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Welding consumables — Wire electrodes, wires, rods and deposits for gas shielded arc welding of creep-resisting steels — Classification

Produits consommables pour le soudage — Fils-électrodes, fils, baguettes et dépôts pour le soudage à l'arc sous 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 21952 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 3, *Welding consumables*.

This second edition cancels and replaces the first edition (ISO 21952:2007) which has been technically revised. The main changes compared to the previous edition are:

a) three new symbols have been added in 4.3B;

b) the gases designations in 4.4B have been updated in accordance with the latest edition of ISO 14175;

c) six new alloys have been added in Tables 1 and 2 on the B side;

d) Clause 6 has been revised to make it clearer;

e) the examples in Clause 10 have been revised.

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.

Introduction

This International Standard was prepared in collaboration with the International Institute of Welding. It recognizes that there are two somewhat different approaches in the global market to classifying a given wire electrode, wire, rod or deposit, and allows for either or both to be used, to suit a particular market need. Application of either type of classification designation (or of both where suitable) identifies a product as classified in accordance with this International Standard. The classification in accordance with system A is mainly based on EN 12070:1999[1]. The classification in accordance with system B is mainly based upon standards used around the Pacific Rim.

This International Standard proposes a classification system for wire electrodes, wires and rods in terms of their chemical composition and, where required, in terms of the yield strength, tensile strength and elongation of the all-weld metal deposit. 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 does not necessarily ensure that the weld metal tensile strength matches that of the parent material. 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 pieces used to classify the electrodes, wires and rods vary from those obtained in production joints because of differences in welding procedure such as electrode size, width of weave, welding position and material composition.

Welding consumables — Wire electrodes, wires, rods and deposits for gas shielded arc welding of creep-resisting steels — Classification

1 Scope

This International Standard specifies requirements for classification of wire electrodes, wires and rods for gas shielded metal arc welding and tungsten inert-gas welding of creep-resisting steels, and for their deposits in the as-welded or post-weld heat-treated condition. One wire 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 wire electrodes, wires and rods with requirements for yield strength and average impact energy of 47 J of all-weld metal, or utilizing a system based upon the tensile strength of the all-weld metal deposits and the chemical composition of wire electrodes, wires and rods.

a) Clauses, subclauses and tables which carry the suffix letter “A” are applicable only to wire electrodes, wires, rods and deposits classified in accordance with the system based upon the chemical composition with requirements for yield strength and the average impact energy of 47 J of all-weld metal deposits under this International Standard.

b) Clauses, subclauses and tables which carry the suffix letter “B” are applicable only to wire electrodes, wires, rods and deposits classified in accordance with the system based upon the tensile strength of all-weld metal deposits and the chemical composition of wire electrodes, wires and rods under this International Standard.

c) Clauses, subclauses and tables which do not have either the suffix letter “A” or the suffix letter “B” are applicable to all wire electrodes, wires, rods and deposits classified under this International Standard.

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 544, *Welding consumables — Technical delivery conditions for filler materials and fluxes — Type of product, dimensions, tolerances and markings*

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

ISO 14175:2008, *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, *Welding consumables — Test methods — Part 1: Test methods for all-weld metal test specimens in steel, nickel and nickel alloys*

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

3 Classification

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

A wire electrode, wire or rod shall be classified in accordance with its chemical composition as given in Table 1.

When the wire electrode, wire, rod or deposit is classified in combination with a shielding gas, the classification shall be prefixed with a symbol in accordance with Clause 4 as appropriate.

3A Classification by chemical composition

The classification is divided into two parts:

1) the first part gives a symbol indicating the product or process to be identified;

2) the second part gives a symbol indicating the chemical composition of the wire electrode, wire, or rod used (see Table 1).

3B Classification by tensile strength and chemical composition

The classification is divided into four parts:

1) the first part gives a symbol indicating the product or process to be identified;

2) the second part gives a symbol indicating the strength and elongation of the all-weld-metal deposit in the post weld heat-treated condition (see Table 2);

3) the third part gives a symbol indicating the shielding gas used (see 4.4);

4) the fourth part gives a symbol indicating the chemical composition of the wire electrode, wire or rod used (see Table 1).

