4.2 Symbol for strength and elongation of all-weld metal

4.2A Classification by yield strength and 47 J impact energy

The symbols in Table 1A indicate yield strength, tensile strength and elongation of the all-weld metal in the as-welded condition determined in accordance with clause 5.

Table 1A — Symbols for strength and elongation of all-weld metal

Symbol	Minimum yield strength [a] N/mm²	Tensile strength N/mm²	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.

4.2B Classification by tensile strength and 27 J impact energy

The symbols in Table 1B indicate 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 clause 5.

Table 1B — Symbols for strength and elongation of all-weld metal

Symbol [a]	Minimum yield strength [b] N/mm²	Tensile strength N/mm²	Minimum elongation [c] %
43X	330	430 to 600	20
49X	390	490 to 670	18
55X	460	550 to 740	17
57X	490	570 to 770	17

a) X is "A" or "P", where "A" indicates testing in the as-welded condition and "P" indicates testing in the post weld heat-treated condition.

b) For yield strength the lower yield (R_{eL}) is used when yielding occurs, otherwise the 0,2 % proof strength ($R_{p0,2}$) is used.

c) Gauge length is equal to five times the test specimen diameter.

4.3 Symbol for impact properties of all-weld metal

4.3A Classification by yield strength and 47 J impact energy

The symbols in Table 2 indicate the temperature at which an impact energy of 47 J is achieved under the conditions given in clause 5. Three test specimens shall be tested. Only one individual value may be lower than 47 J but not lower than 32 J.

4.3B Classification by tensile strength and 27 J impact energy

The symbols in Table 2 indicate 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 clause 5. 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 symbol "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 the 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 2.

Table 2 — Symbol for impact properties of all-weld metal

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

[a] See 4.3A.
[b] See 4.3B.

4.4 Symbol for shielding gas

The symbols M, A and C indicate shielding gases as described in ISO 14175. The symbol C shall be used when the classification has been performed with the shielding gas ISO 14175 – C1, carbon dioxide.

4.4A 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 the shielding gas ISO 14175 – M2, but without helium. The symbol A shall be used when the classification has been performed with the shielding gas M13, Ar, from ISO 14175:1997.

4.4B Classification by tensile strength and 27 J impact energy

The symbol M shall be used when the classification has been performed with the shielding gas – M21, but restricted to Ar + 20 % to 25 % CO_2. The symbol A shall be used when the classification has been performed with Ar + 1 % to 5 % O_2.

4.5 Symbol for the chemical composition of wire electrodes

The symbols in Table 3A or Table 3B indicate the chemical composition of the wire electrode and include an indication of characteristic alloying elements.

Table 3A — Symbol for chemical composition (classification by yield strength and 47 J impact energy)

Symbol	Chemical composition (% by mass) [a, b, c]											
	C	Si	Mn	P	S	Ni	Cr	Mo	V	Cu	Al	Ti + Zr
G0	Any other agreed composition											
G2Si	0,06 to 0,14	0,50 to 0,80	0,90 to 1,30	0,025	0,025	0,15	0,15	0,15	0,03	0,35	0,02	0,15
G3Si1	0,06 to 0,14	0,70 to 1,00	1,30 to 1,60	0,025	0,025	0,15	0,15	0,15	0,03	0,35	0,02	0,15
G3Si2	0,06 to 0,14	1,00 to 1,30	1,30 to 1,60	0,025	0,025	0,15	0,15	0,15	0,03	0,35	0,02	0,15
G4Si1	0,06 to 0,14	0,80 to 1,20	1,60 to 1,90	0,025	0,025	0,15	0,15	0,15	0,03	0,35	0,02	0,15
G2Ti	0,04 to 0,14	0,40 to 0,80	0,90 to 1,40	0,025	0,025	0,15	0,15	0,15	0,03	0,35	0,05 to 0,20	0,05 to 0,25
G2Al	0,08 to 0,14	0,30 to 0,50	0,90 to 1,30	0,025	0,025	0,15	0,15	0,15	0,03	0,35	0,35 to 0,75	0,15
G3Ni1	0,06 to 0,14	0,50 to 0,90	1,00 to 1,60	0,020	0,020	0,80 to 1,50	0,15	0,15	0,03	0,35	0,02	0,15
G2Ni2	0,06 to 0,14	0,40 to 0,80	0,80 to 1,40	0,020	0,020	2,10 to 2,70	0,15	0,15	0,03	0,35	0,02	0,15
G2Mo	0,08 to 0,12	0,30 to 0,70	0,90 to 1,30	0,020	0,020	0,15	0,15	0,40 to 0,60	0,03	0,35	0,02	0,15
G4Mo	0,06 to 0,14	0,50 to 0,80	1,70 to 2,10	0,025	0,025	0,15	0,15	0,40 to 0,60	0,03	0,35	0,02	0,15

