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Third edition
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# Welding consumables — Wire electrodes, wires, rods and deposits for gas shielded arc welding of high strength steels — Classification

*Produits consommables pour le soudage — Fils-électrodes, fils, baguettes et dépôts pour le soudage à l'arc sous flux gazeux des aciers à haute résistance — Classification*



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# Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 3, *Welding consumables,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 121, *Welding and allied processes,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 16834:2012), which has been technically revised.

The main changes are as follows:

— document has been reformatted in single column showing System A and System B in tables and separate clauses and subclauses, some which are new;

— In Clause 4, clarification that System A and System B are independent of each other and can produce different results;

— Table 2 – addition of a new system A symbol 96 for strength and elongation properties of all weld metal;

— Table 3 - addition of new symbols 7 and 8 for impact properties of all-weld metal;

— Table 4 – some classifications have been revised and new classifications, N2M31, N2CM2, N3CM2, N4CM3, N6C1M41 have been added, and footnotes have been revised;

— Tables 5, 7 and 8 – content has been added to the table and has been revised;

— Clause 13 has been updated to reflect changes.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html. Official interpretations of ISO/TC 44 documents, where they exist, are available from this page: https://committee.iso.org/sites/tc44/home/interpretation.html.

# Introduction

This document 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 document.

The classification in accordance with system A was originally based on EN 12534:1999 which has been withdrawn and replaced by this document. The classification in accordance with system B is mainly based upon standards used around the Pacific Rim. Future revisions will aim to merge the two systems into a single classification system.

This document provides a classification for the designation of wire electrodes, wires, rods and deposits in terms of their chemical composition and, where required, in terms of the yield strength, tensile strength and elongation of the all-weld metal. The ratio of yield to tensile strength of weld metal is generally higher than that of the 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. Thus, where the application requires matching tensile strength, selection of the consumable should be made by reference to Table 2 System A or System B, as appropriate.

# Welding consumables — Wire electrodes, wires, rods and deposits for gas shielded arc welding of high strength steels — Classification

## 1 Scope

This document specifies requirements for classification of wire electrodes, wires, rods and all-weld metal deposits in the as-welded condition and in the post-weld heat-treated (PWHT) condition for gas shielded metal arc welding and tungsten inert-gas welding of high-strength steels with a minimum yield strength greater than 500 MPa, or a minimum tensile strength greater than 570 MPa. One wire electrode can be tested and classified with different shielding gases.

This document is a combined specification providing for 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.

a) Clauses, subclauses and tables which carry the suffix "System A" are applicable only to wire electrodes, wires, rods and deposits classified according to the system based upon the yield strength and the average impact energy of 47 J of all-weld metal under this document.

b) Clauses, subclauses and tables which carry the suffix "System B" are applicable only to wire electrodes, wires, rods and deposits classified according to the system based upon the tensile strength and the average impact energy of 27 J of all-weld metal under this document.

c) Clauses, subclauses and tables which do not have either the suffix "System A" or "System B" are applicable to all wire electrodes, wires, rods and deposits classified under this document.

Annex A gives information on the description of composition designations for electrodes in the classification system based upon tensile strength and average impact energy of 27 J – System B.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 — 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 15792-1:2020, *Welding consumables — Test methods — Part 1: Preparation of all-weld metal test pieces and specimens in steel, nickel and nickel alloys*

ISO 80000-1:2022, *Quantities and units — Part 1: General*

## 3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

## 4 Classification

### 4.1 General

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 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 clauses. In most cases, a given commercial product can be classified according to the classification requirements in 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 in Table 4. A weld deposit shall be classified with additional symbols in accordance with the mechanical properties of its all-weld metal, using a shielding gas from a specific group.

Since these are not equivalent, each system shall be used independently of the other, yet both may be used. Differences in welding parameters and PWHT conditions can result in significant differences in the strength and toughness of the weld metal.

### 4.2 Classification systems

Each classification system, A and B, is split into parts as given in Table 1.