4 Symbols and requirements

4.1 Symbol for the product or process

The symbol for the wire electrode, wire or rod used in the arc welding process shall be the letter G (gas shielded metal arc welding) and/or W (gas shielded arc welding with non-consumable tungsten electrode).

4.2 Symbol for the chemical composition of wire electrodes, wires, and rods

The symbol in Table 1 indicates the chemical composition of the wire electrode, wire, and rod determined under the conditions given in 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 deposit obtained with the wire electrodes, wires, and rods 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 for the all-weld metal deposit produced by the gas shielded metal arc welding process and the tungsten inert-gas welding process shall be the following:

— 49 for 490 MPa minimum tensile strength;

— 52 for 520 MPa minimum tensile strength;

— 55 for 550 MPa minimum tensile strength;

— 57 for 570 MPa minimum tensile strength;

— 62 for 620 MPa minimum tensile strength;

— 69 for 690 MPa minimum tensile strength;

— 78 for 780 MPa minimum tensile strength.

The complete mechanical property requirements that shall be fulfilled by the various compositions are specified in Table 2.

4.4 Symbol for shielding gas

4.4A Classification by chemical composition

No symbol shall be used for the shielding gas.

4.4B Classification by tensile strength and chemical composition

The symbols for shielding gases shall be in accordance with ISO 14175:2008, for example:

— the symbol I1 shall be used when the classification has been performed with shielding gas ISO 14175-I1, 100 % argon;

— the symbol M12, for mixed gases, shall be used when the classification has been performed with shielding gas ISO 14175-M12, but without helium;

— the symbol M13 shall be used when the classification has been performed with shielding gas ISO 14175-M13;

— the symbol M20, for mixed gases, shall be used when the classification has been performed with shielding gas ISO 14175-M20, but without helium.

— the symbol M21, for mixed gases, shall be used when the classification has been performed with shielding gas ISO 14175-M21, but without helium;

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

— the symbol Z is used for an unspecified shielding gas.

Table 1 — Symbols and chemical composition requirements of wire electrodes, wires and rods

