INTERNATIONAL STANDARD

ISO 17632

First edition
2004-10-01

Welding consumables — Tubular cored electrodes for gas shielded and non-gas shielded metal arc welding of non-alloy and fine grain steels — Classification

Produits consommables pour le soudage — Fils-électrodes fourrés pour soudage à l'arc avec ou sans gaz de protection des aciers non alliés et des aciers à grains fins — Classification

Reference number
ISO 17632:2004(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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 17632 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 3, *Welding consumables*.

Introduction

This International Standard provides a classification system for tubular cored electrodes in terms of tensile properties, impact properties, chemical composition of the all-weld metal, type of electrode core, shielding gas and welding position. The ratio of yield to tensile strength of weld metal is generally higher than that of parent metal. Users should note that matching weld metal yield strength to parent metal yield 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 3 of Table 1A or Table 1B.

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 758:1997, *Welding consumables — Tubular cored electrodes for metal arc welding with and without a gas shield of non alloy and fine grain 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 and non-gas shielded metal arc welding of non-alloy and fine grain steels — Classification

1 Scope

This International Standard specifies requirements for classification of tubular cored electrodes with or without a gas shield for metal arc welding of non-alloy and fine grain steels in the as-welded condition or in the post-weld heat-treated condition with a minimum yield strength of up to 500 MPa or a minimum tensile strength of up to 570 MPa. One tubular cored electrode can be tested and classified with different shielding gases, if any.

This International Standard is a combined specification providing classification utilizing a system based upon the yield strength and the average impact energy of 47 J of all-weld metal, or utilizing a system based upon the tensile strength and the average impact energy of 27 J 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 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 the average impact energy of 27 J 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 permitted 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 15792-2:2000, *Welding Consumables — Test methods — Part 2: Preparation of single-run and two-run technique test specimens in steel*

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 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. 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. See Annex A.

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 of gas shielded tubular cored electrodes is based on the 1,2 mm electrode size or, if this size is not manufactured, the next larger diameter manufactured. The classification of self-shielded tubular cored electrodes is based on the 2,4 mm diameter or the largest diameter manufactured if less than 2,4 mm.

3.1A Classification by yield strength and 47 J impact energy

The classification is divided into eight 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 for multi-run technique or the strength of the parent material used in classification for the single-run technique (see Table 1A or Table 2A);

3) the third part gives a symbol indicating the impact properties of all-weld metal or welded joint (see Table 3);

4) the fourth part gives a symbol indicating the chemical composition of all-weld metal (see Table 4A);

5) the fifth part gives a symbol indicating the type of electrode core (see Table 5A);

3.1B Classification by tensile strength and 27 J impact energy

The classification is divided into nine 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 for multi-run technique or the strength of the parent material used in classification for the single-run technique (see Table 1B or Table 2B);

3) the third part gives a symbol indicating the impact properties of all-weld metal (see Table 3). The symbol “U”, added as an optional supplemental designator at or near the end of the complete tubular cored electrode designation, indicates that the deposit meets an average optional requirement of 47 J at the designated Charpy test temperature;

4) the fourth part gives a symbol indicating the usability characteristics of the electrode (see Table 5B);

5) the fifth part gives a symbol indicating the welding position (see Table 6B);

6) the sixth part gives a symbol indicating the shielding gas (see 4.6 and 4.6A);

7) the seventh part gives a symbol indicating the welding position (see Table 6A);

8) the eighth part gives a symbol indicating the hydrogen content of deposited metal (see Table 7).

6) the sixth part gives a symbol indicating the shielding gas (see 4.6 and 4.6B). The letter "S" added to this designator indicates that the electrode is classified for single-pass welding;

7) the seventh part gives a symbol indicating whether the classification tests were conducted in the as-welded (A) or post-weld heat-treated condition (P). If the electrode has been classified in both conditions, the symbol AP shall be added to the classification. This designator is omitted in the classification for single-pass welding electrodes as these are tested only in the as-welded condition;

8) the eighth part gives a symbol indicating the chemical composition of all-weld metal (see Table 4B). The symbol is omitted for weld deposits conforming to the "No symbol" in Table 4B;

9) the ninth part gives a symbol indicating the hydrogen content of deposited metal (see Table 7).

Electrodes may be classified under any number of classifications for either or both the as-welded and post-weld heat-treated condition.

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

3.2A Compulsory and optional sections in the classification by yield strength and 47 J impact energy

a) Compulsory section

This section includes the symbols for type of product, strength and elongation, impact properties, chemical composition, type of electrode core and shielding gas, i.e. the symbols defined in 4.1, 4.2.1A, 4.2.2, 4.3A, 4.4, 4.5A and 4.6.