a If not specified, Cr ⩽ 0,15, Cu ⩽ 0,35 and V ⩽ 0,03. Residual copper content in the steel plus any coating shall not exceed 0,35 % by mass.

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 the rules according to annex B, Rule A of ISO 31-0:1992.

Table 3B — Symbol for chemical composition (classification by tensile strength and 27 J impact energy)

Symbol	Chemical composition (% by mass) [a, b, c]											
	C	Si	Mn	P	S	Ni	Cr	Mo	V	Cu	Al	Ti + Zr
G0	Any agreed composition											
G2	0,07	0,40 to 0,70	0,90 to 1,40	0,025	0,030	—	—	—	—	0,50	0,05 to 0,15	Ti : 0,05 to 0,15 Zr : 0,02 to 0,12
G3	0,06 to 0,15	0,45 to 0,75	0,90 to 1,40	0,025	0,035	—	—	—	—	0,50	—	—
G4	0,06 to 0,15	0,65 to 0,85	1,00 to 1,50	0,025	0,035	—	—	—	—	0,50	—	—
G6	0,06 to 0,15	0,80 to 1,15	1,40 to 1,85	0,025	0,035	—	—	—	—	0,50	—	—
G7	0,07 to 0,15	0,50 to 0,80	1,50 to 2,00	0,025	0,035	—	—	—	—	0,50	—	—
G11	0,02 to 0,15	0,55 to 1,10	1,40 to 1,90	0,030	0,030	—	—	—	—	0,50	—	0,02 to 0,30
G12	0,02 to 0,15	0,55 to 1,00	1,25 to 1,90	0,030	0,030	—	—	—	—	0,50	—	—
G13	0,02 to 0,15	0,55 to 1,10	1,35 to 1,90	0,030	0,030	—	—	—	—	0,50	0,10 to 0,50	0,02 to 0,30
G14	0,02 to 0,15	1,00 to 1,35	1,30 to 1,60	0,030	0,030	—	—	—	—	0,50	—	—
G15	0,02 to 0,15	0,40 to 1,00	1,00 to 1,60	0,030	0,030	—	—	—	—	0,50	—	0,02 to 0,15
G16	0,02 to 0,15	0,40 to 1,00	0,90 to 1,60	0,030	0,030	—	—	—	—	0,50	—	—
G17	0,02 to 0,15	0,20 to 0,55	1,50 to 2,10	0,030	0,030	—	—	—	—	0,50	—	0,02 to 0,30
G18	0,02 to 0,15	0,50 to 1,10	1,60 to 2,40	0,030	0,030	—	—	—	—	0,50	—	0,02 to 0,30
G1M3	0,12	0,30 to 0,70	1,30	0,025	0,025	0,20	—	0,40 to 0,65	—	0,35		
G2M3	0,12	0,30 to 0,70	0,60 to 1,40	0,025	0,025	—	—	0,40 to 0,65	—	0,50	—	—
G2M31	0,12	0,30 to 0,90	0,80 to 1,50	0,025	0,025	—	—	0,40 to 0,65	—	0,50	—	—
G3M3T	0,12	0,40 to 1,00	1,00 to 1,80	0,025	0,025	—	—	0,40 to 0,65	—	0,50	—	Ti: 0,02 to 0,30
G3M1	0,05 to 0,15	0,40 to 1,00	1,40 to 2,10	0,025	0,025	—	—	0,10 to 0,45	—	0,50	—	—
G3M1T	0,12	0,40 to 1,00	1,40 to 2,10	0,025	0,025	—	—	0,10 to 0,45	—	0,50	—	Ti: 0,02 to 0,30
G4M31	0,05 to 0,15	0,50 to 0,80	1,60 to 2,10	0,025	0,025	—	—	0,40 to 0,65	—	0,40	—	—
G4M3T	0,12	0,50 to 0,80	1,60 to 2,20	0,025	0,025	—	—	0,40 to 0,65	—	0,50	—	Ti: 0,02 to 0,30