Symbol for classification in accordance with		Chemical composition % (by mass)[a,b]											
chemical composition[c] ISO 21952-A	tensile strength and chemical composition[d] ISO 21952-B	C	Si	Mn	P	S	Ni	Cr	Mo	Cu	Ti	V	Other elements
MoSi	(1M3)	0,08 to 0,15	0,50 to 0,80	0,70 to 1,30	0,020	0,020	—	—	0,40 to 0,60	—	—	—	—
(MoSi)	1M3	0,12	0,30 to 0,70	1,30	0,025	0,025	0,20	–	0,40 to 0,65	0,35	—	—	—
MnMo		0,08 to 0,15	0,05 to 0,25	1,30 to 1,70	0,025	0,025	—	—	0,45 to 0,65	—	—	—	—
	3M3[e]	0,12	0,60 to 0,90	1,10 to 1,60	0,025	0,025	—	—	0,40 to 0,65	0,50	—	—	—
	3M3T[e]	0,12	0,40 to 1,00	1,00 to 1,80	0,025	0,025	—	—	0,40 to 0,65	0,50	0,02 to 0,30	—	—
MoVSi		0,06 to 0,15	0,40 to 0,70	0,70 to 1,10	0,020	0,020	—	0,30 to 0,60	0,50 to 1,00	—	—	0,20 to 0,40	—
	CM	0,12	0,10 to 0,40	0,20 to 1,00	0,025	0,025	—	0,40 to 0,90	0,40 to 0,65	0,40	—	—	—
	CMT[e]	0,12	0,30 to 0,90	1,00 to 1,80	0,025	0,025	—	0,30 to 0,70	0,40 to 0,65	0,40	0,02 to 0,30	—	—
CrMo1Si	(1CM3)	0,08 to 0,14	0,50 to 0,80	0,80 to 1,20	0,020	0,020	—	0,90 to 1,30	0,40 to 0,65	—	—	—	—
CrMoV1Si		0,06 to 0,15	0,50 to 0,80	0,80 to 1,20	0,020	0,020	—	0,90 to 1,30	0,90 to 1,30	—	—	0,10 to 0,35	—
	1CM	0,07 to 0,12	0,40 to 0,70	0,40 to 0,70	0,025	0,025	0,20	1,20 to 1,50	0,40 to 0,65	0,35	—	—	—
	1CM1	0,12	0,20 to 0,50	0,60 to 0,90	0,025	0,025	—	1,00 to 1,60	0,30 to 0,65	0,40	—	—	—
	1CM2	0,05 to 0,15	0,15 to 0,40	1,60 to 2,00	0,025	0,025	—	1,00 to 1,60	0,40 to 0,65	0,40	—	—	—
(CrMo1Si)	1CM3	0,12	0,30 to 0,90	0,80 to 1,50	0,025	0,025	—	1,00 to 1,60	0,40 to 0,65	0,40	—	—	—
	1CML	0,05	0,40 to 0,70	0,40 to 0,70	0,025	0,025	0,20	1,20 to 1,50	0,40 to 0,65	0,35	—	—	—
	1CML1	0,05	0,20 to 0,80	0,80 to 1,40	0,025	0,025	—	1,00 to 1,60	0,40 to 0,65	0,40	—	—	—
	1CMT	0,05 to 0,15	0,30 to 0,90	0,80 to 1,50	0,025	0,025	—	1,00 to 1,60	0,40 to 0,65	0,40	0,02 to 0,30	—	—
	1CMT1	0,12	0,30 to 0,90	1,20 to 1,90	0,025	0,025	—	1,00 to 1,60	0,40 to 0,65	0,40	0,02 to 0,30	—	—
	2CMWV	0,12	0,10 to 0,70	0,20 to 1,00	0,020	0,010	—	2,00 to 2,60	0,40 to 0,65	0,40	—	0,10 to 0,50	Nb 0,01 to 0,08 W 1,00 to 2,00
	2CMWV−Ni	0,12	0,10 to 0,70	0,80 to 1,60	0,020	0,010	0,30 to 1,00	2,00 to 2,60	0,05 to 0,30	0,40	—	0,10 to 0,50	Nb 0,01 to 0,08 W 1,00 to 2,00
CrMo2Si	(2C1M3)	0,04 to 0,12	0,50 to 0,80	0,80 to 1,20	0,020	0,020	—	2,3 to 3,0	0,90 to 1,20	–	—	—	—
CrMo2LSi	(2C1ML1)	0,05	0,50 to 0,80	0,80 to 1,20	0,020	0,020	—	2,3 to 3,0	0,90 to 1,20	–	—	—	—
	2C1M	0,07 to 0,12	0,40 to 0,70	0,40 to 0,70	0,025	0,025	0,20	2,30 to 2,70	0,90 to 1,20	0,35	—	—	—
	2C1M1	0,05 to 0,15	0,10 to 0,50	0,30 to 0,60	0,025	0,025	—	2,10 to 2,70	0,85 to 1,20	0,40	—	—	—
	2C1M2	0,05 to 0,15	0,10 to 0,60	0,50 to 1,20	0,025	0,025	—	2,10 to 2,70	0,85 to 1,20	0,40	—	—	—

Table 1 (*continued*)

