
**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.

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.

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.

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.

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 ^a symbol for classification according to | | Chemical composition (percentage mass fraction) ^{b,c} | | | | | | | | | |
|--|--|--|--------------|------|-------|-------|------|--------------|--------------|--------------|--|
| Chemical composition ISO 17634-A ^d | Tensile Strength and chemical composition ISO 17634-B ^e | 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 ^a symbol for classification according to | | Chemical composition (percentage mass fraction) ^{b,c} | | | | | | | | | |
|--|--|--|--------------|------|-------|-------|------|-------------|--------------|--------------|--|
| Chemical composition ISO 17634-A ^d | Tensile Strength and chemical composition ISO 17634-B ^e | 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 ^f | 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 ^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 | | | | | | | | | |

^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 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.

^b Single values shown in the table are maximum values.

^c 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).

^d Cu ≤ 0,3; Nb ≤ 0,1.

^e 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 %.

^f Nb: 0,02 to 0,10; N: 0,02 to 0,07; Cu: ≤ 0,25; Al: ≤ 0,04.

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

Table 2 — Mechanical properties of all-weld metal

| Chemical composition ^a symbol for classification according to | | Minimum ^b proof strength MPa | Tensile strength MPa | Minimum ^d elongation % | Impact energy J at +20 °C | | Heat treatment of all-weld metal | | |
|--|---------------|--|-------------------------|--------------------------------------|---|-----------------------------------|---|--|-----------------|
| | | | | | Minimum average from three test specimens | Minimum ^e single value | Preheat and interpass temperature °C | Post weld heat treatment of test assembly Temperature °C | Time min |
| Mo | (2M3) | 355 | 510 ^c | 22 | 47 | 38 | < 200 | 570 to 620 ^f | 60 ^g |
| (Mo) | T49TX-X-2M3 | 390 | 490 to 670 | 18 | — | — | 135-165 | 605 to 635 ^h | 60 ⁱ |
| (Mo) | T55TX-X-2M3 | 460 | 550 to 740 | 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 |
| CrMo 1 | T55TX-X-CM | 460 | 550 to 740 | 17 | — | — | 160 to 190 | 675 to 705 ^h | 60 ⁱ |
| | T55TX-X-CML | 460 | 550 to 740 | 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 |
| (CrMo 1) | T55TX-X-1CM | 460 | 550 to 740 | 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 | 460 | 550 to 740 | 17 | — | — | 160 to 190 | 675 to 705 ^h | 60 ⁱ |
| | T55TX-X-1CMH | 460 | 550 to 740 | 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 | 530 | 620 to 820 | 15 | — | — | 160 to 190 | 675 to 705 ^h | 60 ⁱ |
| (CrMo 2) | T69TX-X-2C1M | 600 | 690 to 890 | 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 |
| (CrMo 2L) | T62TX-X-2C1ML | 530 | 620 to 820 | 15 | — | — | 160 to 190 | 675 to 705 ^h | 60 ⁱ |
| | T62TX-X-2C1MH | 530 | 620 to 820 | 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 |

Table 2 (continued)

| Chemical composition ^a symbol for classification according to | | Minimum ^b proof strength MPa | Tensile strength MPa | Minimum ^d elongation % | Impact energy J at +20 °C | | Heat treatment of all-weld metal | | |
|--|--|--|-------------------------|--------------------------------------|---|-----------------------------------|---|---|-----------------|
| Chemical composition ISO 17634-A | Tensile strength and chemical composition ISO 17634-B | | | | Minimum average from three test specimens | Minimum ^e single value | Preheat and interpass temperature °C | Post weld heat treatment of assembly Temperature °C | Time min |
| (CrMo 5) | T55TX-X-5CM | 460 | 550 to 740 | 17 | — | — | 150 to 250 | 730 to 760 ^h | 60 ⁱ |
| | T55TX-X-5CML | 460 | 550 to 740 | 17 | — | — | 150 to 250 | 730 to 760 ^h | 60 ⁱ |
| | T55TX-X-9C1M | 460 | 550 to 740 | 17 | — | — | 150 to 250 | 730 to 760 ^h | 60 ⁱ |
| | T55TX-X-9C1ML | 460 | 550 to 740 | 17 | — | — | 150 to 250 | 730 to 760 ^h | 60 ⁱ |
| | T69TX-X-9C1MV ^f | 565 | 690 to 890 | 14 | — | — | 150 to 250 | 730 to 760 ^h | 60 ⁱ |
| Z | TXXTX-X-G | 565 | 690 to 890 | 14 | — | — | 150 to 250 | 730 to 760 ^h | 60 ⁱ |

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 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.

^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 may 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.

4.4B Classification by tensile strength and chemical composition

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

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.

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 (+) | Globular type | Lime-fluoride | 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 M and C indicate shielding gas as described in ISO 14175:1997.

The symbol C shall be used when the classification has been performed with shielding gas ISO 14175-C1, carbon dioxide.

4.5A Classification by chemical composition

The symbol M, for mixed gases, shall be used when the classification has been performed with shielding gas ISO 14175-M2 but without helium.

4.5B Classification by tensile strength and chemical composition

The symbol M, for mixed gases, shall be used when the classification has been performed with shielding gas ISO 14175-M21, but restricted to Ar + 20 % to 25 % CO₂.

The symbol G shall be used to indicate that some other shielding gas was used as agreed between supplier and purchaser.

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. PA, PB, PC, PD, PE, PF and PG are the symbols specified in ISO 6947:1990. See Clause 7 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

**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

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 letter H is included in the classification, the manufacturer shall state in his literature whether the maximum hydrogen level achieved is 15 ml, 10 ml or 5 ml per 100 g of deposited metal, and 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 this limit.