5 Mechanical tests

5A Classification by yield strength and 47 J impact energy

Tensile and impact tests and any required retests shall be carried out in the as-welded condition using an all-weld metal test assembly type 1.3 in accordance with ISO 15792-1 using a 1,2 mm diameter wire electrode and welding conditions as described in 5.1A and 5.2A.

5B Classification by tensile strength and 27 J impact energy

Tensile and impact tests shall be carried out in the as-welded condition or in the post weld heat-treated condition using an all-weld metal test assembly type 1.3 in accordance with ISO 15792-1 using a 1,2 mm diameter wire electrode and welding conditions as described in 5.1B and 5.2B. If 1,2 mm is not manufactured, closest size at settings as recommended by the manufacturer shall be used.

5.1 Preheating and interpass temperatures

5.1A 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.

5.1B Classification by tensile strength and 27 J impact energy

Preheating and interpass temperatures shall be selected for the appropriate weld metal type from Table 4B. The interpass temperature shall be measured using temperature indicator crayons, surface thermometers or thermocouples (see ISO 13916).

Welding shall continue until the assembly has reached a maximum interpass temperature (165 °C). 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 the indicated interpass temperature, the test assembly shall be reheated into interpass range.

Table 4B — Preheating and interpass temperatures

Symbol	Preheat temperature °C	Interpass temperature °C
G0	As agreed between purchaser and supplier	
G2, G3, G4, G6, G7, G11, G12, G13, G14, G15, G16, G17, G18	Room temperature	150 ± 15
G1M3, G2M3, G2M31, G3M3T, G3M1, G3M1T, G4M31, G4M3T GN1, GN2, GN3, GN5, GN7, GN71, GN9 GNCC, GNCCT, GNCCT1, GNCCT2 GN1M2T, GN2M1T, GN2M2T, GN2M3T, GN2M4T	100 min.	

5.2 Welding conditions and pass sequence

5.2A Classification by yield strength and 47 J impact energy

The welding conditions in Table 5A shall be used with the pass sequence in Table 6A. The direction of welding used to complete a layer consisting of two passes shall not vary. However, the direction of welding of layers shall be alternated.

Table 5A — Welding conditions

Diameter	Welding current	Welding voltage	Contact tube distance
mm	A	V	mm
1,2	280 ± 20	[a]	20

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

Table 6A — Pass sequence

Electrode diameter	Split weave		
mm	Layer No.	Passes per layer	Number of layers
1,2	1 to top	2[a]	6 to 10

[a] The top two layers may be completed with 3 passes per layer.

5.2B Classification by tensile strength and 27 J impact energy

The welding conditions in Table 5B shall be used with the pass sequence in Table 6B. The direction of welding for each pass shall not vary. However, the direction of welding for different passes may be alternated.