Symbol for classification in accordance with		Chemical composition % (by mass)[a,b]											
chemical composition[c] ISO 21952-A	tensile strength and chemical composition[d] ISO 21952-B	C	Si	Mn	P	S	Ni	Cr	Mo	Cu	Ti	V	Other elements
(CrMo2Si)	2C1M3	0,12	0,30 to 0,90	0,75 to 1,50	0,025	0,025	—	2,10 to 2,70	0,90 to 1,20	0,40	—	—	—
	2C1ML	0,05	0,40 to 0,70	0,40 to 0,70	0,025	0,025	0,20	2,30 to 2,70	0,90 to 1,20	0,35	—	—	—
(CrMo2LSi)	2C1ML1	0,05	0,30 to 0,90	0,80 to 1,40	0,025	0,025	—	2,10 to 2,70	0,90 to 1,20	0,40	—	—	—
	2C1MV	0,05 to 0,15	0,10 to 0,50	0,20 to 1,00	0,025	0,025	—	2,10 to 2,70	0,85 to 1,20	0,40	—	0,15 to 0,50	—
	2C1MV1	0,12	0,10 to 0,70	0,80 to 1,60	0,025	0,025	—	2,10 to 2,70	0,90 to 1,20	0,40	—	0,15 to 0,50	—
	2C1MT	0,05 to 0,15	0,35 to 0,80	0,75 to 1,50	0,025	0,025	—	2,10 to 2,70	0,90 to 1,20	0,40	0,02 to 0,30	—	—
	2C1MT1	0,04 to 0,12	0,20 to 0,80	1,60 to 2,30	0,025	0,025	—	2,10 to 2,70	0,90 to 1,20	0,40	0,02 to 0,30	—	—
	3C1M	0,12	0,10 to 0,70	0,50 to 1,20	0,025	0,025	—	2,75 to 3,75	0,90 to 1,20	0,40	—	—	—
	3C1MV	0,05 to 0,15	0,5	0,20 to 1,00	0,025	0,025	—	2,75 to 3,75	0,90 to 1,20	0,40	—	0,15 to 0,50	—
	3C1MV1	0,12	0,10 to 0,70	0,80 to 1,60	0,025	0,025	—	2,75 to 3,75	0,90 to 1,20	0,40	—	0,15 to 0,50	—
CrMo5Si	(5CM)	0,03 to 0,10	0,30 to 0,60	0,30 to 0,70	0,020	0,020	—	5,5 to 6,5	0,50 to 0,80	—	—	—	—
(CrMo5Si)	5CM	0,10	0,50	0,40 to 0,70	0,025	0,025	0,60	4,50 to 6,00	0,45 to 0,65	0,35	—	—	—
CrMo9		0,06 to 0,10	0,30 to 0,60	0,30 to 0,70	0,025	0,025	1,0	8,5 to 10,0	0,80 to 1,20	—	—	0,15	—
CrMo9Si	(9C1M)	0,03 to 0,10	0,40 to 0,80	0,40 to 0,80	0,020	0,020	—	8,5 to 10,0	0,80 to 1,20	—	—	—	—
CrMo91		0,07 to 0,15	0,60	0,4 to 1,5	0,020	0,020	0,4 to 1,0	8,0 to 10,5	0,80 to 1,20	0,25	—	0,15 to 0,30	Nb 0,03 to 0,10 N 0,02 to 0,07
(CrMo9Si)	9C1M	0,10	0,50	0,40 to 0,70	0,025	0,025	0,50	8,00 to 10,50	0,80 to 1,20	0,35	—	—	—
	9C1MV	0,07 to 0,13	0,15 to 0,50	1,20	0,010	0,010	0,80	8,00 to 10,50	0,85 to 1,20	0,20	—	0,15 to 0,30	Nb 0,02 to 0,10 Al 0,04 N 0,03 to 0,07 Mn + Ni 1,50
	9C1MV1	0,12	0,50	0,50 to 1,25	0,025	0,025	0,10 to 0,80	8,00 to 10,50	0,80 to 1,20	0,40	—	0,10 to 0,35	Nb 0,01 to 0,12 N 0,01 to 0,05
	9C1MV2	0,12	0,10 to 0,60	1,20 to 1,90	0,025	0,025	0,20 to 1,00	8,00 to 10,50	0,80 to 1,20	0,40	—	0,15 to 0,50	Nb 0,01 to 0,12 N 0,01 to 0,05
	10CMV	0,05 to 0,15	0,10 to 0,70	0,20 to 1,00	0,025	0,025	0,30 to 1,00	9,00 to 11,50	0,40 to 0,65	0,40	—	0,10 to 0,50	Nb 0,04 to 0,16 N 0,02 to 0,07
	10CMWV－Co	0,12	0,10 to 0,70	0,20 to 1,00	0,020	0,020	0,30 to 1,00	9,00 to 11,50	0,20 to 0,55	0,40	—	0,10 to 0,50	Co 0,80 to 1,20 Nb 0,01 to 0,08 W 1,00 to 2,00 N 0,02 to 0,07
	10CMWV－Co1	0,12	0,10 to 0,70	0,80 to 1,50	0,020	0,020	0,30 to 1,00	9,00 to 11,50	0,25 to 0,55	0,40	—	0,10 to 0,50	Co 1,00 to 2,00 Nb 0,01 to 0,08 W 1,00 to 2,00 N 0,02 to 0,07

