).

In both systems, the electrode classification shall include all compulsory sections, and may include an optional section as outlined below.



### 3.2A Compulsory and optional section in the classification by chemical composition

#### a) Compulsory section

This section includes the symbols for the type of product, the chemical composition, the type of electrode core and the shielding gas, i.e. the symbols defined in 4.1, 4.2, 4.4A, 4.5 and 4.5A.

#### b) Optional section

This section includes the symbols for the welding positions for which the electrode is suitable and the symbol for hydrogen content, i.e. the symbols defined in 4.6 and 4.7.

The full designation (see Clause 10) shall be used on packages and in the manufacturer's literature and data sheets.

### 3.2B Compulsory and optional section in the classification by tensile strength and chemical composition

#### a) Compulsory section

This section includes the symbols for the type of product, the strength and elongation in the post-weld heat-treated condition, the welding positions for which the electrode is suitable, the usability characteristics, the shielding gas, the impact properties and the chemical composition, i.e. the symbols defined in 4.1, 4.2, 4.3B, 4.4B, 4.5, 4.5B and 4.6.

#### b) Optional section

This section includes the symbol for hydrogen content, i.e. the symbol defined in 4.7.

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## 4 Symbols and requirements

### 4.1 Symbol for the product/process

ISO 17634:2004

The symbol for the tubular cored electrode used in the gas shielded metal arc welding process is the letter T.

### 4.2 Symbol for the chemical composition of all-weld metal

The symbol in Table 1 indicates the chemical composition of all-weld metal determined in accordance with Clause 6.

### 4.3 Symbol for the mechanical properties of all-weld metal

#### 4.3A Classification by chemical composition

No symbol shall be used for the mechanical properties of the all-weld metal. The all-weld metal obtained with the tubular cored electrodes in Table 1 under conditions given in Clause 5 shall also fulfil the mechanical property requirements specified in Table 2.

#### 4.3B Classification by tensile strength and chemical composition

The symbol for tensile strength shall be 49 for 490 MPa to 670 MPa tensile strength, 55 for 550 MPa to 740 MPa tensile strength, 62 for 620 MPa to 820 MPa tensile strength, or 69 for 690 MPa to 890 MPa tensile strength. The complete mechanical property requirements that shall be fulfilled by the various compositions are specified in Table 2.

Table 1 — Symbol for chemical composition of all-weld metal

Chemical composition <sup>a</sup> symbol for classification according to		Chemical composition (percentage mass fraction) <sup>b,c</sup>									
Chemical composition ISO 17634-A <sup>d</sup>	Tensile Strength and chemical composition ISO 17634-B <sup>e</sup>	C	Mn	Si	P	S	Ni	Cr	Mo	V	
Mo	(2M3)	0,07 to 0,12	0,60 to 1,30	0,80	0,020	0,020	0,3	0,2	0,40 to 0,65	0,03	
(Mo)	2M3	0,12	1,50	0,80	0,030	0,030	—	—	0,40 to 0,65	—	
MoL		0,07	0,60 to 1,70	0,80	0,020	0,020	0,3	0,2	0,40 to 0,65	0,03	
MoV		0,07 to 0,12	0,40 to 1,00	0,80	0,020	0,020	0,3	0,30 to 0,60	0,50 to 0,80	0,25 to 0,45	
	CM	0,05 to 0,12	1,50	0,80	0,030	0,030	—	0,40 to 0,65	0,40 to 0,65	—	
	CML	0,05	1,50	0,80	0,030	0,030	—	0,40 to 0,65	0,40 to 0,65	—	
CrMo 1	(1CM)	0,05 to 0,12	0,40 to 1,30	0,80	0,020	0,020	0,3	0,90 to 1,40	0,40 to 0,65	0,03	
(CrMo 1)	1CM	0,05 to 0,12	1,50	0,80	0,030	0,030	—	1,00 to 1,50	0,40 to 0,65	—	
CrMo 1L	(1CML)	0,05	0,40 to 1,30	0,80	0,020	0,020	0,3	0,90 to 1,40	0,40 to 0,65	0,03	
(CrMo 1L)	1CML	0,05	1,50	0,80	0,030	0,030	—	1,00 to 1,50	0,40 to 0,65	—	
	1CMH	0,10 to 0,15	1,50	0,80	0,030	0,030	—	1,00 to 1,50	0,40 to 0,65	—	
CrMo 2	(2C1M)	0,05 to 0,12	0,40 to 1,30	0,80	0,020	0,020	0,3	2,00 to 2,50	0,90 to 1,30	0,03	
(CrMo 2)	2C1M	0,05 to 0,12	1,50	0,80	0,030	0,030	—	2,00 to 2,50	0,90 to 1,20	—	
CrMo 2L	(2C1ML)	0,05	0,40 to 1,30	0,80	0,020	0,020	0,3	2,00 to 2,50	0,90 to 1,30	0,03	
(CrMo 2L)	2C1ML	0,05	1,50	0,80	0,030	0,030	—	2,00 to 2,50	0,90 to 1,20	—	
	2C1MH	0,10 to 0,15	1,50	0,80	0,030	0,030	—	2,00 to 2,50	0,90 to 1,20	—	
CrMo 5	(5CM)	0,03 to 0,12	0,40 to 1,30	0,80	0,020	0,025	0,3	4,0 to 6,0	0,40 to 0,70	0,03	
(CrMo 5)	5CM	0,05 to 0,12	1,50	1,00	0,030	0,030	0,40	4,0 to 6,0	0,45 to 0,65	—	