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 4.7 and 4.8.

3.2B Compulsory and optional sections in the classification by tensile strength and 27 J impact energy

a) Compulsory section

This section includes the symbols for type of product, strength and elongation in the as-welded condition or post-weld heat-treated condition, welding positions for which the electrode is suitable, usability characteristics, shielding gas, impact properties and chemical composition, i.e. the symbols defined in 4.1, 4.2.1B, 4.2.2, 4.3B, 4.4, 4.5B, 4.6, 4.7 and 4.9B.

b) Optional section

This section includes the symbol "U" to indicate that the weld metal has an average of 47J impact energy at the classification test temperature and the symbol for hydrogen content, i.e. the symbol "U" defined in 4.3B and the symbols defined in 4.8.

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 metal arc welding process is the letter T.

4.2 Symbol for tensile properties of all-weld metal or welded joint

4.2.1 Multi-run technique

4.2.1A Classification by yield strength and 47 J impact energy

For products suitable for single- and multi-run welding, the symbol in Table 1A indicates yield strength, tensile strength and elongation of the all-weld metal in the as-welded condition determined in accordance with 5.1A.

4.2.1B Classification by tensile strength and 27 J impact energy

For electrodes suitable for single- and multi-run welding, the symbol in Table 1B indicates yield strength, tensile strength and elongation of the all-weld metal in the as-welded condition or in the post-weld heat-treated condition determined in accordance with 5.1B.

Classification of products suitable for both single- and multi-run welding does not require the single-run test of 5.2.

Table 1A — Symbol for tensile properties by multi-run technique (classification by yield strength and 47 J impact energy)

Symbol	Minimum yield strength [a] MPa	Tensile strength MPa	Minimum elongation [b] %
35	355	440 to 570	22
38	380	470 to 600	20
42	420	500 to 640	20
46	460	530 to 680	20
50	500	560 to 720	18

[a] For yield strength the lower yield, R_{eL}, is used when yielding occurs, otherwise the 0,2 % proof strength, $R_{p0,2}$, is used.

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

Table 1B — Symbol for tensile properties by multi-run technique (classification by tensile strength and 27 J impact energy)

Symbol	Minimum yield strength [a] MPa	Tensile strength MPa	Minimum elongation [b] %
43	330	430 to 600	20
49	390	490 to 670	18
55	460	550 to 740	17
57	490	570 to 770	17

[a] For yield strength the lower yield, R_{eL}, is used when yielding occurs, otherwise the 0,2 % proof strength , $R_{p0,2}$, is used.

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

4.2.2 Single-run technique

For tubular cored electrodes suitable for single-run welding only, the symbol in Table 2A or Table 2B indicates strength of the welded joint in the as-welded condition in relation to the parent material used in single-run tests satisfactorily completed in accordance with 5.2.

Table 2A — Symbol for tensile properties by single-run technique (classification by yield strength and 47 J impact energy)

Symbol	Minimum parent material yield strength MPa	Minimum tensile strength of the welded joint MPa
3T	355	470
4T	420	520
5T	500	600

Table 2B — Symbol for tensile properties by single-run technique (classification by tensile strength and 27 J impact energy)

Symbol	Minimum tensile strength of the parent metal and of the welded joint MPa
43	430
49	490
55	550
57	570

4.3 Symbol for impact properties of all-weld metal or welded joint

4.3A Classification by yield strength and 47 J impact energy

The symbol in Table 3 indicates the temperature at which an impact energy of 47 J is achieved under the conditions given in 5.1A or 5.2. Three test specimens shall be tested. Only one individual value may be lower than 47 J but no lower than 32 J.

4.3B Classification by tensile strength and 27 J impact energy

The symbol in Table 3 indicates the temperature at which an impact energy of 27 J is achieved in the as-welded condition or in the post-weld heat-treated condition under the conditions given in 5.1B or 5.2. Five test specimens shall be tested. The lowest and highest values obtained shall be disregarded. Two of the three remaining values shall be greater than the specified 27 J level, one of the three may be lower but shall be no less than 20 J. The average of the three remaining values shall be at least 27 J. Three test specimens shall be tested when the optional supplemental designator “U” is used to indicate that the weld deposit will meet a minimum impact energy of 47 J at the test temperature. The impact value shall be determined by the average of the three test specimens. The average of three values shall be 47 J or greater.

When an all-weld metal has been classified for a certain temperature, it automatically covers any higher temperature listed in Table 3.