**Table 1 — Parts of the classification systems, A and B**

| Part of classification designation | Classification system | |
|---|---|---|
| | **System A**<br>**Classification by yield strength and 47 J impact energy** | **System B**<br>**Classification by tensile strength and 27 J impact energy** |
| 1 | symbol indicating the product/process to be identified (see 5.1) | |
| 2 | symbol indicating the strength and elongation of all-weld metal (see Table 2) | symbol indicating the strength and elongation of the all-weld metal in either the as-welded or post-weld heat-treated condition (see Table 2 and 5.6.2) |
| 3 | symbol indicating the impact properties of all-weld metal (see Table 3); | symbol indicating the impact properties of all-weld metal in the same condition as specified for the tensile strength (see Table 3).<br>The letter "U" after this designator indicates that the deposit meets an average optional requirement of 47 J at the designated Charpy test temperature. |
| 4 | symbol indicating the shielding gas used (see 5.4) | |
| 5 | symbol indicating the chemical composition of the wire electrode, wire or rod used (see Table 4); | |
| 6 | symbol indicating the post-weld heat treatment in case this is applied (see 5.6.1). | — |

# 5 Symbols and requirements

## 5.1 Symbols for the product/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).

## 5.2 Symbols for strength and elongation properties of all-weld metal

### 5.2.1 Classification by yield strength and 47 J impact energy – System A

For classification by yield strength and 47 J impact energy , the symbol in Table 2 indicates yield strength, tensile strength and elongation of the all-weld metal in the as-welded condition determined in accordance with Clause 6 and Clause 7.

### 5.2.2 Classification by tensile strength and 27 J impact energy – System B

For classification by tensile strength and 27 J impact energy, the symbol in Table 2 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 Clause 6 and Clause 7.

**Table 2 — Symbols for strength and elongation properties of all-weld metal**

| System A — Classification by yield strength and 47 J impact energy | | | | System B — Classification by tensile strength and 27 J impact energy | | | |
|---|---|---|---|---|---|---|---|
| Symbol | Minimum yield strength[a] MPa | Tensile strength MPa | Minimum elongation[b] % | Symbol[c] | Tensile strength MPa | Minimum yield strength[a] MPa | Minimum elongation[b] % |
| 55 | 550 | 640 to 820 | 18 | 59X | 590 to 790 | 490 | 16 |
| 62 | 620 | 700 to 890 | 18 | 62X | 620 to 820 | 530 | 15 |
| 69 | 690 | 770 to 940 | 17 | 69X | 690 to 890 | 600 | 14 |
| 79 | 790 | 880 to 1 080 | 16 | 76X | 760 to 960 | 680 | 13 |
| 89 | 890 | 940 to 1 180 | 15 | 78X | 780 to 980 | 680 | 13 |
| 96 | 960 | 980 to 1 220 | 13 | 83X | 830 to 1 030 | 745 | 12 |

[a] For yield strength, the lower yield strength, $R_{eL}$, 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.
[c] X is "A", "P" or "AP"; see 5.6.2.

NOTE Post-weld heat treatment can alter the strength of the weld metal from that obtained in the as-welded condition.

## 5.3 Symbol for impact properties of all-weld metal

### 5.3.1 Classification by yield strength and 47 J impact energy – System A

The symbols in Table 3 indicate the temperature at which an impact energy of 47 J is achieved under the conditions given in Clause 6 and Clause 7. Three test specimens shall be tested. Only one individual value may be lower than 47 J but not lower than 32 J.

### 5.3.2 Classification by tensile strength and 27 J impact energy – System B

The symbols in Table 3 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 6 and Clause 7.

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 not be less than 20 J. The average of the three remaining values shall be at least 27 J.

The addition of the optional symbol U, immediately after the symbol for condition of heat treatment, indicates that the supplemental requirement of 47 J impact energy at the normal 27 J impact test temperature has also been satisfied. For the 47 J impact requirement, the number of specimens tested and values obtained shall meet the requirement of 5.3.1.

**Table 3 — 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 |

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

[a] See 5.3.1.

[b] See 5.3.2.



## 5.4 Symbol for shielding gas

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.

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

The symbols in Table 4 indicate the chemical composition of the wire electrode, wire or rod and includes an indication of characteristic alloying elements.

## 5.6 Symbol for condition of post-weld heat treatment

### 5.6.1 Classification by yield strength and 47 J impact energy – System A

The symbol T, placed after the symbol related to the chemical composition, indicates that strength, elongation and impact properties in the classification of all-weld metal are obtained after a post-weld heat treatment. The post-weld heat-treated condition shall be as specified in 8.2.1.

### 5.6.2 Classification by tensile strength and 27 J impact energy – System B

The symbol A shall be added to the classification of the weld deposits classified in the as-welded condition. The symbol P shall be added to the classification for weld deposits classified in the post weld heat-treated condition. Both symbols A and P shall be added to the classification for weld deposits classified in both conditions - see Table 2, note c for the location of A and P.

