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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

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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 second edition cancels and replaces the first edition (ISO 17634:2004), which has been technically revised.

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. 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 consumables is made by reference to column 4 of Table 2.

Of note is 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. The classification according to system B is mainly based upon standards used around the Pacific Rim.

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

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 15792-1:2000/Amd 1:2011, *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*

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

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).

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).

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, and 4.5.

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.

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, and 4.6.

b) Optional section

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

The full designation shall comprise the compulsory symbols and may include optional symbols chosen by the manufacturer. The full designation (see Clause 10) shall be used on packages and in the manufacturer's literature and data sheets.

4 Symbols and requirements

4.1 Symbol for the product/process

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 the following:

— 49 for 490 MPa to 660 MPa tensile strength;

— 55 for 550 MPa to 690 MPa tensile strength;

— 62 for 620 MPa to 760 MPa tensile strength;

— 69 for 690 MPa to 830 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[a] symbol for classification according to		**Chemical composition** (percentage mass fraction)[b]								
Chemical composition ISO 17634-A[c]	Tensile Strength and chemical composition ISO 17634-B[d]	**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	1,25	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	1,25	0,80	0,030	0,030	—	0,40 to 0,65	0,40 to 0,65	—
	CML	0,05	1,25	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	1,25	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	1,25	0,80	0,030	0,030	—	1,00 to 1,50	0,40 to 0,65	—
	1CMH	0,10 to 0,15	1,25	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	1,25	0,80	0,030	0,030	—	2,00 to 2,50	0,90 to 1,20	—

[a] 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 can, 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.

[b] Single values shown in the table are maximum values.

[c] Cu ≤ 0,3; Nb ≤ 0,1.

[d] 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 %.

[e] Cu 0,50.

[f] Nb: 0,02 to 0,10; N: 0,02 to 0,07; Cu ≤ 0,25; Al ≤ 0,04, Mn + Ni = 1,40 max.

[g] Nb: 0,01 to 0,08; N: 0,02 to 0,07; Cu ≤ 0,25; Al ≤ 0,04.

[h] Consumables for which the chemical composition is not listed in this table shall be symbolized similarly and prefixed by the letter Z or G. The chemical composition ranges are not specified and therefore it is possible that two electrodes with the same Z classification are not interchangeable.

Table 1 *(continued)*

Chemical composition[a] symbol for classification according to		**Chemical composition** (percentage mass fraction)[b]								
Chemical composition ISO 17634-A[c]	Tensile Strength and chemical composition ISO 17634-B[d]	**C**	**Mn**	**Si**	**P**	**S**	**Ni**	**Cr**	**Mo**	**V**
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	1,25	0,80	0,030	0,030	—	2,00 to 2,50	0,90 to 1,20	—
	2C1MH	0,10 to 0,15	1,25	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	1,25	1,00	0,025	0,030	0,40	4,0 to 6,0	0,45 to 0,65	—
	5CML	0,05	1,25	1,00	0,025	0,030	0,40	4,0 to 6,0	0,45 to 0,65	—
	9C1M[e]	0,05 to 0,12	1,25	1,00	0,040	0,030	0,40	8,0 to 10,5	0,85 to 1,20	—
	9C1ML[e]	0,05	1,25	1,00	0,040	0,030	0,40	8,0 to 10,5	0,85 to 1,20	—
	9C1MV[f]	0,08 to 0,13	1,20	0,50	0,020	0,015	0,80	8,0 to 10,5	0,85 to 1,20	0,15 to 0,30
	9C1MV1[g]	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[h]								

[a] 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 can, 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.

[b] Single values shown in the table are maximum values.

[c] Cu ≤ 0,3; Nb ≤ 0,1.

[d] 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 %.

[e] Cu 0,50.

[f] Nb: 0,02 to 0,10; N: 0,02 to 0,07; Cu ≤ 0,25; Al ≤ 0,04, Mn + Ni = 1,40 max.

[g] Nb: 0,01 to 0,08; N: 0,02 to 0,07; Cu ≤ 0,25; Al ≤ 0,04.

[h] Consumables for which the chemical composition is not listed in this table shall be symbolized similarly and prefixed by the letter Z or G. The chemical composition ranges are not specified and therefore it is possible that two electrodes with the same Z classification are not interchangeable.

Table 2 — Mechanical properties of all-weld metal

Chemical composition[a] symbol for classification according to		Minimum[b] proof strength	Tensile strength	Minimum[d] elongation	Impact energy J at +20 °C		Heat treatment of all-weld metal		
							Preheat and interpass temperature	Post weld heat treatment of test assembly	
Chemical composition ISO 17634-A	Tensile strength and chemical composition ISO 17634-B	MPa	MPa	%	Minimum average from three test specimens	Minimum[e] single value	°C	Temperature °C	Time min
Mo	(2M3)	355	510[c]	22	47	38	<200	570 to 620[f]	60[g]
(Mo)	T49TX-X-2M3	400	490 to 660	18	—	—	135–165	605 to 635[h]	60[i]
(Mo)	T55TX-X-2M3	470	550 to 690	17	—	—	135–165	605 to 635[h]	60[i]
MoL		355	510[c]	22	47	38	<200	570 to 620[f]	60[g]
MoV		355	510[c]	18	47	38	200 to 300	690 to 730[f]	60[g]
	T55TX-X-CM	470	550 to 690	17	—	—	160 to 190	675 to 705[h]	60[i]
	T55TX-X-CML	470	550 to 690	17	—	—	160 to 190	675 to 705[h]	60[i]
CrMo 1	(1CM)	355	510[c]	20	47	38	150 to 250	660 to 700[f]	60[g]

[a] 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 can, 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.

[b] The 0,2 % proof strength, $R_{p0,2}$, is used.

[c] Minimum tensile strength.

[d] Gauge length is equal to five times the specimen diameter.

[e] Only one single value lower than minimum average is permitted.

[f] The test assembly shall be cooled in the furnace to 300 °C at a rate not exceeding 200 °C/h.

[g] Tolerance shall be $^{+10}_{-10}$ min.

[h] The furnace shall be at a temperature no higher than 315 °C when the test assembly is placed in it. The heating rate from that point to the holding temperature shall not exceed 280 °C/h. When the holding time has been completed, the assembly shall be allowed to cool in the furnace to a temperature below 315 °C at a rate not exceeding 195 °C/h. The assembly can be removed from the furnace at any temperature below 315 °C and allowed to cool in still air to room temperature.

[i] Tolerance shall be $^{+15}_{0}$ min.

Table 2 *(continued)*

Chemical composition[a] symbol for classification according to		Minimum[b] proof strength	Tensile strength	Minimum[d] elongation	Impact energy J at +20 °C		Heat treatment of all-weld metal		
							Preheat and interpass temperature	Post weld heat treatment of test assembly	
Chemical composition ISO 17634-A	Tensile strength and chemical composition ISO 17634-B	MPa	MPa	%	Minimum average from three test specimens	Minimum[e] single value	°C	Temperature °C	Time min
(CrMo 1)	T55TX-X-1CM	470	550 to 690	17	—	—	160 to 190	675 to 705[h]	60[i]
CrMo 1L	(1CML)	355	510[c]	20	47	38	150 to 250	660 to 700[f]	60[g]
(CrMo 1L)	T55TX-X-1CML	470	550 to 690	17	—	—	160 to 190	675 to 705[h]	60[i]
	T55TX-X-1CMH	470	550 to 690	17	—	—	160 to 190	675 to 705[h]	60[i]
CrMo 2	(2C1M)	400	500[c]	18	47	38	200 to 300	690 to 750[f]	60[g]
(CrMo 2)	T62TX-X-2C1M	540	620 to 760	15	—	—	160 to 190	675 to 705[h]	60[i]
(CrMo 2)	T69TX-X-2C1M	610	690 to 830	14	—	—	160 to 190	675 to 705[h]	60[i]
CrMo 2L	(2C1ML)	400	500[c]	18	47	38	200 to 300	690 to 750[f]	60[g]

[a] 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 can, 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.

[b] The 0,2 % proof strength, $R_{p0,2}$, is used.

[c] Minimum tensile strength.

[d] Gauge length is equal to five times the specimen diameter.

[e] Only one single value lower than minimum average is permitted.

[f] The test assembly shall be cooled in the furnace to 300 °C at a rate not exceeding 200 °C/h.

[g] Tolerance shall be $^{+10}_{-10}$ min.

[h] The furnace shall be at a temperature no higher than 315 °C when the test assembly is placed in it. The heating rate from that point to the holding temperature shall not exceed 280 °C/h. When the holding time has been completed, the assembly shall be allowed to cool in the furnace to a temperature below 315 °C at a rate not exceeding 195 °C/h. The assembly can be removed from the furnace at any temperature below 315 °C and allowed to cool in still air to room temperature.

[i] Tolerance shall be $^{+15}_{0}$ min.

Table 2 *(continued)*

Chemical composition[a] symbol for classification according to		Minimum[b] proof strength	Tensile strength	Minimum[d] elongation	Impact energy J at +20 °C		Heat treatment of all-weld metal		
							Preheat and interpass temperature	Post weld heat treatment of test assembly	
Chemical composition ISO 17634-A	Tensile strength and chemical composition ISO 17634-B	MPa	MPa	%	Minimum average from three test specimens	Minimum[e] single value	°C	Temperature °C	Time min
(CrMo 2L)	T62TX-X-2C1ML	540	620 to 760	15	—	—	160 to 190	675 to 705[h]	60[i]
	T62TX-X-2C1MH	540	620 to 760	15	—	—	160 to 190	675 to 705[h]	60[i]
CrMo 5	(5CM)	400	590[c]	17	47	38	200 to 300	730 to 760[f]	60[g]
(CrMo 5)	T55TX-X-5CM	470	550 to 690	17	—	—	150 to 250	730 to 760[h]	60[i]
	T55TX-X-5CML	470	550 to 690	17	—	—	150 to 250	730 to 760[h]	60[i]
	T55TX-X-9C1M	470	550 to 690	17	—	—	150 to 250	730 to 760[h]	60[i]
	T55TX-X-9C1ML	470	550 to 690	17	—	—	150 to 250	730 to 760[h]	60[i]

[a] 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 can, 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.

[b] The 0,2 % proof strength, $R_{p0,2}$, is used.

[c] Minimum tensile strength.

[d] Gauge length is equal to five times the specimen diameter.

[e] Only one single value lower than minimum average is permitted.

[f] The test assembly shall be cooled in the furnace to 300 °C at a rate not exceeding 200 °C/h.

[g] Tolerance shall be $^{+10}_{-10}$ min.

[h] The furnace shall be at a temperature no higher than 315 °C when the test assembly is placed in it. The heating rate from that point to the holding temperature shall not exceed 280 °C/h. When the holding time has been completed, the assembly shall be allowed to cool in the furnace to a temperature below 315 °C at a rate not exceeding 195 °C/h. The assembly can be removed from the furnace at any temperature below 315 °C and allowed to cool in still air to room temperature.

[i] Tolerance shall be $^{+15}_{0}$ min.

Table 2 *(continued)*

Chemical composition[a] symbol for classification according to		Minimum[b] proof strength	Tensile strength	Minimum[d] elongation	Impact energy J at +20 °C		Heat treatment of all-weld metal		
							Preheat and interpass temperature	Post weld heat treatment of test assembly	
Chemical composition ISO 17634-A	Tensile strength and chemical composition ISO 17634-B	MPa	MPa	%	Minimum average from three test specimens	Minimum[e] single value	°C	Temperature °C	Time min
	T69TX-X-9C1MV[f]	610	690 to 830	14	—	—	150 to 250	730 to 760[h]	60[i]
	T69TX-X-9C1MV1[f]	610	690 to 830	14	—	—	150 to 250	730 to 760[h]	60[i]
Z	TXXTX-X-G	As agreed between purchaser and supplier							

a 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 can, 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.

b The 0,2 % proof strength, $R_{p0,2}$, is used.

c Minimum tensile strength.

d Gauge length is equal to five times the specimen diameter.

e Only one single value lower than minimum average is permitted.

f The test assembly shall be cooled in the furnace to 300 °C at a rate not exceeding 200 °C/h.

g Tolerance shall be $^{+10}_{-10}$ min.

h The furnace shall be at a temperature no higher than 315 °C when the test assembly is placed in it. The heating rate from that point to the holding temperature shall not exceed 280 °C/h. When the holding time has been completed, the assembly shall be allowed to cool in the furnace to a temperature below 315 °C at a rate not exceeding 195 °C/h. The assembly can be removed from the furnace at any temperature below 315 °C and allowed to cool in still air to room temperature.

i Tolerance shall be $^{+15}_{0}$ min.

4.4 Symbol for type of electrode core or the usability characteristics of the electrodes

4.4A Classification by chemical composition

The symbol in Table 3A indicates different types of tubular cored electrodes relative to their core composition and slag characteristics. Manufacturers shall provide information on recommended polarity.

Table 3A — Symbol for type of electrode core (Classification by chemical composition)

Symbol	Characteristics
R	Rutile, slow-freezing slag
P	Rutile, fast-freezing slag
B	Basic
M	Metal powder
Z	Other types
NOTE A description of the characteristics of each of the types of core is given in Annex C.	

4.4B Classification by tensile strength and chemical composition

The symbol in Table 3B indicates the usability characteristics of the electrodes.

Table 3B — Usability characteristics (classification by tensile strength and chemical composition)

Usability designator	Shielding gas	Operating polarity	Transfer of droplet	Type of core	Welding position[a]	Characteristics
T1	Required	dc (+)	Spray type	Rutile	0 or 1	Low spatter loss, flat to slightly convex bead, and high deposition rates
T5	Required	dc (+) or dc (-)	Globular type	Lime-fluo-ride	0 or 1	Slightly convex bead, a thin slag without completely covering the weld bead, good impact properties, and hot and cold crack resistance compared with “T1”
T15	Required	dc (+)	Very fine droplet spray type	Metal	0 or 1	Core consisting of metal alloys and iron powder and minimal slag cover
TG[b]	As agreed between purchaser and supplier					

NOTE A description of the usability characteristics of the electrodes is given in Annex D.

[a] See Table 4B.

[b] For electrodes that are not covered by any currently defined usability designator.

4.5 Symbol for shielding gas

The symbols for shielding gases shall be in accordance with ISO 14175 except that the symbol NO shall be used for non-gas shielded tubular cored electrodes.

4.6 Symbol for welding position

The symbol in Table 4A or Table 4B indicates the positions for which the electrode is suitable for classification to ISO 17634-A or ISO 17634-B in accordance with ISO 15792-3 (see Clause 8 for testing requirements).

Table 4A — Symbol for welding position (classification by chemical composition)

Symbol	Welding positions[a]
1	PA, PB, PC, PD, PE, PF, and PG
2	PA, PB, PC, PD, PE, and PF
3	PA and PB
4	PA
5	PA, PB, and PG

[a] 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
In accordance with ISO 6947.

Table 4B — Symbol for welding position (classification by tensile strength and chemical composition)

Symbol	Welding positions[a]
0	PA and PB
1	PA, PB, PC, PD, PE, PF or PG, or PF + PG

[a] 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
In accordance with ISO 6947.

4.7 Symbol for hydrogen content of deposited metal

The symbol in Table 5 indicates the hydrogen content determined in accordance with the method given in ISO 3690.

Table 5 — Symbol for hydrogen content of deposited metal

Symbol	Hydrogen content ml/100 g deposited metal, max.
H5	5
H10	10
H15	15

When the symbol for hydrogen content in accordance with Table 7 is included in the classification, the manufacturer shall state in their literature what restrictions need to be placed on the conditions of storage and on current, arc voltage, electrode extension, polarity, and shielding gas to remain within the required limit.

5 Mechanical tests

5.1 Tensile and impact tests

Tensile and impact tests shall be carried out on weld metal in the post-weld heat-treated condition using an all-weld metal test assembly type 1.3 in accordance with ISO 15792-1:2000/ Amd 1:2011

using 1,2 mm for gas shielded electrodes or if this size is not manufactured, the closest diameter manufactured, and welding conditions as described in 5.2 and 5.3.

5.2 Preheating and interpass temperatures

Preheating and interpass temperatures shall be selected for the appropriate weld metal type from Table 2. The preheating and interpass temperature shall be measured using temperature indicator crayons, surface thermometers, or thermocouples (see ISO 13916).

The interpass temperature shall not exceed the maximum temperature indicated in Table 2. If after any pass this interpass temperature is exceeded, the test assembly shall be cooled in air to a temperature within the limits of the interpass temperature.

5.3 Pass sequence

The procedures used for the welding of multi-run test assemblies shall conform to the requirements given in Table 6A or Table 6B.

Table 6A — Pass and layer sequence (classification by chemical composition)

Diameter mm	Passes per layer		Number of layers	Total number of passes
	First layer	Other layers[a]		
1,2	1 or 2	2 or 3	6 to 9	12 to 19
1,4 to 2,0	1 or 2	2 or 3	5 to 8	10 to 17
2,4 to 3,2	1 or 2	2 or 3	4 to 7	7 to 14

[a] The final layer may have four passes.

Table 6B — Pass and layer sequence (classification by tensile strength and chemical composition)

Diameter mm	Required average heat input kJ/mm	Passes per layer		Number of layers
		First layer	Other layers[a]	
≤0,8 0,9	0,8 to 1,4	1 or 2	2 or 3	6 to 9
1,0 1,2	1,0 to 2,0	1 or 2	2 or 3	6 to 9
1,4 1,6	1,0 to 2,2	1 or 2	2 or 3	5 to 8
1,8 2,0	1,4 to 2,6	1 or 2	2 or 3	5 to 8
2,4	1,6 to 2,6	1 or 2	2 or 3	4 to 8
2,8	2,0 to 2,8	1 or 2	2 or 3	4 to 7
3,2	2,2 to 3,0	1 or 2	2	4 to 7
4,0	2,6 to 3,3	1	2	4 to 7

[a] The final layer may have four passes.

6 Chemical analysis

Chemical analysis is performed on any suitable all-weld metal test specimen. The referee method is ISO 6847. Any analytical technique can be used, but in case of dispute, reference shall be made to established published methods.

7 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.

8 Fillet weld test

The fillet weld test assembly shall be as shown in ISO 15792-3.

8A Classification by chemical composition

The plate material shall be selected from the range of materials for which the electrode is recommended by the manufacturer or shall be unalloyed steel of 0,30 % C maximum. The fillet welds shall be deposited as a single run using the diameter of electrode and welding position shown in Table 7A. Throat thickness, leg length, and convexity shall conform to the requirements of Table 7A.

8B Classification by tensile strength and chemical composition

For the electrodes classified as symbol 0 in Table 4B, the fillet weld test shall be performed in the PB position. For the electrodes classified as symbol 1 in Table 4B, the fillet weld test shall be performed in positions PE and PF or PG.

The plate material shall be unalloyed steel of 0,30 % C maximum. The welding procedure and the size of the electrode to be tested shall be as selected by the manufacturer. The fillet welds shall be deposited as a single pass.

The maximum convexity and leg length difference shall conform to the dimensional requirements:

a) Maximum convexity

   2,0 mm for <7,0 mm in measured fillet weld size

   2,5 mm for ≥7,0 mm in measured fillet weld size

b) Maximum leg length difference (mm) = 0,5 × [fillet weld size (mm)] − 0,5

Incomplete fusion at the root of the weld shall not exceed 20 % of the total length of the weld.

Table 7 — A — Test requirements for fillet welds (classification by chemical composition)

Symbol of position for classification	Test position	Electrode size[a] mm	Throat thickness mm	Maximum leg length difference mm	Maximum convexity mm
1 or 2	PB	2,4	5,5 min.	2,0	3,0
3	PB	2,4	5,5 min.	2,0	3,0
5	PB	2,4[b]	5,5 min.	2,0	3,0
1 or 2	PF	2,4[c]	7,0 max.	Not specified	2,0
1, 2 or 5	PD	1,2[d]	4,5 max.	1,5	2,5
5	PG	1,2[d]	4,5 max.	Not specified	1,5[e]

[a] Where the largest size claimed for positional welding is smaller than that specified, use the largest size and adjust criteria pro rata.

[b] Or largest size made up to 2,4 mm.

[c] Maximum size for which positional classification is sought.

[d] Or as recommended by the manufacturer.

[e] Maximum concavity.

9 Retests

If any test fails to meet the requirement, that test shall be repeated twice. The results of both retests shall meet the requirement. Specimens for the retest could 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 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 proper prescribed procedures. In this case, the requirement for doubling the number of test specimens does not apply.

10 Technical delivery conditions

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

11 Example of designation

The designation of the tubular cored electrode shall follow the principle given in the examples below.

11A Classification by chemical composition

EXAMPLE 1A A tubular cored electrode (T) for gas shielded metal arc welding deposits a weld metal with a chemical composition within the limits of the alloy symbol CrMo1 of Table 1. The electrode with a basic type core (B) was tested under mixed gas (M21) and can be used in flat butt and flat fillet welds (4). Hydrogen is determined in accordance with ISO 3690 and does not exceed 5 ml/100 g deposited metal (H5).

This is designated as follows:

ISO 17634-A — T CrMo1 B M21 4 H5

Compulsory section:

ISO 17634-A — T CrMo1 B M21

where

ISO 17634-A	is the number of this International Standard with classification by chemical composition;
T	indicates a tubular cored electrode/gas shielded metal arc welding (see 4.1);
CrMo1	is the chemical composition of all-weld metal (see Table 1);
B	is the type of electrode core (see Table 3A);
M21	is the shielding gas (see 4.5);
4	is the welding position (see Table 4A);
H5	is the hydrogen content (see Table 5).

11B Classification by tensile strength and chemical composition

EXAMPLE 1B A tubular cored electrode (T) for gas shielded metal arc welding deposits a weld metal with a minimum tensile strength in the post-weld heat-treated condition of 550 MPa (55) and has a chemical composition within the limits of the alloy symbol 1CM of Table 1. The electrode with a lime-fluoride slag (T5) was tested under mixed gas (M21) and can be used in flat and horizontal vertical position (0). Hydrogen is determined in accordance with ISO 3690 and does not exceed 5 ml/100 g deposited metal (H5).

This is designated as follows:

ISO 17634-B — T55T5–0M21–1CM-H5

Compulsory section:

ISO 17634-B — T55T5–0M21–1CM

where

ISO 17634-B	is the number of this International Standard with classification by tensile strength and chemical composition;
T	indicates a tubular cored electrode/metal arc welding (see 4.1);
55	represents the tensile properties (see Table 2);
T5	is the usability designator (see Table 3B);
0	is the welding position (see Table 4B);
M21	is the shielding gas (see 4.5);
1CM	is the chemical composition of all-weld metal (see Table 1);
H5	is the hydrogen content (see Table 5).

EXAMPLE 2A A tubular cored electrode (T) for gas shielded metal arc welding deposits a weld with a chemical composition of 0,11 % C, 0,6 % Mn, 0,25 % Si, 9,4 % Cr, 0,3 % Ni, 1,0 % Mo, 0,2 % V, and 0,045 % N. The electrode with a basic type core (B) was tested under mixed gas (M21) and can be used in all positions (1). Hydrogen is determined in accordance with ISO 3690 and does not exceed 5 ml/100 g deposited metal (H5).

This is designated as follows:

ISO 17634-A — T Z CrMo91 B M21 1 H5

Compulsory section:

ISO 17634-A — T Z CrMo91 B M21

where

ISO 17634-A	is the number of this International Standard with classification by chemical composition;
T	indicates a tubular cored electrode/gas shielded metal arc welding (see 4.1);
Z	chemical composition and mechanical properties are agreed between manufacturer and customer;
CrMo91	indicates the chemical composition of the all weld metal;
B	is the type of electrode core (see Table 3A);
M21	is the shielding gas (see 4.5);
1	is the welding position (see Table 4A);
H5	is the hydrogen content (see Table 5).

Annex A
(informative)

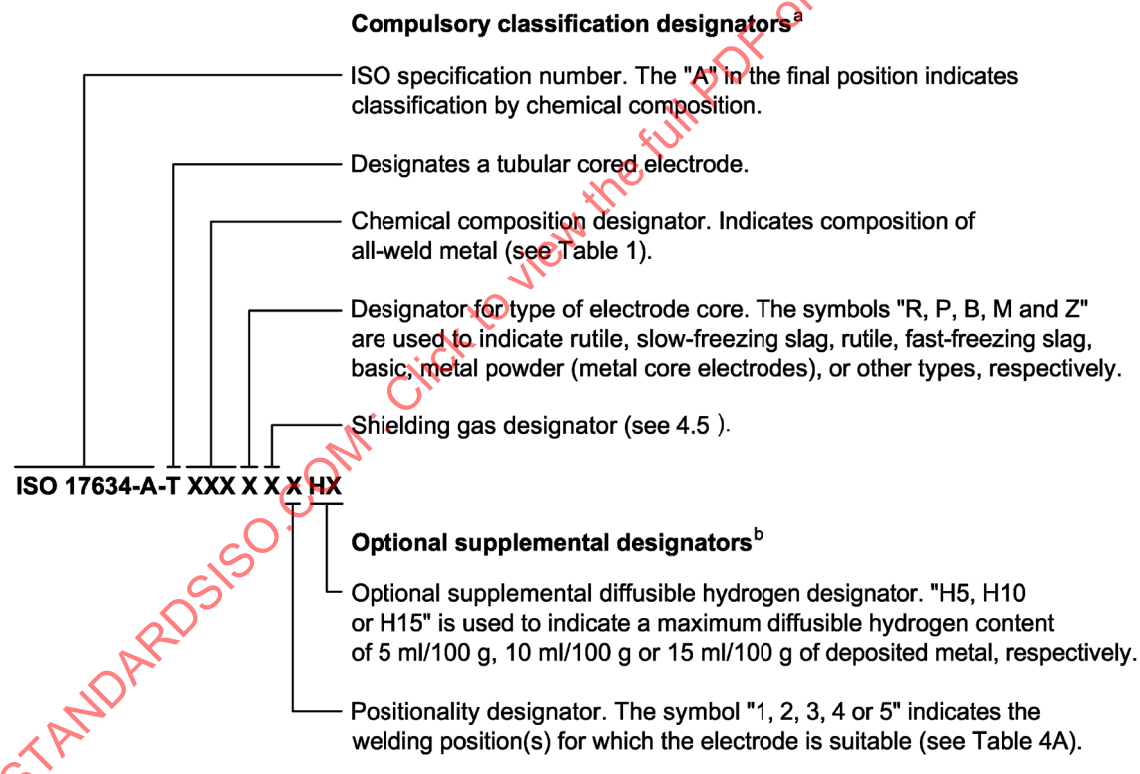
Classification systems

A.1 ISO 17634-A

The ISO 17634 classification system for tubular cored electrodes based upon chemical composition is shown in Figure A1.

A.2 ISO 17634-B

The ISO 17634 classification system for tubular cored electrodes based upon tensile strength and chemical composition is shown in Figure A2.

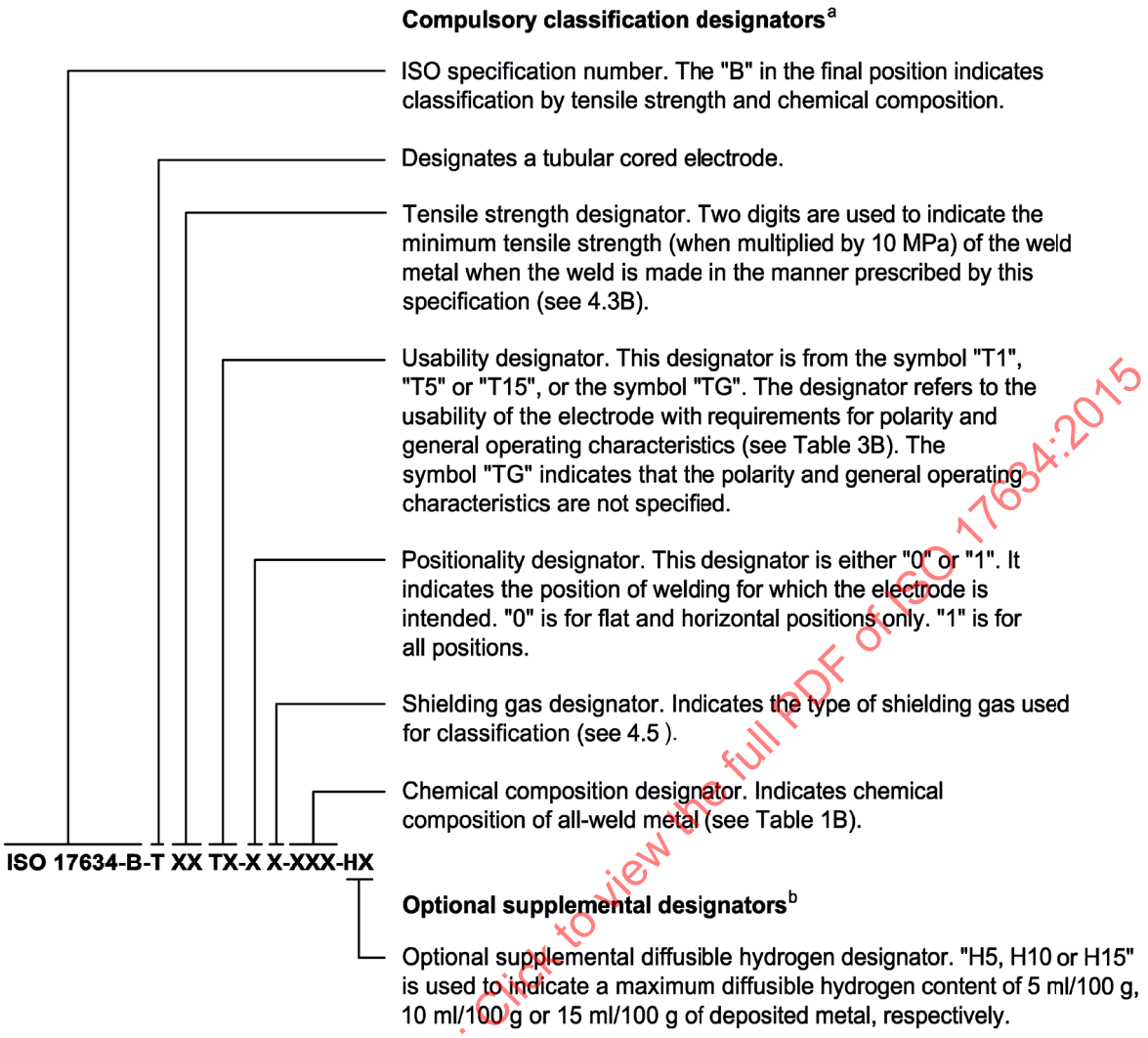


Key

a The combination of these designators constitutes the tubular cored electrode classification.

b These designators are optional and do not constitute part of the tubular cored electrode classification.

Figure A.1 — ISO 17634-A classification system for tubular cored electrodes based upon chemical composition



Key

a The combination of these designators constitutes the tubular cored electrode classification.

b This designator is optional and does not constitute a part of the tubular cored electrode classification.

Figure A.2 — ISO 17634-B classification system for tubular cored electrodes based upon tensile strength and chemical composition