Table 1 (*continued*)

Symbol for classification in accordance with		Chemical composition % (by mass)[a,b]											
chemical composition[c] ISO 21952-A	tensile strength and chemical composition[d] ISO 21952-B	C	Si	Mn	P	S	Ni	Cr	Mo	Cu	Ti	V	Other elements
	10CMWV－Cu	0,05 to 0,15	0,10 to 0,70	0,20 to 1,00	0,020	0,020	0,70 to 1,40	9,00 to 11,50	0,20 to 0,50	1,00 to 2,00	—	0,10 to 0,50	Nb 0,01 to 0,08 W 1,00 to 2,00 N 0,02 to 0,07
CrMoWV12Si		0,17 to 0,24	0,20 to 0,60	0,40 to 1,00	0,025	0,020	0,8	10,5 to 12,0	0,80 to 1,20	—	—	0,20 to 0,40	W: 0,35 to 0,80
Z[f]	G[f]	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 are maxima.

[c] If not specified, Ni < 0,3 % (by mass), Cu < 0,3 % (by mass), V < 0,03 % (by mass), Nb < 0,01 % (by mass), and Cr < 0,2 % (by mass).

[d] The filler metal shall be analysed for the specific elements for which values are shown. If the presence of other elements is indicated in the course of this work, the amount of these elements shall be determined to ensure that their total (excluding Fe) does not exceed 0,50 % (by mass).

[e] Compositions containing approximately 0,5 % (by mass) Mo, without Cr, and with Mn significantly in excess of 1 % (by mass), may not provide optimum creep resistance.

[f] Consumables for which the chemical composition is not listed shall be symbolized similarly and prefixed by the letter Z (ISO 21952-A) or G (ISO 21952-B). The chemical composition ranges are not specified and therefore it is possible that two electrodes with the same Z or G classification are not interchangeable.

Table 2 — Mechanical properties of all-weld metal

Symbol for classification in accordance with		Minimum proof strength[c] MPa	Minimum tensile strength MPa	Minimum elongation[d] %	Impact energy at +20 °C J		Heat treatment of all-weld metal		
Chemical composition symbol[a] ISO 21952-A	Tensile strength and chemical composition[a,b] ISO 21952-B				Minimum average from three test pieces	Minimum single value[e]	Preheat and interpass temperature °C	Post-weld heat treatment of test piece	
								Temperature °C	Time min
	X 52X 1M3	400	520	17	—	—	135 to165	605 to 635[f]	60[g]
MoSi	(1M3)	355	510	22	47	38	<200	—	—
MnMo	(3M3)	355	510	22	47	38	<200	—	—
(MoSi)	X 49X 3M3 X 49X 3M3T	390	490	22	—	—	135 to165	605 to 635[f]	60[g]
MoVSi		355	510	18	47	38	200 to 300	690 to 730[h]	60[g]
(CrMo1Si)	X 55X CM X 55X CMT	470	550	17	—	—	135 to 165	605 to 635[f]	60[g]
CrMo1Si	(1CM)	355	510	20	47	38	150 to 250	660 to 700[h]	60[g]
	X 55X 1CM	470	550	17	—	—	135 to 165	605 to 635[f]	60[g]
(CrMo1Si)	X 55X 1CM1 X 55X 1CM2 X 55X 1CM3 X 55X 1CMT X 55X 1CMT1	470	550	17	—	—	135 to 165	675 to 705[f]	60[g]
	X 52X 1CML	400	520	17		—	135 to 165	605 to 635[f]	60[g]
	X 52X 1CML1	400	520	17	—	—	135 to 165	675 to 705[f]	60[g]
	X 52X 2CMWV	400	520	17	—	—	160 to 190	700 to 730	120[g]
	X 57X 2CMWV—Ni	490	570	15	—	—	160 to 190	700 to 730	120[g]
CrMoV1Si		435	590	15	24	21	200 to 300	680 to 730[h]	60[g]
CrMo2Si	(2C1M)	400	500	18	47	38	200 to 300	690 to 750[h]	60[g]
(CrMo2Si)	X 62X 2C1M X 62X 2C1M1 X 62X 2C1M2 X 62X 2C1M3 X 62X 2C1MT X 62X 2C1MT1	540	620	15	—	—	185 to 215	675 to 705[f]	60[g]

