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Welding — Guidelines for a metallic materials grouping system

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

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

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Foreword

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In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

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ISO/TR 15608 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 10, *Unification of requirements in the field of metal welding*.

This third edition cancels and replaces the second edition (ISO/TR 15608:2005), which has been technically revised.

Requests for official interpretations of any aspect of this Technical Report 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 Technical Report provides a uniform system for grouping of materials for welding purposes. It can also apply to other purposes, such as heat treatment, forming and non-destructive testing.

This Technical Report 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 Grouping system for steels

Steels are grouped as shown in Table 1. Only those elements that are specified in material standards or specifications shall be considered. The figures given in groups

— 1, 2, 3 and 11 refer to the chemical composition specified in the material standard (specified values), and

— 4 to 10 are based on the elemental content used in the designation of the alloys.

Table 1 — Grouping system for steels

Group	Subgroup	Type of steel
1		Steels with a specified minimum yield strength $R_{eH} \leq 460$ N/mm² [a] and with analysis in per cent (%):
		C ≤ 0,25[d]
		Si ≤ 0,60
		Mn ≤ 1,8
		Mo ≤ 0,70[b]
		S ≤ 0,045
		P ≤ 0,045
		Cu ≤ 0,40[b]
		Ni ≤ 0,5[b]
		Cr ≤ 0,3 (0,4 for castings)[b]
		Nb ≤ 0,06
		V ≤ 0,1[b]
		Ti ≤ 0,05
	1.1	Steels with a specified minimum yield strength $R_{eH} \leq 275$ N/mm²
	1.2	Steels with a specified minimum yield strength 275 N/mm² < $R_{eH} \leq 360$ N/mm²
	1.3	Normalized fine-grain steels with a specified minimum yield strength $R_{eH} > 360$ N/mm²
	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 $R_{eH} > 360$ N/mm²
	2.1	Thermomechanically treated fine-grain steels and cast steels with a specified minimum yield strength 360 N/mm² < $R_{eH} \leq 460$ N/mm²
	2.2	Thermomechanically treated fine-grain steels and cast steels with a specified minimum yield strength $R_{eH} > 460$ N/mm²
3		Quenched and tempered and precipitation hardened fine-grain steels except stainless steels with a specified minimum yield strength $R_{eH} > 360$ N/mm²
	3.1	Quenched and tempered fine-grain steels with a specified minimum yield strength 360 N/mm² < $R_{eH} \leq 690$ N/mm²
	3.2	Quenched and tempered fine-grain steels with a specified minimum yield strength $R_{eH} > 690$ N/mm²
	3.3	Precipitation-hardened fine-grain steels except stainless steels
4		Low vanadium alloyed Cr-Mo-(Ni) steels with Mo ≤ 0,7 % and V ≤ 0,1 %
	4.1	Steels with Cr ≤ 0,3 % and Ni ≤ 0,7 %
	4.2	Steels with Cr ≤ 0,7 % and Ni ≤ 1,5 %
5		Cr-Mo steels free of vanadium with C ≤ 0,35 %
	5.1	Steels with 0,75 % ≤ Cr ≤ 1,5 % and Mo ≤ 0,7 %
	5.2	Steels with 1,5 % < Cr ≤ 3,5 % and 0,7 % < Mo ≤ 1,2 %
	5.3	Steels with 3,5 % < Cr ≤ 7,0 % and 0,4 % < Mo ≤ 0,7 %
	5.4	Steels with 7,0 % < Cr ≤ 10,0 % and 0,7 % < Mo ≤ 1,2 %

