
Welding — Guidelines for a metallic materials grouping system

Soudage — Lignes directrices pour un système de groupement des matériaux métalliques





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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.

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This document was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 10, *Quality management in the field of welding*.

This fourth edition cancels and replaces the third edition (ISO/TR 15608:2013), which has been revised and contains the following changes:

- a) the grouping systems for steels have been revised ([Clause 2](#));
- b) the Bibliography has been updated and the document editorially revised.

Requests for official interpretations of any aspect of this document should be directed to the Secretariat of ISO/TC 44/SC 10 via your national standards body. A complete listing of these bodies can be found at www.iso.org.

Welding — Guidelines for a metallic materials grouping system

1 Scope

This document provides guidelines for a uniform system for grouping materials for welding purposes. It can also be applied for other purposes, such as heat treatment, forming and non-destructive testing.

It covers grouping systems for the following standardized materials:

- steels;
- aluminium and its alloys;
- copper and its alloys;
- nickel and its alloys;
- titanium and its alloys;
- zirconium and its alloys;
- cast irons.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

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

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

4 Grouping system for steels

Steels are grouped as shown in [Table 1](#). Only those elements that are specified in material standards or specifications should be considered. Ladle (or heat) analyses should be used in preference of product analysis when both are specified. The figures given in groups:

- 1, 2, 3 and 11 refer to the chemical composition specified in the material standard (specified values);
- 4 to 10 are based on the elemental content used in the designation of the alloys.

Materials assigned to a group in ISO/TR 20172, ISO/TR 20173 and ISO/TR 20174 should be considered assigned to those groups by this document. For materials that are not assigned to a group, the criteria of this document apply.

Table 1 — Grouping system for steels

Group	Subgroup	Type of steel
1		Steels with a specified minimum yield strength $R_{eH} \leq 460 \text{ N/mm}^2$ ^a and with analysis in per cent (%):
		$C \leq 0,25$
		$Si \leq 0,60$
		$Mn \leq 1,8$
		$Mo \leq 0,70^b$
		$S \leq 0,045$
		$P \leq 0,045$
		$Cu \leq 0,40^b$
		$Ni \leq 0,5^b$
		$Cr \leq 0,3$ (0,4 for castings) ^b
		$Nb \leq 0,06$
		$V \leq 0,1^b$
		$Ti \leq 0,05$
	1.1	Steels with a specified minimum yield strength $R_{eH} \leq 275 \text{ N/mm}^2$
	1.2	Steels with a specified minimum yield strength $275 \text{ N/mm}^2 < R_{eH} \leq 360 \text{ N/mm}^2$
1.3	Normalized fine-grain steels with a specified minimum yield strength $R_{eH} > 360 \text{ N/mm}^2$	
1.4	Steels with improved atmospheric corrosion resistance whose analysis may exceed the requirements for the single elements as indicated in group 1	
2		Thermomechanically treated fine-grain steels and cast steels with a specified minimum yield strength $R_{eH} > 360 \text{ N/mm}^2$
	2.1	Thermomechanically treated fine-grain steels and cast steels with a specified minimum yield strength $360 \text{ N/mm}^2 < R_{eH} \leq 460 \text{ N/mm}^2$
	2.2	Thermomechanically treated fine-grain steels and cast steels with a specified minimum yield strength $R_{eH} > 460 \text{ N/mm}^2$
3		Quenched and tempered and precipitation hardened fine-grain steels except stainless steels with a specified minimum yield strength $R_{eH} > 360 \text{ N/mm}^2$
	3.1	Quenched and tempered fine-grain steels with a specified minimum yield strength $360 \text{ N/mm}^2 < R_{eH} \leq 690 \text{ N/mm}^2$
	3.2	Quenched and tempered fine-grain steels with a specified minimum yield strength $R_{eH} > 690 \text{ N/mm}^2$
	3.3	Precipitation-hardened fine-grain steels except stainless steels
4		Low vanadium alloyed Cr-Mo-(Ni) steels with $Mo \leq 0,7 \%$ and $V \leq 0,1 \%$
	4.1	Steels with $Cr \leq 0,3 \%$ and $Ni \leq 0,7 \%$
	4.2	Steels with $Cr \leq 0,7 \%$ and $Ni \leq 1,5 \%$
5		Cr-Mo steels free of vanadium with $C \leq 0,35 \%$
	5.1	Steels with $0,75 \% \leq Cr \leq 1,5 \%$ and $Mo \leq 0,7 \%$
	5.2	Steels with $1,5 \% < Cr \leq 3,5 \%$ and $0,7 \% < Mo \leq 1,2 \%$
	5.3	Steels with $3,5 \% < Cr \leq 7,0 \%$ and $0,4 \% < Mo \leq 0,7 \%$
	5.4	Steels with $7,0 \% < Cr \leq 10,0 \%$ and $0,7 \% < Mo \leq 1,2 \%$
^a	In accordance with the specification of the steel product standards, R_{eH} may be replaced by $R_{p0,2}$ or $R_{t0,5}$.	
^b	A higher value is accepted, provided $Cr + Mo + Ni + Cu + V \leq 0,75 \%$.	
^c	A higher value is accepted, provided $Cr + Mo + Ni + Cu + V \leq 1 \%$.	