NOTE Impact testing is not required to classify electrodes for the single-run technique

Table 3 — Symbol for impact properties of all-weld metal or welded joint

Symbol	Temperature for minimum average impact energy of 47 J [a,b] or 27 J [c] °C
Z[a]	No requirements
A[b] or Y[c]	+ 20
0	0
2	– 20
3	– 30
4	– 40
5	– 50
6	– 60
7	– 70
8	– 80
9	– 90
10	– 100

a Only the symbol Z is used for electrodes for the single-run technique.
b Classification by yield strength and 47 J impact energy.
c Classification by tensile strength and 27 J impact energy.

4.4 Symbol for chemical composition of all-weld metal

The symbol in Table 4A or Table 4B indicates the chemical composition of all-weld metal determined in accordance with Clause 6.

Table 4A — Symbol for chemical composition of all-weld metal (classification by yield strength and 47 J impact energy)

Composition designation	Chemical composition (percentage mass fraction) [a, b]											
	C	Mn	Si	P	S	Cr	Ni	Mo	V	Nb	Al [c]	Cu
No symbol	—	2,0	—	—	—	0,2	0,5	0,2	0,08	0,05	2,0	0,3
Mo	—	1,4	—	—	—	0,2	0,5	0,3 to 0,6	0,08	0,05	2,0	0,3
MnMo	—	1,4 to 2,0	—	—	—	0,2	0,5	0,3 to 0,6	0,08	0,05	2,0	0,3
1Ni	—	1,4	0,80	—	—	0,2	0,6 to 1,2	0,2	0,08	0,05	2,0	0,3
1.5Ni	—	1,6	—	—	—	0,2	1,2 to 1,8	0,2	0,08	0,05	2,0	0,3
2Ni	—	1,4	—	—	—	0,2	1,8 to 2,6	0,2	0,08	0,05	2,0	0,3
3Ni	—	1,4	—	—	—	0,2	2,6 to 3,8	0,2	0,08	0,05	2,0	0,3
Mn1Ni	—	1,4 to 2,0	—	—	—	0,2	0,6 to 1,2	0,2	0,08	0,05	2,0	0,3
1NiMo	—	1,4	—	—	—	0,2	0,6 to 1,2	0,3 to 0,6	0,08	0,05	2,0	0,3
Z [d]	—	—	—	—	—	—	—	—	—	—	—	—

a Single values shown in the table are maximum values.

b 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.

c Self-shielded electrodes only.

d Any other agreed composition.

Table 4B — Symbol for chemical composition of all-weld metal (Classification by tensile strength and 27 J impact energy)

Composition designation	Chemical composition (percentage mass fraction) [a, b, c]										
	C	Mn	Si	P	S	Cr	Ni	Mo	Cu	V	Al [d]
No symbol	0,18 [e]	2,00	0,90	0,030	0,030	0,20 [f]	0,50 [f]	0,30 [f]	—	0,08 [f]	2,0
K	0,20	1,60	1,00	0,030	0,030	0,20 [f]	0,50 [f]	0,30 [f]	—	0,08 [f]	—
2M3	0,12	1,50	0,80	0,030	0,030	—	—	0,40 to 0,65	—	—	1,8
3M2	0,15	1,25 to 2,00	0,80	0,030	0,030	—	—	0,25 to 0,55	—	—	1,8
N1	0,12	1,75	0,80	0,030	0,030	—	0,30 to 1,00	0,35	—	—	1,8
N2	0,12	1,75	0,80	0,030	0,030	—	0,80 to 1,20	0,35	—	—	1,8
N3	0,12	1,75	0,80	0,030	0,030	—	1,00 to 2,00	0,35	—	—	1,8
N5	0,12	1,75	0,80	0,030	0,030	—	1,75 to 2,75	—	—	—	1,8
N7	0,12	1,75	0,80	0,030	0,030	—	2,75 to 3,75	—	—	—	1,8
CC	0,12	0,60 to 1,40	0.20 to 0.80	0,030	0,030	0,30 to 0,60	—	—	0,20 to 0,50	—	1,8
NCC	0,12	0,60 to 1,40	0.20 to 0.80	0,030	0,030	0,45 to 0,75	0,10 to 0,45	—	0,30 to 0,75	—	1,8
NCC1	0,12	0,50 to 1,30	0.20 to 0.80	0,030	0,030	0,45 to 0,75	0,30 to 0,80	—	0,30 to 0,75	—	1,8
N1M2	0,15	2,00	0,80	0,030	0,030	0,20	0,40 to 1,00	0,20 to 0,65	—	0,05	1,8
N2M2	0,15	2,00	0,80	0,030	0,030	0,20	0,80 to 1,20	0,20 to 0,65	—	0,05	1,8
N3M2	0,15	2,00	0,80	0,030	0,030	0,20	1,00 to 2,00	0,20 to 0,65	—	0,05	1,8
G [g]	—	—	—	—	—	—	—	—	—	—	—

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

[b] 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.