Table 1 *(continued)*

Group	Subgroup	Type of steel
6		High vanadium alloyed Cr-Mo-(Ni) steels
	6.1	Steels with 0,3 % ≤ Cr ≤ 0,75 %, Mo ≤ 0,7 % and V ≤ 0,35 %
	6.2	Steels with 0,75 % < Cr ≤ 3,5 %, 0,7 % < Mo ≤ 1,2 % and V ≤ 0,35 %
	6.3	Steels with 3,5 % < Cr ≤ 7,0 %, Mo ≤ 0,7 % and 0,45 % ≤ V ≤ 0,55 %
	6.4	Steels with 7,0 % < Cr ≤ 12,5 %, 0,7 % < Mo ≤ 1,2 % and V ≤ 0,35 %
7		Ferritic, martensitic or precipitation-hardened stainless steels with C ≤ 0,35 % and 10,5 % ≤ Cr ≤ 30 %
	7.1	Ferritic stainless steels
	7.2	Martensitic stainless steels
	7.3	Precipitation-hardened stainless steels
8		Austenitic stainless steels, Ni ≤ 35 %
	8.1	Austenitic stainless steels with Cr ≤ 19 %
	8.2	Austenitic stainless steels with Cr > 19 %
	8.3	Manganese austenitic stainless steels with 4 % < Mn ≤ 12 %
9		Nickel alloy steels with Ni ≤ 10,0 %
	9.1	Nickel alloy steels with Ni ≤ 3,0 %
	9.2	Nickel alloy steels with 3,0 % < Ni ≤ 8,0 %
	9.3	Nickel alloy steels with 8,0 % < Ni ≤ 10,0 %
10		Austenitic ferritic stainless steels (duplex)
	10.1	Austenitic ferritic stainless steels with Cr ≤ 24 %
	10.2	Austenitic ferritic stainless steels with Cr > 24 %
	10.3	Austenitic ferritic stainless steels with Ni ≤ 2 %
11		Steels covered by group 1[c] except 0,25 % < C ≤ 0,85 %
	11.1	Steels as indicated under 11 with 0,25 % < C ≤ 0,35 %
	11.2	Steels as indicated under 11 with 0,35 % < C ≤ 0,5 %
	11.3	Steels as indicated under 11 with 0,5 % < C ≤ 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 Cr + Mo + Ni + Cu + V ≤ 0,75 %. c A higher value is accepted, provided Cr + Mo + Ni + Cu + V ≤ 1 %. d A higher value is acceptable, provided Cr + Mo + Ni + Cu + V ≤ 1 % and CE (IIW) ≤ 0,55. The CE (IIW) is specified in ISO/TR 17671-2.		

3 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 ≤ 1,5 %
	22.3	Aluminium-magnesium alloys with 1,5 % < Mg ≤ 3,5 %
	22.4	Aluminium-magnesium alloys with Mg > 3,5 %
23		Heat treatable alloys
	23.1	Aluminium-magnesium-silicon alloys
	23.2	Aluminium-zinc-magnesium alloys
24		Aluminium-silicon alloys with Cu ≤ 1 %
	24.1	Aluminium-silicon alloys with Cu ≤ 1 % and 5 % < Si ≤ 15 %
	24.2	Aluminium-silicon-magnesium alloys with Cu ≤ 1 %; 5 % < Si ≤ 15 % and 0,1 % < Mg ≤ 0,80 %
25		Aluminium-silicon-copper alloys with 5 % < Si ≤ 14 % ; 1 % < Cu ≤ 5 % and Mg ≤ 0,8 %
26		Aluminium-copper alloys with 2 % < Cu ≤ 6 %
NOTE	Groups 21 to 23 are generally for wrought materials and groups 24 to 26 are generally for cast materials.	

4 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

5 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 %

6 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 $O_2 \leq 0{,}20$ %
	51.2	Titanium with $0{,}20\ \% < O_2 \leq 0{,}25$ %
	51.3	Titanium with $0{,}25\ \% < O_2 \leq 0{,}35$ %
	51.4	Titanium with $0{,}35\ \% < O_2 \leq 0{,}40$ %
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.

7 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

8 Grouping system for cast irons

Cast irons are grouped as indicated in Table 7.