Table 2 (*continued*)

Symbol for classification in accordance with		Minimum proof strength[c] MPa	Minimum tensile strength MPa	Minimum elongation[d] %	Impact energy at +20 °C J		Heat treatment of all-weld metal		
Chemical composition symbol[a] ISO 21952-A	Tensile strength and chemical composition[a,b] ISO 21952-B				Minimum average from three test pieces	Minimum single value[e]	Preheat and interpass temperature °C	Post-weld heat treatment of test piece	
								Temperature °C	Time min
CrMo2LSi	(2C1ML)	400	500	18	47	38	200 to 300	690 to 750[h]	60[g]
(CrMo2LSi)	X 55X 2C1ML X 55X 2C1ML1	470	550	15	—	—	185 to 215	675 to 705[f]	60[g]
	X 55X 2C1MV X 55X 2C1MV1	470	550	15	—	—	185 to 215	675 to 705[f]	60[g]
	X 62X 3C1M	530	620	15	—	—	185 to 215	675 to 705[f]	60[g]
	X 62X 3C1MV X 62X 3C1MV1	530	620	15	—	—	185 to 215	675 to 705[f]	60[g]
(CrMo5Si)	X 55X 5CM	470	550	15	—	—	175 to 235	730 to 760[f]	60[g]
CrMo5Si	(5CM)	400	590	17	47	38	200 to 300	730 to 760[h]	60[g]
CrMo9 CrMo9Si	(9C1M)	435	590	18	34	27	200 to 300	740 to 780[h]	120[g]
	X 55X 9C1M	470	550	15		—	205 to 260	730 to 760[f]	60[g]
CrMo91	(9C1M)	415	585	17	47	38	250 to 350	750 to 760[h]	120[g]
	X 62X 9C1MV X 62X 9C1MV1 X 62X 9C1MV2	410	620	15	—	—	205 to 320	745 to 775[f]	120[g]
	X 62X 10CMWV−Co X 62X 10CMWV−Co1	530	620	15	—	—	205 to 260	725 to 755	480[g]
	X 69X 10CMWV−Cu	600	690	15	—	—	100 to 200	725 to 755	60[g]
	X 78X 10CMV	680	780	13	—	—	205 to 260	675 to 705	480[g]

Table 2 (*continued*)

Symbol for classification in accordance with		Minimum proof strength[c] MPa	Minimum tensile strength MPa	Minimum elongation[d] %	Impact energy at +20 °C J		Heat treatment of all-weld metal		
Chemical composition symbol[a] ISO 21952-A	Tensile strength and chemical composition[a,b] ISO 21952-B				Minimum average from three test pieces	Minimum single value[e]	Preheat and interpass temperature °C	Post-weld heat treatment of test piece Temperature °C	Time min
CrMoWV12Si		550	690	15	34	27	250 to 350[i] or 400 to 500[i]	740 to 780[h]	120 minimum
Z[j]	X XXX G[j]	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 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 this table are also satisfied.

[b] See 4.1 and 4.4B for the explanation of the initial and second "X", respectively.

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

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

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

[f] The furnace shall be at a temperature not higher than 315 °C when the test piece is placed in it. The heating rate, from that point to the holding temperature, shall not exceed 220 °C/h. When the holding time has been completed, the test piece shall be allowed to cool in the furnace to a temperature below 315 °C at a rate not exceeding 195 °C/h. The test piece may be removed from the furnace at any temperature below 315 °C and allowed to cool in still air, to room temperature.

[g] The tolerance shall be minus zero, plus 15 min.

[h] The test piece shall be cooled in the furnace to 300 °C at a rate not exceeding 200 °C/h. The test piece may be removed from the furnace at any temperature below 300 °C and allowed to cool in still air, to room temperature.