Table 1 (continued)

Group	Subgroup	Type of steel
6		High vanadium alloyed Cr-Mo-(Ni) steels
	6.1	Steels with $0,3 \% \leq \text{Cr} \leq 0,75 \%$, $\text{Mo} \leq 0,7 \%$ and $\text{V} \leq 0,35 \%$
	6.2	Steels with $0,75 \% < \text{Cr} \leq 3,5 \%$, $0,7 \% < \text{Mo} \leq 1,2 \%$ and $\text{V} \leq 0,35 \%$
	6.3	Steels with $3,5 \% < \text{Cr} \leq 7,0 \%$, $\text{Mo} \leq 0,7 \%$ and $0,45 \% \leq \text{V} \leq 0,55 \%$
	6.4	Steels with $7,0 \% < \text{Cr} \leq 12,5 \%$, $0,7 \% < \text{Mo} \leq 1,2 \%$ and $\text{V} \leq 0,35 \%$
7		Ferritic, martensitic or precipitation-hardened stainless steels with $\text{C} \leq 0,35 \%$ and $10,5 \% \leq \text{Cr} \leq 30 \%$
	7.1	Ferritic stainless steels
	7.2	Martensitic stainless steels
	7.3	Precipitation-hardened stainless steels
8		Austenitic stainless steels, $\text{Ni} \leq 35 \%$
	8.1	Austenitic stainless steels with $\text{Cr} \leq 19 \%$
	8.2	Austenitic stainless steels with $\text{Cr} > 19 \%$
	8.3	Manganese austenitic stainless steels with $4 \% < \text{Mn} \leq 12 \%$
9		Nickel alloy steels with $\text{Ni} \leq 10,0 \%$
	9.1	Nickel alloy steels with $\text{Ni} \leq 3,0 \%$
	9.2	Nickel alloy steels with $3,0 \% < \text{Ni} \leq 8,0 \%$
	9.3	Nickel alloy steels with $8,0 \% < \text{Ni} \leq 10,0 \%$
10		Austenitic ferritic stainless steels (duplex)
	10.1	Austenitic ferritic stainless steels with $\text{Cr} \leq 24 \%$ and $\text{Ni} > 4 \%$
	10.2	Austenitic ferritic stainless steels with $\text{Cr} > 24 \%$ and $\text{Ni} > 4 \%$
	10.3	Austenitic ferritic stainless steels with $\text{Ni} \leq 4 \%$
11		Steels covered by group 1 ^c except $0,30 \% < \text{C} \leq 0,85 \%$
	11.1	Steels as indicated under 11 with $0,30 \% < \text{C} \leq 0,35 \%$
	11.2	Steels as indicated under 11 with $0,35 \% < \text{C} \leq 0,5 \%$
	11.3	Steels as indicated under 11 with $0,5 \% < \text{C} \leq 0,85 \%$
Based on the actual product analysis, group 2 steels may be considered group 1 steels.		
If a material has different minimum specified yield strengths depending on the thickness, the highest yield strength shall be used for the determination of the subgroup.		
a	In accordance with the specification of the steel product standards, R_{eH} may be replaced by $R_{p0,2}$ or $R_{t0,5}$.	
b	A higher value is accepted, provided $\text{Cr} + \text{Mo} + \text{Ni} + \text{Cu} + \text{V} \leq 0,75 \%$.	
c	A higher value is accepted, provided $\text{Cr} + \text{Mo} + \text{Ni} + \text{Cu} + \text{V} \leq 1 \%$.	

5 Grouping system for aluminium and aluminium alloys

Aluminium and aluminium alloys are grouped as shown in [Table 2](#). The figures given are based on the element content used in the designation of the alloys.

Table 2 — Grouping system for aluminium and aluminium alloys

Group	Subgroup	Type of aluminium and aluminium alloy
21		Pure aluminium ≤ 1 % impurities or alloy content
22		Non heat treatable alloys
	22.1	Aluminium-manganese alloys
	22.2	Aluminium-magnesium alloys with $Mg \leq 1,5$ %
	22.3	Aluminium-magnesium alloys with $1,5$ % < $Mg \leq 3,5$ %
23	22.4	Aluminium-magnesium alloys with $Mg > 3,5$ %
		Heat treatable alloys
	23.1	Aluminium-magnesium-silicon alloys
24	23.2	Aluminium-zinc-magnesium alloys
		Aluminium-silicon alloys with $Cu \leq 1$ %
	24.1	Aluminium-silicon alloys with $Cu \leq 1$ % and 5 % < $Si \leq 15$ %
	24.2	Aluminium-silicon-magnesium alloys with $Cu \leq 1$ %; 5 % < $Si \leq 15$ % and $0,1$ % < $Mg \leq 0,80$ %
25		Aluminium-silicon-copper alloys with 5 % < $Si \leq 14$ % ; 1 % < $Cu \leq 5$ % and $Mg \leq 0,8$ %
26		Aluminium-copper alloys with 2 % < $Cu \leq 6$ %
NOTE Groups 21 to 23 are generally for wrought materials and groups 24 to 26 are generally for cast materials.		