[c] The weld metal shall be analysed for the specific elements for which values as shown in this table.

[d] Self-shielded electrodes only.

[e] 0,30 % for self-shielded electrodes.

[f] The analysis of these elements shall be reported only if added intentionally.

[g] Any other agreed composition.

4.5 Symbol for type of electrode core or for the usability characteristics of the electrode

4.5A Classification by yield strength and 47 J impact energy

The symbol in Table 5A indicates different types of tubular cored electrodes relative to their core composition and slag characteristics. Manufacturers shall provide information on recommended polarity.

Table 5A — Symbol for type of electrode core (classification by yield strength and 47 J impact energy)

Symbol	Characteristics	Types of weld	Shielding gas
R	Rutile, slow-freezing slag	Single and multiple pass	Required
P	Rutile, fast-freezing slag	Single and multiple pass	Required
B	Basic	Single and multiple pass	Required
M	Metal powder	Single and multiple pass	Required
V	Rutile or basic/fluoride	Single pass	Not required
W	Basic/fluoride, slow-freezing slag	Single and multiple pass	Not required
Y	Basic/fluoride fast-freezing slag	Single and multiple pass	Not required
Z	Other types		

NOTE A description of the characteristics of each of the types of core is given in Annex B.

4.5B Classification by tensile strength and 27 J impact energy

The symbol in Table 5B indicates the usability characteristics of the electrode.

4.6 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.

The symbol N shall be used for tubular cored electrodes without a gas shield.

4.6A Classification by yield strength and 47 J impact energy

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

4.6B Classification by tensile strength and 27 J impact energy

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 % CO_2.

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

Table 5B — Usability characteristics (classification by tensile strength and 27 J impact energy)

Usability designator	Shielding gas	Operating polarity	Transfer of droplet	Type of core	Welding [a] position	Characteristics	Type of weld
T1	Required	d.c.(+)	Spray type	Rutile	0 or 1	Low spatter loss, flat to slightly convex bead and high deposition rates	Single and multiple pass
T2	Required	d.c.(+)	Spray type	Rutile	0	Similar to “T1” type, higher manganese and/or silicon for improved performance	Single pass
T3	Not required	d.c.(+)	Globular type	Not specified	0	Very high welding speeds	Single pass
T4	Not required	d.c.(+)	Globular type	Basic	0	Very high deposition rates, excellent resistance to hot cracking and low penetration	Single and multiple pass
T5	Required	d.c.(+)	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”	Single and multiple pass
T6	Not required	d.c.(+)	Spray type	Not specified	0	Good impact properties, good penetration into the root of the weld and excellent slag removal even in a deep groove	Single and multiple pass
T7	Not required	d.c.(–)	Small droplet to spray type	Not specified	0 or 1	High deposition rates and excellent resistance to hot cracking	Single and multiple pass
T8	Not required	d.c.(–)	A small droplet or spray type	Not specified	0 or 1	Very good low temperature impact properties	Single and multiple pass
T10	Not required	d.c.(–)	Small droplet	Not specified	0	High travel speeds on any thickness	Single pass
T11	Not required	d.c.(–)	Spray type	Not specified	0 or 1	Some electrodes are designed for thin plate only. The manufacturer should be consulted regarding any plate thickness limitations.	Single and multiple pass
T12	Required	d.c.(+)	Spray type	Rutile	0 or 1	Similar to “T1” type, improved impact properties and lower manganese requirements	Single and multiple pass
T13	Not required	d.c.(–)	Short arc transfer	Not specified	0 or 1	Welding for open gap root passes	Single pass
T14	Not required	d.c.(–)	Spray type	Not specified	0 or 1	High speed welding on coated sheet steels	Single pass
T15	Required	d.c.(+)	Very fine droplet spray type	Metal	0 or 1	Core consisting of metal alloys and iron powder, and minimal slag cover	Single and multiple pass
TG [b]	As agreed between purchaser and supplier						

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

[a] See Table 6B.

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

4.7 Symbol for welding position

The symbols in Table 6A or Table 6B indicate the positions for which the electrode is suitable for classification to ISO 17632-A or ISO 17632-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 6A — Symbol for welding position (classification by yield strength and 47 J impact energy)

Symbol	Welding positions [a]
1	PA, PB, PC, PD, PE, PF & PG
2	PA, PB, PC, PD, PE & PF
3	PA & PB
4	PA
5	PA, PB & 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 6B — Symbol for welding position (classification by tensile strength and 27 J impact energy)

Symbol	Welding positions [a]
0	PA & 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

4.8 Symbol for hydrogen content of deposited metal

The symbols in Table 7 indicate the hydrogen content determined in accordance with the method given in ISO 3690.