Table 1 (continued)

Chemical composition <sup>a</sup> symbol for classification according to		Chemical composition (percentage mass fraction) <sup>b,c</sup>									
Chemical composition ISO 17634-A <sup>d</sup>	Tensile Strength and chemical composition ISO 17634-B <sup>e</sup>	C	Mn	Si	P	S	Ni	Cr	Mo	V	
	5CML	0,05	1,50	1,00	0,030	0,030	0,40	4,0 to 6,0	0,45 to 0,65	—	
	9C1M	0,05 to 0,12	1,50	1,00	0,030	0,030	0,40	8,0 to 10,5	0,85 to 1,20	—	
	9C1ML	0,05	1,50	1,00	0,030	0,030	0,40	8,0 to 10,5	0,85 to 1,20	—	
	9C1MV <sup>f</sup>	0,08 to 0,13	1,20	0,50	0,020	0,015	1,00	8,0 to 10,5	0,85 to 1,20	0,15 to 0,30	
	9C1MV1 <sup>g</sup>	0,05 to 0,12	1,25 to 2,00	0,50	0,020	0,015	1,00	8,0 to 10,5	0,85 to 1,20	0,15 to 0,30	
Z	G	Any other agreed composition									

<sup>a</sup> A designation in parentheses [e.g., (CrMo1) or (1CM)] indicates a near match in the other designation system, but not an exact match. The correct designation for a given composition range is the one without parentheses. A given product may, by having a more restricted chemical composition which fulfils both sets of designation requirements, be assigned both designations independently, provided that the mechanical property requirements of Table 2 are also satisfied.

<sup>b</sup> Single values shown in the table are maximum values.

<sup>c</sup> The results shall be rounded to the same number of significant figures as in the specified value using rule A in accordance with Annex B of ISO 31-0:1992 (see 4.8).

<sup>d</sup> Cu ≤ 0,3; Nb ≤ 0,1.

<sup>e</sup> The weld metal shall be analysed for the specific elements for which values are shown in this table. Other elements listed without specified values shall be reported, if intentionally added. The total of those latter unspecified elements and all other elements not intentionally added shall not exceed 0,50 %.

<sup>f</sup> Nb: 0,02 to 0,10; N: 0,02 to 0,07; Cu: ≤ 0,25; Al: ≤ 0,04.

<sup>g</sup> Nb: 0,01 to 0,08; N: 0,02 to 0,07; Cu ≤ 0,25; Al: ≤ 0,04.