## Table 4 — Symbol for chemical composition

| System A – Classification by yield strength and 47 J impact energy | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Symbol (ISO 16834-A)** | **Chemical composition,** % (by mass) [a] | | | | | | | | | | |
| | **C** | **Si** | **Mn** | **P** | **S** | **Ni** | **Cr** | **Mo** | **Cu** [b] | **V** | **Total other elements** [c] |
| Mn3NiCrMo | 0,14 | 0,60 to 0,80 | 1,30 to 1,80 | 0,015 | 0,018 | 0,50 to 0,65 | 0,40 to 0,65 | 0,15 to 0,30 | 0,30 | 0,03 | 0,25 |
| Mn3Ni1CrMo | 0,12 | 0,40 to 0,70 | 1,30 to 1,80 | 0,015 | 0,018 | 1,20 to 1,60 | 0,20 to 0,40 | 0,20 to 0,30 | 0,35 | 0,05 to 0,13 | 0,25 |
| Mn3Ni1Mo | 0,12 | 0,40 to 0,80 | 1,30 to 1,90 | 0,015 | 0,018 | 0,80 to 1,30 | 0,15 | 0,25 to 0,65 | 0,30 | 0,03 | 0,25 |
| Mn3Ni1,5Mo | 0,08 | 0,20 to 0,60 | 1,30 to 1,80 | 0,015 | 0,018 | 1,40 to 2,10 | 0,15 | 0,25 to 0,55 | 0,30 | 0,03 | 0,25 |
| Mn3Ni1Cu | 0,12 | 0,20 to 0,60 | 1,20 to 1,80 | 0,015 | 0,018 | 0,80 to 1,25 | 0,15 | 0,20 | 0,30 to 0,65 | 0,03 | 0,25 |
| Mn3Ni1MoCu | 0,12 | 0,20 to 0,60 | 1,20 to 1,80 | 0,015 | 0,018 | 0,80 to 1,25 | 0,15 | 0,20 to 0,55 | 0,30 to 0,65 | 0,03 | 0,25 |
| Mn3Ni2,5CrMo | 0,12 | 0,40 to 0,70 | 1,30 to 1,80 | 0,015 | 0,018 | 2,30 to 2,80 | 0,20 to 0,60 | 0,30 to 0,65 | 0,30 | 0,03 | 0,25 |
| Mn4Ni1Mo | 0,12 | 0,50 to 0,80 | 1,60 to 2,10 | 0,015 | 0,018 | 0,80 to 1,25 | 0,15 | 0,20 to 0,55 | 0,30 | 0,03 | 0,25 |
| Mn4Ni2Mo | 0,12 | 0,25 to 0,60 | 1,60 to 2,10 | 0,015 | 0,018 | 2,00 to 2,60 | 0,15 | 0,30 to 0,65 | 0,30 | 0,03 | 0,25 |
| Mn4Ni1,5CrMo | 0,12 | 0,50 to 0,80 | 1,60 to 2,10 | 0,015 | 0,018 | 1,30 to 1,90 | 0,15 to 0,40 | 0,30 to 0,65 | 0,30 | 0,03 | 0,25 |
| Mn4Ni2CrMo | 0,12 | 0,60 to 0,90 | 1,60 to 2,10 | 0,015 | 0,018 | 1,80 to 2,35 | 0,20 to 0,45 | 0,45 to 0,70 | 0,30 | 0,03 | 0,25 |
| Mn4Ni2,5CrMo | 0,13 | 0,50 to 0,80 | 1,60 to 2,10 | 0,015 | 0,018 | 2,30 to 2,80 | 0,20 to 0,60 | 0,30 to 0,65 | 0,30 | 0,03 | 0,25 |
| Z[d] | Any other agreed composition | | | | | | | | | | |

[a] Single values are maximum values.

[b] The residual copper content in the steel including any coating shall conform with the stated value.

[c] Ti ≤ 0,10 % (by mass), Zr ≤ 0,10 % (by mass) and Al ≤ 0,12 % (by mass). Analysis for B is required to be reported if intentionally added, or if it is known to be present at levels greater that 0,001 0 %.

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

[e] The filler metal shall be analysed for the specific elements for which values are shown in this table. 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 iron) does not exceed 0,50 % (by mass). Analysis for B is required to be reported if intentionally added, or if it is known to be present at levels greater that 0,001 0 %.

[f] V 0,05 % (by mass), Zr 0,10 % (by mass), Al 0,10 % (by mass).

[g] V 0,04 % (by mass), Zr 0,10 % (by mass), Al 0,10 % (by mass).

[h] V 0,03 % (by mass), Zr 0,10 % (by mass), Al 0,10 % (by mass).