6 Grouping system for copper and copper alloys

Copper and copper alloys are grouped as indicated in [Table 3](#).

Table 3 — Grouping system for copper and copper alloys

Group	Subgroup	Type of copper and copper alloy
31		Copper with up to 6 % Ag and 3 % Fe
32		Copper-zinc alloys
	32.1	Copper-zinc alloys, binary
	32.2	Copper-zinc alloys, complex
33		Copper-tin alloys
34		Copper-nickel alloys
35		Copper-aluminium alloys
36		Copper-nickel-zinc alloys
37		Copper alloys, low alloyed (less than 5 % other elements) not covered by groups 31 to 36
38		Other copper alloys (5 % or more other elements) not covered by groups 31 to 36

7 Grouping system for nickel and nickel alloys

Nickel and nickel alloys are grouped as indicated in [Table 4](#). The figures given are based on the element content used in the designation of the alloys.

Table 4 — Grouping system for nickel and nickel alloys

Group	Type of nickel and nickel alloy
41	Pure nickel
42	Nickel-copper alloys (Ni-Cu) Ni ≥ 45 %, Cu ≥ 10 %
43	Nickel-chromium alloys (Ni-Cr-Fe-Mo) Ni ≥ 40 %
44	Nickel-molybdenum alloys (Ni-Mo) Ni ≥ 45 %, Mo ≤ 32 %
45	Nickel-iron-chromium alloys (Ni-Fe-Cr) Ni ≥ 31 %
46	Nickel-chromium-cobalt alloys (Ni-Cr-Co) Ni ≥ 45 %, Co ≥ 10 %
47	Nickel-iron-chromium-copper alloys (Ni-Fe-Cr-Cu) Ni ≥ 45 %
48	Nickel-iron-cobalt alloys (Ni-Fe-Co-Cr-Mo-Cu) 31 % ≤ Ni ≤ 45 % and Fe ≥ 20 %

8 Grouping system for titanium and titanium alloys

Titanium and titanium alloys are grouped as indicated in [Table 5](#).

Table 5 — Grouping system for titanium and titanium alloys

Group	Subgroup	Type of titanium and titanium alloy
51		Pure titanium
	51.1	Titanium with O ₂ ≤ 0,20 %
	51.2	Titanium with 0,20 % < O ₂ ≤ 0,25 %
	51.3	Titanium with 0,25 % < O ₂ ≤ 0,35 %
	51.4	Titanium with 0,35 % < O ₂ ≤ 0,40 %
52		Alpha alloys ^a
53		Alpha-beta alloys ^b
54		Near-beta and beta alloys ^c
^a Alloys covered by group 52 are: Ti-0,2Pd; Ti-2,5Cu; Ti-5Al-2,5Sn; Ti-8Al-1Mo-1V; Ti-6Al-2Sn-4Zr-2Mo; Ti-6Al-2Nb-1Ta-0,8Mo.		
^b Alloys covered by group 53 are: Ti-3Al-2,5V; Ti-6Al-4V; Ti-6Al-6V-2Sn; Ti-7Al-4Mo.		
^c Alloys covered by group 54 are: Ti-10V-2Fe-3Al; Ti-13V-11Cr-3Al; Ti-11,5Mo-6Zr-4,5Sn; Ti-3Al-8V-6Cr-4Zr-4Mo.		

9 Grouping system for zirconium and zirconium alloys

Zirconium and zirconium alloys are grouped as indicated in [Table 6](#).

Table 6 — Grouping system for zirconium and zirconium alloys

Group	Type of zirconium and zirconium alloy
61	Pure zirconium
62	Zirconium with 2,5 % Nb

10 Grouping system for cast irons

Cast irons are grouped as indicated in [Table 7](#).

Table 7 — Grouping system for cast irons

Group	Subgroup	Type of cast iron
71		Grey cast irons with specified tensile strength or Brinell hardness
72		Spheroidal graphite cast irons with specified mechanical properties
	72.1	Spheroidal graphite cast irons, ferrite type, with specified tensile strength, 0,2 % proof stress, elongation and specified impact resistance values
	72.2	Spheroidal graphite cast irons, ferrite type, with specified tensile strength, 0,2 % proof stress and elongation or specified Brinell hardness
	72.3	Spheroidal graphite cast irons EN-GJS-500-7 and EN-GJS-450-10 (if > 20 % perlite) or specified Brinell hardness
	72.4	Spheroidal graphite cast irons, perlite type, with specified tensile strength, 0,2 % proof stress and elongation or specified Brinell hardness
73		Malleable cast irons
74		Austempered ductile cast irons
75		Austenitic cast irons
76		Cast irons excepting 71 to 75

Bibliography

- [1] ISO/TR 20172, *Welding — Grouping systems for materials — European materials*
- [2] ISO/TR 20173, *Welding — Grouping systems for materials — American materials*
- [3] ISO/TR 20174, *Welding — Grouping systems for materials — Japanese materials*

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