[i] Immediately after welding, the test piece shall be cooled down to 120 °C to 100 °C and kept at this temperature for at least 1 h.

[j] Consumables for which the chemical composition is not listed shall be symbolized similarly and prefixed by the letter Z (ISO 21952-A) or X XXX G (ISO 21952-B). The chemical composition ranges are not specified and therefore it is possible that two electrodes with the same Z or X XXX G classification are not interchangeable.

5 Mechanical tests

5A Classification by chemical composition

Tensile and impact tests shall be carried out in the as-welded or post-weld heat-treated condition, as specified in Table 2, using a type 1.3 all-weld metal test piece in accordance with ISO 15792-1 prepared using 1,2 mm diameter wire for gas metal arc electrodes, or a type 1.1 test piece in accordance with ISO 15792-1 prepared using 2,4 mm diameter rod or wire for tungsten inert-gas welding. The welding conditions are described in 5.1 and 5.2A. The shielding gas shall be as recommended by the manufacturer and shall be recorded in the test report.

5B Classification by tensile strength and chemical composition

Tensile tests shall be carried out in the post-weld heat-treated condition using a type 1.3 all-weld metal test piece in accordance with ISO 15792-1 prepared using 1,2 mm diameter wire for gas metal arc electrodes, or a type 1.1 test piece in accordance with ISO 15792-1 prepared using 2,4 mm diameter rod or wire for tungsten inert-gas welding, and welding conditions and the as-welded or post-weld heat-treated condition as specified in Table 2 and as described in 5.1 and 5.2B. If the 1,2 mm diameter or 2,4 mm diameter is not manufactured, use the closest size at settings as recommended by the manufacturer.

5.1 Preheating and interpass temperatures

Preheating and interpass temperatures shall be as specified in Table 2. The preheating and interpass temperature shall be measured using temperature indicator crayons, surface thermometers, or thermocouples in accordance with 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 piece shall be cooled in air to a temperature within the limits of the interpass temperature range.

5.2 Welding conditions and pass sequence

5.2A Classification by chemical composition

The welding conditions shall be in accordance with Table 3A and the pass sequence shall be in accordance with Table 4. The direction of welding to complete a layer shall not vary. However, the direction of welding of layers shall be alternated.

5.2B Classification by tensile strength and chemical composition

The welding conditions shall be in accordance with Table 3B and the pass sequence shall be in accordance with Table 4. The direction of welding to complete a layer shall not vary, However, the direction of welding for different layers may be alternated.

Table 3A — Welding conditions
(Classification by chemical composition)

Process	Diameter mm	Welding current A	Welding voltage V	Contact tip-to-work distance mm	Travel speed mm/min
G	1,2	280 ± 10	—[a]	20 ± 3	450 ± 50
W	2,4	200 ± 20	—[b]	—	150 ± 20

[a] The welding voltage depends on the choice of shielding gas.

[b] It is not possible to set the voltage on TIG equipment.

Table 3B — Welding conditions
(Classification by tensile strength and chemical composition)

Process	Diameter mm	Welding current A	Welding voltage V	Contact tip-to-work distance mm	Travel speed mm/min
G	1,2	290 ± 30	—[a]	20 ± 3	330 ± 60
W	2,4	220 ± 30	—[b]	—	125 ± 25

[a] The welding voltage depends on the choice of shielding gas.

[b] It is not possible to set the voltage on TIG equipment.

Table 4 — Pass sequence

Diameter mm	Passes per layer	Number of layers
1,2	2 or 3	6 to 10
2,4	2[a]	8 to 11
[a] The top layer can be completed with 3 or 4 passes.		

6 Chemical analysis

Chemical analysis shall be performed on specimens of the wire electrode, wires or rods. Any analytical technique may be used, but in case of dispute, reference shall be made to established published methods. In case of chemical elements that do not change during production, chemical analysis of the wire electrode, wires or rods may be substituted by an analysis of product in process or raw material or a report of the ladle chemical analysis of a raw material.

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 Retest

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 piece or from a new test piece. For chemical analysis, retest need only be 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 piece 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 pieces does not apply.

9 Technical delivery conditions

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