[i] V 0,03 % (by mass), Zr 0,10 % (by mass), Al 0,12 % (by mass).

[j] Consumables for which the chemical composition is not listed in this table shall be symbolized by the letter G. The chemical composition ranges are not specified and therefore it is possible that two products with a G classification are not interchangeable.

**Table 4** *(continued)*

| System B – Classification by tensile strength and 27 J impact energy | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Symbol (ISO 16834-B)** | **Chemical composition** % (by mass) [a,e] | | | | | | | | | |
| | **C** | **Si** | **Mn** | **P** | **S** | **Ni** | **Cr** | **Mo** | **Cu** | **Ti** |
| 2M3 | 0,12 | 0,30 to 0,70 | 0,60 to 1,40 | 0,025 | 0,025 | — | — | 0,40 to 0,65 | 0,50 | — |
| 3M1 | 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 | — |
| 3M1T | 0,12 | 0,40 to 1,00 | 1,40 to 2,10 | 0,025 | 0,025 | — | — | 0,10 to 0,45 | 0,50 | 0,02 to 0,30 |
| 3M3 | 0,12 | 0,60 to 0,90 | 1,10 to 1,60 | 0,025 | 0,025 | — | — | 0,40 to 0,65 | 0,50 | — |
| 3M31 | 0,12 | 0,30 to 0,90 | 1,00 to 1,85 | 0,025 | 0,025 | — | — | 0,40 to 0,65 | 0,50 | — |
| 3M3T | 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 |
| 4M3 | 0,12 | 0,30 | 1,50 to 2,00 | 0,025 | 0,025 | — | — | 0,40 to 0,65 | 0,50 | — |
| 4M31 | 0,07 to 0,12 | 0,50 to 0,80 | 1,60 to 2,10 | 0,025 | 0,025 | — | — | 0,40 to 0,60 | 0,50 | — |
| 4M3T | 0,12 | 0,50 to 0,80 | 1,60 to 2,20 | 0,025 | 0,025 | — | — | 0,40 to 0,65 | 0,50 | 0,02 to 0,30 |
| N1M2T | 0,12 | 0,60 to 1,00 | 1,70 to 2,30 | 0,025 | 0,025 | 0,40 to 0,80 | — | 0,20 to 0,60 | 0,50 | 0,02 to 0,30 |
| N1M3 | 0,12 | 0,20 to 0,80 | 1,00 to 1,80 | 0,025 | 0,025 | 0,30 to 0,90 | — | 0,40 to 0,65 | 0,50 | — |
| N2M1T | 0,12 | 0,30 to 0,80 | 1,10 to 1,90 | 0,025 | 0,025 | 0,80 to 1,60 | — | 0,10 to 0,45 | 0,50 | 0,02 to 0,30 |
| N2M2T | 0,05 to 0,15 | 0,30 to 0,90 | 1,00 to 1,80 | 0,025 | 0,025 | 0,70 to 1,20 | — | 0,20 to 0,60 | 0,50 | 0,02 to 0,30 |
| N2M3 | 0,12 | 0,30 | 1,10 to 1,60 | 0,025 | 0,025 | 0,80 to 1,20 | — | 0,40 to 0,65 | 0,50 | — |
| N2M31 | 0,10 to 0,18 | 0,30 | 1,50 to 2,40 | 0,025 | 0,025 | 0,70 to 1,10 | — | 0,40 to 0,65 | 0,35 | — |
| N2M3T | 0,05 to 0,15 | 0,30 to 0,90 | 1,40 to 2,10 | 0,025 | 0,025 | 0,70 to 1,20 | — | 0,40 to 0,65 | 0,50 | 0,02 to 0,30 |
| N2M4T | 0,12 | 0,50 to 1,00 | 1,70 to 2,30 | 0,025 | 0,025 | 0,80 to 1,30 | — | 0,55 to 0,85 | 0,50 | 0,02 to 0,30 |

[a] Single values are maximum values.

[b] The residual copper content in the steel including any coating shall conform with the stated value.

[c] Ti ≤ 0,10 % (by mass), Zr ≤ 0,10 % (by mass) and Al ≤ 0,12 % (by mass). Analysis for B is required to be reported if intentionally added, or if it is known to be present at levels greater that 0,001 0 %.

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

[e] The filler metal shall be analysed for the specific elements for which values are shown in this table. 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 iron) does not exceed 0,50 % (by mass). Analysis for B is required to be reported if intentionally added, or if it is known to be present at levels greater that 0,001 0 %.

[f] V 0,05 % (by mass), Zr 0,10 % (by mass), Al 0,10 % (by mass).