Table 7 — 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.

4.9 Symbol for condition of postweld heat treatment of all-weld metal

4.9A Classification by yield strength and 47 J impact energy

Classification is based upon mechanical properties of the all-weld metal in the as-welded condition only. No symbol is used to indicate this.

4.9B Classification by tensile strength and 27 J impact energy

If the electrode has been classified in the as-welded condition, the symbol A shall be added to the classification. If the electrode has been classified in the post-weld heat-treated condition, the condition of post-weld heat treatment, shall be as specified in 5.1.3B, and the symbol P shall be added to the classification. If the electrode has been classified in both conditions, the symbol AP shall be added to the classification.

5 Mechanical tests

5.1 Multi-run technique

5.1A Classification by yield strength and 47 J impact energy

Tensile and impact tests and any required retests shall be carried out on weld metal prepared as described in 5.1.1A and 5.1.2, in the as-welded condition using an all-weld metal, test assembly type 1.3 in accordance with ISO 15792-1:2000 using 1,2 mm for gas shielded electrodes or, if this size is not manufactured, the next larger diameter manufactured, and 2,4 mm for self-shielded electrodes, or the largest size manufactured if less than 2,4 mm.

5.1B Classification by tensile strength and 27 J impact energy

Tensile and impact tests shall be carried out on weld metal prepared as described in 5.1.1B, 5.1.2 and 5.1.3B, in the as-welded condition and/or 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 for gas shielded electrodes or, if this size is not manufactured, the next larger diameter manufactured, and 2,4 mm for self-shielded electrodes, or the largest size manufactured if less than 2,4 mm.

5.1.1 Preheating and interpass temperatures

5.1.1A Classification by yield strength and 47 J impact energy

Preheating is not required, welding may start from room temperature. The interpass temperature shall be measured using temperature indicator crayons, surface thermometers or thermocouples. See ISO 13916.

The interpass temperature shall not exceed 250 °C. If, after any pass, this interpass temperature is exceeded, the test assembly shall be cooled in air to a temperature below that limit.

5.1.1B Classification by tensile strength and 27 J impact energy

Preheating and interpass temperatures shall be selected for the appropriate weld metal type from Table 8B. 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 8B. If, after any pass, this interpass temperature is exceeded, the test assembly shall be cooled in air to a temperature within that range. If below interpass, reheat into interpass range.

Tableau 8B — Preheating and interpass temperatures (classification by tensile strength and 27 J impact energy)

Composition designation	Preheat temperature °C	Interpass temperature °C
No symbol, K	Room temperature	150 ± 15
2M3, 3M2, N1, N2, N3, N5, N7, CC, NCC, NCC1, N1M2, N2M2, N3M2	100 min.	

5.1.2 Procedure requirements for welding multi-run test assemblies.

The procedures used for the welding of multi-run test assemblies shall conform to the requirements given in Table 9A or Table 9B.

Table 9A — Pass and layer sequence for multi-run electrode classifications (classification by yield strength and 47 J impact energy)

Diameter mm	Passes per layer		Number of layers
	First layer	Other layers [a]	
0,8 0,9	1 or 2	2 or 3	6 to 9
1,0 1,2	1 or 2	2 or 3	6 to 9
1,4 1,6	1 or 2	2 or 3	5 to 8
2,0	1 or 2	2 or 3	5 to 8
2,4	1 or 2	2 or 3	4 to 8
2,8	1 or 2	2 or 3	4 to 7
3,2	1 or 2	2	4 to 7
4,0	1	2	4 to 7

[a] The final layer may have four passes.

Table 9B — Pass and layer sequence for multi-run electrode classifications (classification by tensile strength and 27 J impact energy)

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
4,0	2,6 to 3,3	1	2	4 to 7

[a] The final layer may have four passes.

5.1.3 Post-weld heat treatment (PWHT) condition

5.1.3A Classification by yield strength and 47 J impact energy

No PWHT condition is used in this specification.

5.1.3B Classification by tensile strength and 27 J impact energy

Test assemblies made with electrodes classified in the PWHT condition shall be heat treated at 620 °C ± 15 °C for 1 h ($^{+15}_{0}$ min). 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 620 °C ± 15 °C holding temperature, shall not exceed 220 °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.

5.2 Single-run technique

Tensile tests shall be carried out in the as-welded condition using a test assembly type 2.1 or 2.3 in accordance with ISO 15792-2:2000. Impact testing is not required for single-run technique.