Table 5B — Welding conditions

Diameter	Welding current	Welding voltage	Contact tube distance
mm	A	V	mm
1,2	290 ± 30	[a]	20 ± 3

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

Table 6B — Pass sequence

Electrode diameter	Layer No.	Passes per layer	Number of layers
mm			
1,2	1 to top	2 or 3	6 to 10

5.3 PWHT condition

5.3A Classification by yield strength and 47 J impact energy

No PWHT condition is used in this specification.

5.3B Classification by tensile strength and 27 J impact energy

Test assemblies made with wire 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 not 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.

6 Chemical analysis

Chemical analysis shall be performed on specimens of the wire. Any analytical technique may be used, but in cas of dispute, reference shall be made to established published methods.

6A Classification by yield strength and 47 J impact energy

The results of chemical analysis shall fulfil the requirements given in Table 3A for the classification under test.

6B Classification by tensile strength and 27 J impact energy

The results of chemical analysis shall fulfil th requirements given in Table 3B for the classificatio under test

7 Retest

If any test fails to meet the requirement, that test shall be repeated twice. The results of both retests shall meet th requirement. Specimens for the retest may be taken from the original test assembly or from a new test assembl For chemical analysis, retest need only be for those specific elements that failed to meet their test requirement. the results of one or both retests fail to meet the requirement, the material under test shall be considered as no 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 prope 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 tes 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.

8 Technical delivery conditions

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

9 Example of designation

9A Classification by yield strength and 47 J impact energy

The designation of the wire electrode shall follow the principle given in the example below.

EXAMPLE 1A

A weld deposit produced by gas shielded metal arc welding having a minimum yield strength of 460 N/mm^2 (46) and a minimum average impact energy of 47 J at – 50 °C (5) under mixed gas (M) using the wire G3Si1 is designated as folllows:

ISO 14341-A-G 46 5 M G3Si1

A wire electrode complying with the chemical requirement of G3Si1 in Table 3A is designated as follows:

ISO 14341-A-G3Si1

9B Classification by tensile strength and 27 J impact energy

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

EXAMPLE 1B

A weld deposit produced by gas shielded metal arc welding having a minimum tensile strength of 490 N/mm^2 (49) and a minimum average impact energy of 27 J at – 60°C (6) in the as-welded condition under mixed gas (M) using the wire G3 is designated as follows:

ISO 14341-B-G 49A 6 M G3

A wire electrode complying with the chemical requirement o G3 in Table 3B is designated as follows:

ISO 14341-B-G3

where

ISO 14341-A is the number of this International Standard, with classification by yield strength and 47 J impact energy;

G is the wire electrode and/or deposit/gas shielded metal arc welding (see 4.1);

46 is the strength and elongation (see Table 1a);

5 is the impact properties (see Table 2);

M is the shielding gas (see 4.4);

G3Si1 is the chemical composition of the wire electrode (see Table 3A).

where

ISO 14341-B is the number of this International Standard, with classification by tensile strength and 27 J impact energy;

G is the deposit/gas shielded metal arc welding (see 4.1);

49A is the strength and elongation in the as-welded condition (see Table 1B);

6 is the impact properties in the as-welded condition (see Table 2);

M is the shielding gas (see 4.4);

G3 is the chemical composition of the wire electrode (see Table 3B).

EXAMPLE 2B

A weld deposit produced by gas shielded metal arc welding having a minimum tensile strength of 490 N/mm^2 (49) and a minimum average impact energy of 27 J at 0 °C (0) in the as-welded condition under carbon dioxide (C) using the wire G11 is designated as follows:

ISO 14341-B-G 49A 0U C G11

A wire electrode complying with the chemical requirement of G11 in Table 3B is designated as follows:

ISO 14341-B-G11

where

ISO 14341-B is the number of this International Standard, with classification by tensile strength and 27 J impact energy;

G is the deposit/gas shielded metal arc welding (see 4.1);

49A is the strength and elongation in the as-welded condition (see Table 1B);

0U is the impact properties in the as-welded condition [see 3B 3) and Table 2];

C is the shielding gas (see 4.4);

G11 is the chemical composition of the wire electrode (see Table 3B).

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