[g] V 0,04 % (by mass), Zr 0,10 % (by mass), Al 0,10 % (by mass).

[h] V 0,03 % (by mass), Zr 0,10 % (by mass), Al 0,10 % (by mass).

[i] V 0,03 % (by mass), Zr 0,10 % (by mass), Al 0,12 % (by mass).

[j] Consumables for which the chemical composition is not listed in this table shall be symbolized by the letter G. The chemical composition ranges are not specified and therefore it is possible that two products with a G classification are not interchangeable.

**Table 4** *(continued)*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| N3M2[f] | 0,08 | 0,20 to 0,55 | 1,25 to 1,80 | 0,010 | 0,010 | 1,40 to 2,10 | 0,30 | 0,25 to 0,55 | 0,25 | 0,10 |
| N4M2[g] | 0,09 | 0,20 to 0,55 | 1,40 to 1,80 | 0,010 | 0,010 | 1,90 to 2,60 | 0,50 | 0,25 to 0,55 | 0,25 | 0,10 |
| N4M3T | 0,12 | 0,45 to 0,90 | 1,40 to 1,90 | 0,025 | 0,025 | 1,50 to 2,10 | — | 0,40 to 0,65 | 0,50 | 0,01 to 0,30 |
| N4M4T | 0,12 | 0,40 to 0,90 | 1,60 to 2,10 | 0,025 | 0,025 | 1,90 to 2,50 | — | 0,40 to 0,90 | 0,50 | 0,02 to 0,30 |
| N5M3[i] | 0,10 | 0,25 to 0,60 | 1,40 to 1,80 | 0,010 | 0,010 | 2,00 to 2,80 | 0,60 | 0,30 to 0,65 | 0,25 | 0,10 |
| N5M3T | 0,12 | 0,40 to 0,90 | 1,40 to 2,00 | 0,025 | 0,025 | 2,40 to 3,10 | — | 0,40 to 0,70 | 0,50 | 0,02 to 0,30 |
| N7M4T | 0,12 | 0,30 to 0,70 | 1,30 to 1,70 | 0,025 | 0,025 | 3,20 to 3,80 | 0,30 | 0,60 to 0,90 | 0,50 | 0,02 to 0,30 |
| C1M1T | 0,02 to 0,15 | 0,50 to 0,90 | 1,10 to 1,60 | 0,025 | 0,025 | — | 0,30 to 0,60 | 0,10 to 0,45 | 0,40 | 0,02 to 0,30 |
| N2CM2[h] | 0,08 to 0,15 | 0,30 to 0,80 | 1,30 to 1,80 | 0,020 | 0,020 | 0,80 to 1,00 | 0,15 to 0,40 | 0,30 to 0,65 | 0,30 | 0,10 |
| N3CM2[h] | 0,04 to 0,12 | 0,50 to 0,80 | 1,60 to 2,10 | 0,020 | 0,020 | 1,30 to 1,90 | 0,15 to 0,40 | 0,30 to 0,65 | 0,30 | 0,10 |
| N3C1M4T | 0,12 | 0,35 to 0,75 | 1,25 to 1,70 | 0,025 | 0,025 | 1,30 to 1,80 | 0,30 to 0,60 | 0,50 to 0,75 | 0,50 | 0,02 to 0,30 |
| N4CM2T | 0,12 | 0,20 to 0,60 | 1,30 to 1,80 | 0,025 | 0,025 | 1,50 to 2,10 | 0,20 to 0,50 | 0,30 to 0,60 | 0,50 | 0,02 to 0,30 |
| N4CM21T | 0,12 | 0,20 to 0,70 | 1,10 to 1,70 | 0,025 | 0,025 | 1,80 to 2,30 | 0,05 to 0,35 | 0,25 to 0,60 | 0,50 | 0,02 to 0,30 |
| N4CM22T | 0,12 | 0,65 to 0,95 | 1,90 to 2,40 | 0,025 | 0,025 | 2,00 to 2,30 | 0,10 to 0,30 | 0,35 to 0,55 | 0,50 | 0,02 to 0,30 |
| N4CM3[i] | 0,05 to 0,13 | 0,60 to 0,90 | 1,60 to 2,10 | 0,020 | 0,020 | 1,80 to 2,30 | 0,20 to 0,45 | 0,45 to 0,70 | 0,30 | 0,10 |
| N5CM3T | 0,12 | 0,20 to 0,70 | 1,10 to 1,70 | 0,025 | 0,025 | 2,40 to 2,90 | 0,05 to 0,35 | 0,35 to 0,70 | 0,50 | 0,02 to 0,30 |
| N5C1M3T | 0,12 | 0,40 to 0,90 | 1,40 to 2,00 | 0,025 | 0,025 | 2,40 to 3,00 | 0,40 to 0,60 | 0,40 to 0,70 | 0,50 | 0,02 to 0,30 |
| N6CM2T | 0,12 | 0,30 to 0,60 | 1,50 to 1,80 | 0,025 | 0,025 | 2,80 to 3,00 | 0,05 to 0,30 | 0,25 to 0,50 | 0,50 | 0,02 to 0,30 |
| N6C1M4 | 0,12 | 0,25 | 0,90 to 1,40 | 0,025 | 0,025 | 2,65 to 3,15 | 0,20 to 0,50 | 0,55 to 0,85 | 0,50 | — |
| N6C1M41[f] | 0,04 to 0,12 | 0,40 | 0,90 to 1,40 | 0,025 | 0,025 | 2,60 to 3,20 | 0,10 to 0,60 | 0,50 to 0,90 | 0,25 | 0,10 |
| N6C2M2T | 0,12 | 0,20 to 0,50 | 1,50 to 1,90 | 0,025 | 0,025 | 2,50 to 3,10 | 0,70 to 1,00 | 0,30 to 0,60 | 0,50 | 0,02 to 0,30 |