Test assembly and welding conditions shall correspond to the range recommended by the manufacturer and shall be recorded to demonstrate compliance with this International Standard.

6 Chemical analysis

Chemical analysis is performed on any suitable all-weld metal test specimen. The reference method is that described in 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 yield strength and 47 J impact energy

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 10A. Throat thickness, leg length and convexity shall conform to the requirements of Table 10A.

7B Classification by tensile strength and 27 J impact energy

For the electrodes classified as symbol 0 in Table 6B, the fillet weld test shall be performed in the PB position. For the electrodes classified as symbol 1 in Table 6B, the fillet weld test shall be performed in the PE, and PF or PG positions.

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 10A — Test requirements for fillet welds (classification by yield strength and 47 J impact energy)

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.		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.		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 following dimensional requirements:

a) Maximum convexity

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

2,5 mm for $\geqslant 7,0$ 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.

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, retesting 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 given in ISO 544 and ISO 14344.

10 Examples of designation

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

10A Classification by yield strength and 47 J impact energy

EXAMPLE 1:

A tubular cored electrode (T) for gas shielded arc welding deposits a weld metal with a minimum yield strength of 460 MPa (46) and a minimum average impact energy of 47 J at – 30 °C (3) in the as-welded condition and has a chemical composition of 1,1 % Mn and 1,0 % Ni (1Ni). The electrode with a basic type core (B) was tested under mixed gas (M) 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 17632-A - T46 3 1Ni B M 1 H5

Compulsory section:

ISO 17632-A - T46 3 1Ni B M

where:

ISO 17632-A is the number of this International Standard, with classification by yield strength and 47 J impacts;

T indicates a tubular cored electrode/metal arc welding (see 4.1);

46 represents the tensile properties (see Table 1A);

3 indicates impact properties of 47 J, minimum (see Table 3);

1Ni is the chemical composition of all-weld metal (see Table 4A);

B is the type of electrode core (see Table 5A);

M is the shielding gas (see 4.6);

1 is the welding position (see Table 6A);

H5 is the hydrogen content (see Table 7).

10B Classification by tensile strength and 27 J impact energy

EXAMPLE 1:

A tubular cored electrode (T) for gas shielded arc welding deposits a weld metal with a minimum tensile strength of 550 MPa (55) and a minimum average impact energy of 27 J at – 40°C (4) in the as-welded condition (A). The symbol “U”, added as an optional supplemental designator, indicates that the deposit also meets a minimum optional requirement of 47 J at the designated Charpy test temperature (– 40 °C). The electrode with a usability designator (T5) was tested using mixed gas (M) and can be used in all positions (1). The weld deposit has a chemical composition of 1,1 % Mn and 1,0 % Ni (N2). 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 17632-B - T554T5-1MA-N2-UH5

Compulsory section:

ISO 17632-B - T554T5-1MA-N2

where:

ISO 17632-B is the standard number of this International Standard, with classification by tensile strength and 27 J impacts;

T indicates a tubular cored electrode;

55 represents the tensile properties (see Table 1B);

4 indicates impact properties of 27 J, minimum (see Table 3);

T5 is the usability designator (see Table 5B);

1 is the welding position (see Table 6B);

M is the shielding gas (see 4.6);

A indicates tested in the as-welded condition;

N2 is the chemical composition of all-weld metal (see Table 4B);

U indicates (optional designator) that the weld deposit in the as-welded condition will have impact properties of 47J minimum at the classification test temperature;

H5 is the hydrogen content (see Table 7).

EXAMPLE 2:

A tubular cored electrode (T) for gas shielded arc welding deposits a weld metal using a single-run technique with a minimum yield strength of 355 MPa (3T) and no impact reqirement in the as-welded condition. The electrode with a rutile, slow freezing slag (R) was tested under CO_2 gas (C) and can be used in flat and horizontal vertical position (3). Hydrogen is determined in accordance with ISO 3690 and does not exceed 10 ml/100 g deposited metal (H10).

This is designated as follows:

ISO 17632-A - T3T Z R C 3 H10

Compulsory section:

ISO 17632-A - T3T Z R C

where:

ISO 17632-A is the number of this International Standard with classification by yield strength and 47 J impacts;

T indicates a tubular cored electrode/metal arc welding (see 4.1);

3T represents the tensile properties (see Table 2A);

Z indicates no impact requirement (see Table 3);

R is the type of electrode core (see Table 5A);

C is the shielding gas (see 4.6);

3 is the welding position (see Table 6A);

H10 is the hydrogen content (see Table 7).