Diffusible hydrogen shall be determined in accordance with ISO 3690.

4.8 Rounding-off procedure

For the purposes of determining compliance with the requirements of this International Standard, the actual test values obtained shall be subjected to the rounding-off rules of ISO 31-0:1992, Annex B, 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 off. If an average value is to be compared to the requirements of this International Standard, rounding-off shall be done only after calculating the average. In the case where the testing standard cited in the normative references of this International Standard contains instructions for rounding-off that conflict with the instructions of this International Standard, the rounding-off requirements of the testing standard shall apply. The rounded-off results shall fulfil the requirements of the appropriate table for the classification under test.

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 using 1,2 mm, or if this size is not manufactured the next larger 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 1,6 | 1 or 2 | 2 or 3 | 6 to 9 |
| 1,0 1,2 | 1,2 to 2,0 | 1 or 2 | 2 or 3 | 6 to 9 |
| 1,4 1,6 | 1,4 to 2,2 | 1 or 2 | 2 or 3 | 5 to 8 |
| 2,0 | 1,8 to 2,4 | 1 or 2 | 2 or 3 | 5 to 8 |
| 2,4 | 2,0 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 |
| ^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 Fillet weld test

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

7A 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.

7B 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.

**Table 7A — 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 min. | 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.

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 percent of the total length of the weld.

8 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 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 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.

9 Technical delivery conditions

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

10 Example of designation

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

10A Classification by chemical composition

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 (M) and may be used in flat butt and flat fillet welds (4). Hydrogen is determined in accordance with ISO 3690 and does not exceed 5 ml/100g deposited metal (H5).

This is designated as follows:

ISO 17634-A - T CrMo1 B M 4 H5

Compulsory section:

ISO 17634-A - T CrMo1 B M

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);

M is the shielding gas (see 4.5);

4 is the welding position (see Table 4A);

H5 is the hydrogen content (see Table 5).

10B Classification by tensile strength and chemical composition

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 Ar + 20 % to 25 % CO₂ (M) and may be used in flat and horizontal vertical position (0). Hydrogen is determined in accordance with ISO 3690 and does not exceed 5 ml/100g deposited metal (H5).

This is designated as follows:

ISO 17634-B - T55T5-0M-1CM-H5

Compulsory section:

ISO 17634-B - T55T5-0M-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);

M 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).

Annex A (informative)

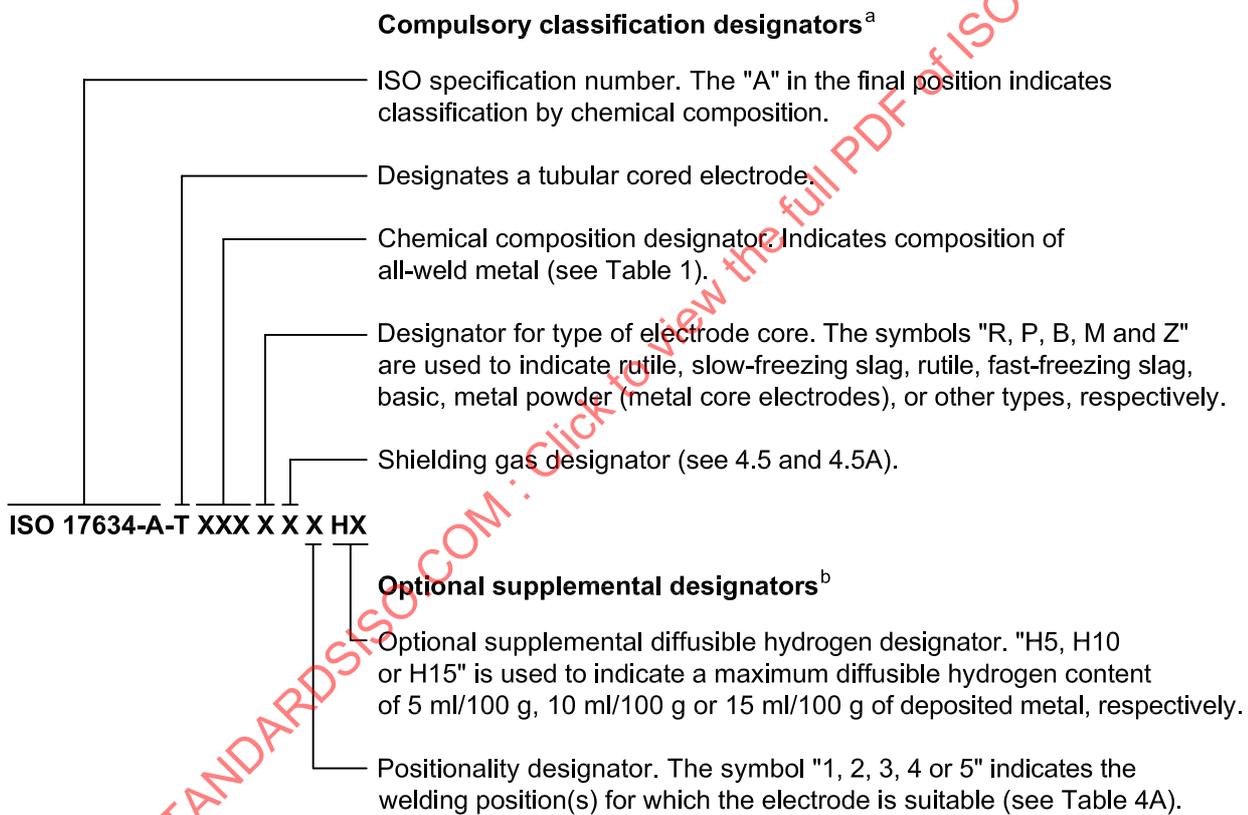
Classification systems

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.



^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