[a] Single values are maximum values.

[b] The residual copper content in the steel including any coating shall conform with the stated value.

[c] Ti ≤ 0,10 % (by mass), Zr ≤ 0,10 % (by mass) and Al ≤ 0,12 % (by mass). Analysis for B is required to be reported if intentionally added, or if it is known to be present at levels greater that 0,001 0 %.

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

[e] The filler metal shall be analysed for the specific elements for which values are shown in this table. 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 iron) does not exceed 0,50 % (by mass). Analysis for B is required to be reported if intentionally added, or if it is known to be present at levels greater that 0,001 0 %.

[f] V 0,05 % (by mass), Zr 0,10 % (by mass), Al 0,10 % (by mass).

[g] V 0,04 % (by mass), Zr 0,10 % (by mass), Al 0,10 % (by mass).

[h] V 0,03 % (by mass), Zr 0,10 % (by mass), Al 0,10 % (by mass).

[i] V 0,03 % (by mass), Zr 0,10 % (by mass), Al 0,12 % (by mass).

[j] Consumables for which the chemical composition is not listed in this table shall be symbolized by the letter G. The chemical composition ranges are not specified and therefore it is possible that two products with a G classification are not interchangeable.

**Table 4** *(continued)*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| N6C2M4 | 0,12 | 0,40 to 0,60 | 1,80 to 2,00 | 0,025 | 0,025 | 2,80 to 3,00 | 1,00 to 1,20 | 0,50 to 0,80 | 0,50 | 0,04 |
| N6CM3T | 0,12 | 0,30 to 0,70 | 1,20 to 1,50 | 0,025 | 0,025 | 2,70 to 3,30 | 0,10 to 0,35 | 0,40 to 0,65 | 0,50 | 0,02 to 0,30 |
| G[j] | Any agreed analysis not specified in This document | | | | | | | | | |

[a] Single values are maximum values.

[b] The residual copper content in the steel including any coating shall conform with the stated value.

[c] Ti ≤ 0,10 % (by mass), Zr ≤ 0,10 % (by mass) and Al ≤ 0,12 % (by mass). Analysis for B is required to be reported if intentionally added, or if it is known to be present at levels greater that 0,001 0 %.

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

[e] The filler metal shall be analysed for the specific elements for which values are shown in this table. 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 iron) does not exceed 0,50 % (by mass). Analysis for B is required to be reported if intentionally added, or if it is known to be present at levels greater that 0,001 0 %.

[f] V 0,05 % (by mass), Zr 0,10 % (by mass), Al 0,10 % (by mass).

[g] V 0,04 % (by mass), Zr 0,10 % (by mass), Al 0,10 % (by mass).

[h] V 0,03 % (by mass), Zr 0,10 % (by mass), Al 0,10 % (by mass).

[i] V 0,03 % (by mass), Zr 0,10 % (by mass), Al 0,12 % (by mass).

[j] Consumables for which the chemical composition is not listed in this table shall be symbolized by the letter G. The chemical composition ranges are not specified and therefore it is possible that two products with a G classification are not interchangeable.