EXAMPLE 2:

A tubular cored electrode (T) for gas shielded arc welding deposits a weld metal using a single-run technique (S) with a minimum tensile strength of 490 MPa (49). The electrode with a usability designator (T2) was tested using CO_2 gas (C) and can be used in flat and horizontal vertical position (0). The absence of a chemical composition designator indicates that the all-weld metal composition conforms to the “No symbol” (Table 4B). Hydrogen is determined in accordance with ISO 3690 and does not exceed 10 ml/100 g deposited metal (H10).

This is designated as follows:

ISO 17632-B - T49T2-0CS-H10

Compulsory section:

ISO 17632-B - T49T2-0CS

where:

ISO 17632-B is the number of this International Standard, with classification by tensile strength and 27 J impacts;

T indicates a tubular cored electrode;

49 represents the tensile properties (see Table 2B);

T2 is the usability designator (See Table 5B);

0 is the welding position (see Table 6B);

C is the shielding gas (see 4.6);

S indicates classification is for single-run technique;

H10 is the hydrogen content (see Table 7).

Annex A
(informative)

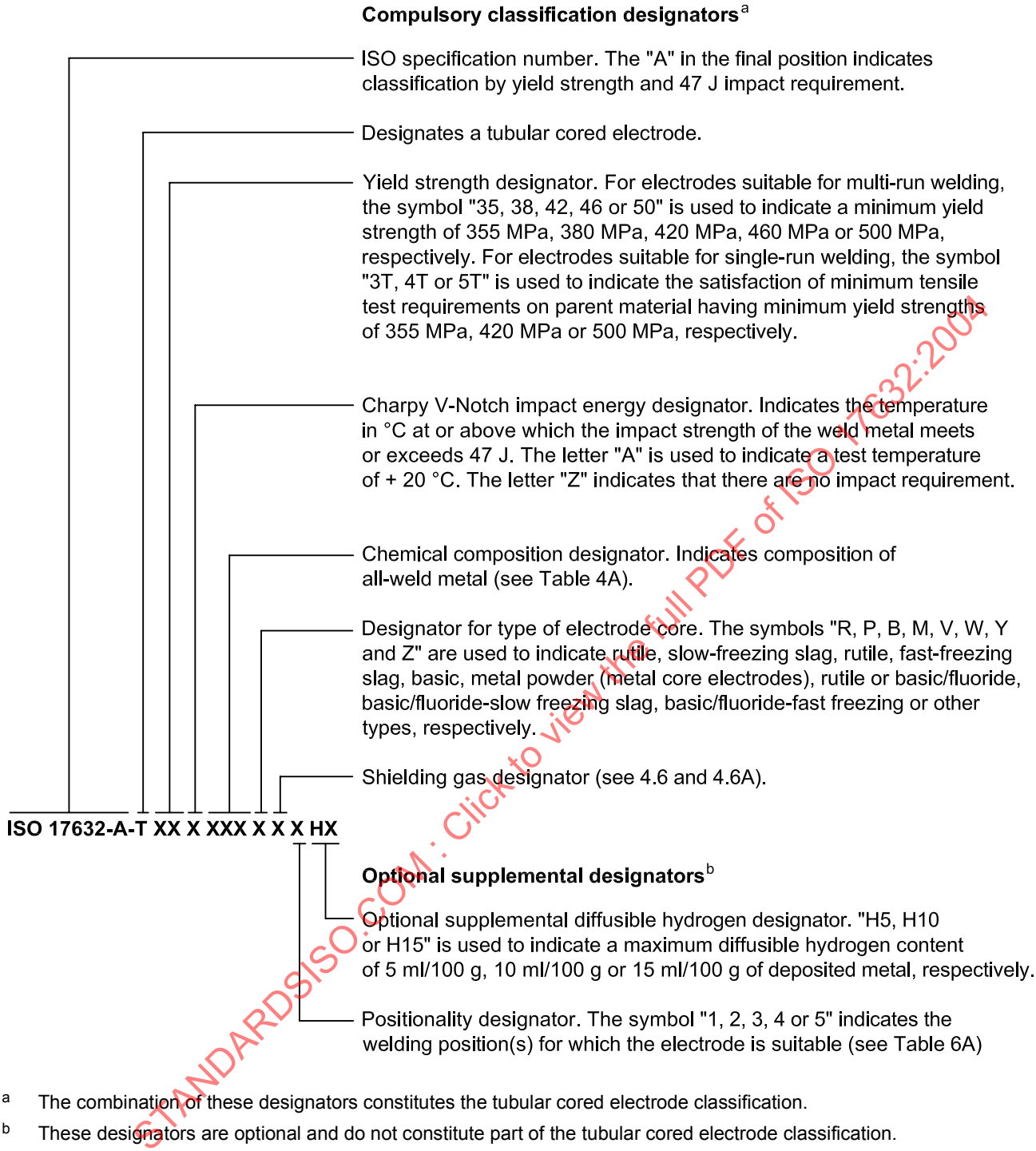
Classification systems

A.1 ISO 17632-A

The ISO 17632 classification system for tubular cored electrodes based upon yield strength and 47 J minimum impact strength is shown in Figure A.1.