## 6 Mechanical tests

Tensile and impact tests shall be carried out in the as-welded condition or in the post-weld heat-treated condition (see 8.2.1 for System A and 8.2.2 for System B):

a) using an all-weld metal test piece type 1.3, in accordance with ISO 15792-1:2020, Table 1, using 1,2 mm diameter for gas shielded electrodes

b) using test piece type 1.1, in accordance with ISO 15792-1:2020, using 2,4 mm diameter for tungsten inert-gas welding rods or wires, and welding conditions

If a 1,2 mm or 2,4 mm diameter is not manufactured, the closest size and settings as recommended by the manufacturer shall be used.

## 7 Preheating and interpass temperatures

The preheating and interpass temperatures required for each classification system, A and B, are given in Table 5.

**Table 5 — Preheating and interpass temperatures**

| Condition | System A – Classification by yield strength and 47 J impact energy | System B – Classification by tensile strength and 27 J impact energy |
|---|---|---|
| Preheating | Not required. Welding can start from room temperature. | Shall be selected for the appropriate weld metal type from Table 6. |
| Interpass temperature | Shall be measured using temperature indicator crayons, surface thermometers, or thermocouples in accordance with ISO 13916. | |
| | Welding of the all-weld metal test piece shall be executed in a temperature range from 120 °C to 180 °C, with the exception of the first layer in the test piece, which may be welded without preheating | Shall be selected for the appropriate weld metal type from Table 6.<br>Welding shall continue until the maximum interpass temperature given in Table 6 has been reached. If, after any pass, this interpass temperature is exceeded, the test piece shall be cooled in air to a temperature within that range. If below interpass temperature, reheat into the interpass range. |

**Table 6 — Preheating and interpass temperatures Classification by tensile strength and 27 J impact energy – System B**

| Symbol | Preheat temperature for first pass only °C | Preheat and interpass temperature for all other passes °C |
|---|---|---|
| GG and WG | As agreed between purchaser and supplier | |
| Other symbols except for GG and WG | 100 to 165 | 150 ± 15 |

## 8 Welding conditions and pass sequence

### 8.1 General

The welding conditions and pass sequence in Table 7 and Table 8 shall be used.

**Table 7 — Welding conditions**

| System A – Classification by yield strength and 47 J impact energy | | | | | | System B – Classification by tensile strength and 27 J impact energy | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| The direction of welding to complete a layer consisting of two passes shall not vary, but the direction of welding of layers shall be alternated | | | | | | | | | | | |
| **Process** | **Diameter** mm | **Welding current** A | **Welding voltage** V | **Contact tube distance** mm | **Travel speed** mm/min | **Process** | **Diameter** mm | **Welding current** A | **Welding voltage** V | **Contact tube distance** mm | **Travel speed** mm/min |
| G | 1,2 | 280 ± 10 | a | 20 ± 3 | 450 ± 50 | G | 1,2 | 290 ± 30 | a | 20 ± 3 | 330 ± 60 |
| W | 2,4 | 200 ± 20 | b | — | 150 ± 15 | W | 2,4 | 220 ± 30 | b | — | 100 ± 30 |

NOTE Differences in welding conditions for System A and System B can result in significant differences in mechanical properties.

[a] For process G, the welding voltage depends on the choice of shielding gas.

[b] For process W, voltage is not specified.

**Table 8 — Pass sequence**

| System A – Classification by yield strength and 47 J impact energy | | | | System B – Classification by tensile strength and 27 J impact energy | | | |
|---|---|---|---|---|---|---|---|
| **Process** | **Diameter** mm | **Passes per layer** | **Number of layers** | **Process** | **Diameter** mm | **Passes per layer** | **Number of layers** |
| G | 1,2 | 2 to 4 | 6 to 10 | G | 1,2 | 2 or 3 | 6 to 10 |
| W | 2,4 | 2[a] | 8 to 11 | W | 2,4 | 2[a] | 8 to 11 |

[a] The top layer can be completed with three or four passes.

## 8.2 Post-weld heat-treated condition

### 8.2.1 Classification by yield strength and 47 J impact energy – System A

Test pieces made with wire electrodes, wires, rods and deposits classified in the PWHT condition shall be heat-treated at 560 °C to 600 °C for 60 min. The test piece shall be left in the furnace to cool to 300 °C.

### 8.2.2 Classification by tensile strength and 27 J impact energy – System B

Test pieces made with wire electrodes, wires, rods and deposits classified in the PWHT condition shall be heat-treated at 610 °C ± 25 °C for 60 min to 75 min. The furnace shall be at a temperature not higher than 300 °C when the test piece is placed in it. The heating rate, from that point to the 610 °C ± 25 °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 300 °C at a rate not exceeding 195 °C/h. The assembly may be removed from the furnace at any temperature below 300 °C, and allowed to cool in still air to room temperature.