A.2 ISO 17632-B

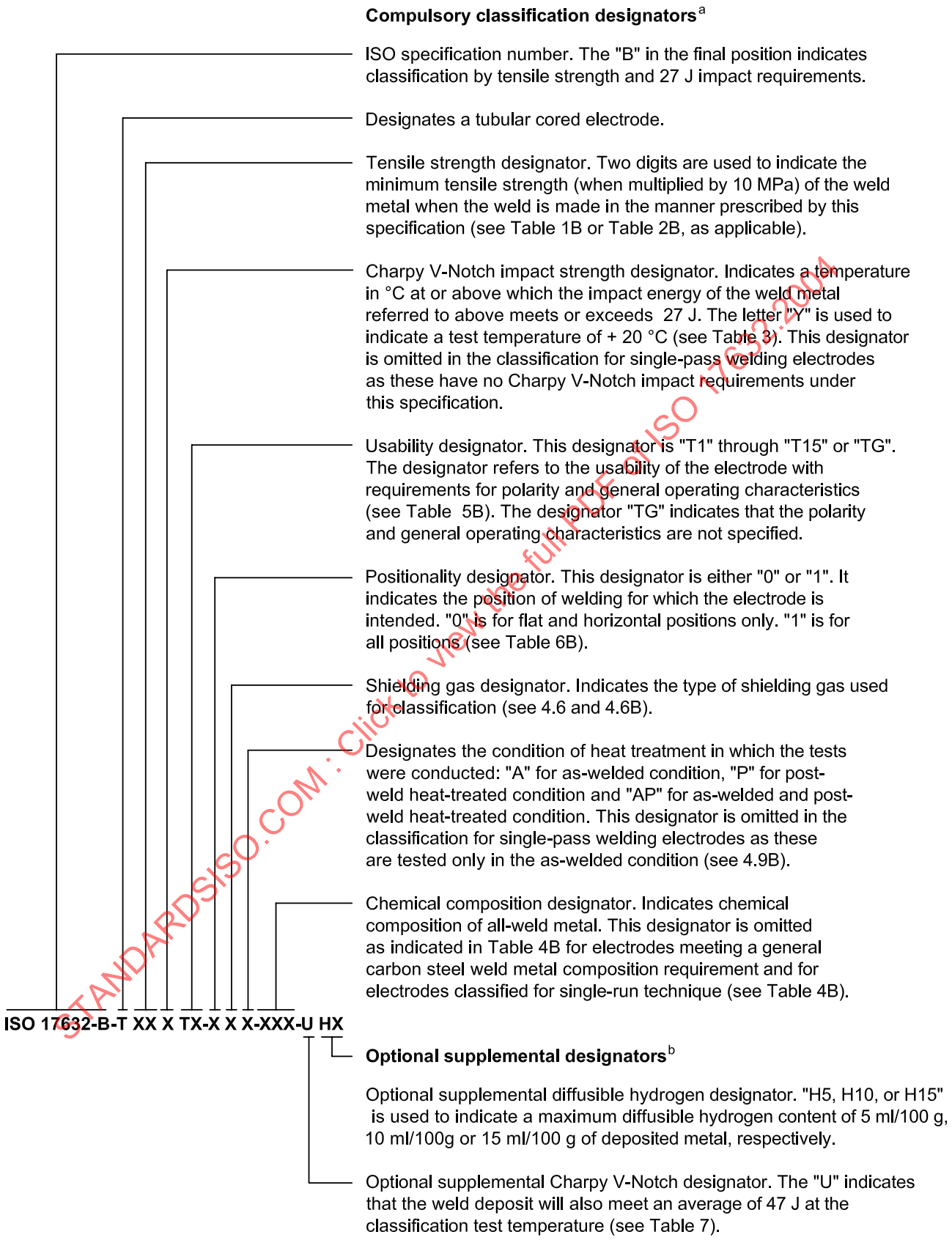
The ISO 17632 classification system for tubular cored electrodes based upon tensile strength and 27 J minimum impact strength is shown in Figure A.2.



[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 17632-A classification system for tubular cored electrodes based upon yield strength and 47 J minimum impact energy



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

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

Figure A.2 — ISO 17632-B classification system for tubular cored electrodes based upon tensile strength and 27 J minimum impact energy