# 9 Chemical analysis

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

The results of chemical analysis shall fulfil the requirements given in Table 4 for the classification under test.

# 10 Rounding procedure

Actual test values obtained shall be subject to ISO 80000-1:2022, B.3, Rule A. If the measured values are obtained by equipment calibrated in units other than those of this document, the measured values shall

be converted to the units of this document before rounding. If an average value is to be compared to the requirements of this document, rounding shall be done only after calculating the average. The rounded results shall fulfil the requirements of the appropriate table for the classification under test.

## 11 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, retests 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 specimens does not apply.

## 12 Technical delivery conditions

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

## 13 Examples of designation

### 13.1 General

The designation of the rod or wire shall follow the principles given in 13.2 to 13.7.

### 13.2 Example 1 – Classification by yield strength and 47 J impact energy – System A

A weld deposit produced by gas shielded metal arc welding (G) having a minimum yield strength of 620 MPa (62) and a minimum average impact energy of 47 J at –60 °C (6) under mixed gas (M21) using the wire Mn4Ni1Mo in the as welded condition is designated as follows:

**ISO 16834-A – G 62 6 M21 Mn4Ni1Mo**

A wire electrode conforming with the chemical requirement of Mn4Ni1Mo in Table 4 is designated as follows:

**ISO 16834-A – G Mn4Ni1Mo**

where

| | |
|---|---|
| ISO 16834-A | is the number of this document, with classification by yield strength and 47 J impact energy; |
| G | designates a wire electrode and/or deposit, gas shielded metal arc welding (see 5.1); |
| 62 | is the strength and elongation in the as-welded condition (see Table 2); |
| 6 | is the impact properties in the as-welded condition (see Table 3); |
| M21 | is the shielding gas (see 5.4); |
| Mn4Ni1Mo | is the chemical composition of the wire electrode (see Table 4). |

### 13.3 Example 2 - Classification by tensile strength and 27 J impact energy – System B

A weld deposit produced by gas shielded metal arc welding (G) having a minimum tensile strength of 690 MPa (69) and a minimum average impact energy of 27 J at –60 °C (6) under mixed gas (M21) using the wire N2M3T in the as welded condition (A) is designated as follows:

**ISO 16834-B – G 69A 6 M21 N2M3T**

A wire electrode conforming with the chemical requirement of N2M3T in Table 4 is designated as follows:

**ISO 16834-B – G N2M3T**

where

| | |
|---|---|
| ISO 16834-B | is the number of this document, with classification by tensile strength and 27 J impact energy; |
| G | designates a wire electrode and/or deposit, gas shielded metal arc welding (see 5.1); |
| 69A | is the strength and elongation in the as-welded condition (see Table 2); |
| 6 | is the impact properties in the as-welded condition (see Table 3); |
| M21 | is the shielding gas (see 5.4); |
| N2M3T | is the chemical composition of the wire electrode (see Table 4). |

### 13.4 Example 3 – Classification by yield strength and 47 J impact energy – System A

A weld deposit by tungsten inert gas welding (W) having a minimum yield strength of 550 MPa (55) and a minimum average impact energy of 47 J at –60 °C (6) under argon shield (I1) using the wire/rod Mn4Ni1Mo in the post-weld heat-treated condition (T) is designated as follows:

**ISO 16834-A – W 55 6 I1 Mn4Ni1Mo T**

A wire/rod conforming with the chemical requirement of Mn4Ni1Mo in Table 4 is designated as follows:

**ISO 16834-A – W Mn4Ni1Mo**

where

| | |
|---|---|
| ISO 16834-A | is the number of this document, with classification by yield strength and 47 J impact energy; |
| W | designates a wire/rod and/or deposit, tungsten inert gas welding process (see 5.1); |
| 55 | is the strength and elongation (see Table 2); |
| 6 | is the impact properties (see Table 3); |
| I1 | is the shielding gas (see 5.4); |
| Mn4Ni1Mo | is the chemical composition of the wire/rod (see Table 4); |
| T | is the post-weld heat-treated condition (see 5.6.1). |

### 13.5 Example 4 - Classification by tensile strength and 27 J impact energy – System B

A weld deposit by tungsten inert gas welding (W) having a minimum tensile strength of 620 MPa (62) and a minimum average impact energy of 27 J at –60 °C (6) under argon shield (I1) using the wire/rod N2M3 in the post-weld heat-treated condition (P) is designated as follows: