
International Standard



4948/2

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Steels — Classification — Part 2 : Classification of unalloyed and alloy steels according to main quality classes and main property or application characteristics

Aciers — Classification — Partie 2 : Classification des aciers alliés et aciers non alliés en fonction des principales classes de qualité et des caractéristiques principales de propriété ou d'application

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

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It has been approved by the member bodies of the following countries :

| | | |
|---------------------|------------------------|-----------------------|
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No member body expressed disapproval of the document.

Steels — Classification —

Part 2 : Classification of unalloyed and alloy steels according to main quality classes and main property or application characteristics

1 Scope and field of application

This part of ISO 4948 lays down a classification of unalloyed and alloy steels according to main quality classes and main property or application characteristics.

Part 1 lays down the classification of steels into unalloyed and alloy steels based on chemical composition.

2 References

ISO 630, *Structural steels.*

ISO/R 683/1, *Heat-treated steels, alloy steels and free-cutting steels — Part 1 : Quenched and tempered unalloyed steels.*¹⁾

ISO/R 683/3, *Heat-treated steels, alloy steels and free-cutting steels — Part 3 : Wrought quenched and tempered unalloyed steels with controlled sulphur content.*¹⁾

ISO/R 683/5, *Heat-treated steels, alloy steels and free-cutting steels — Part 5 : Wrought quenched and tempered manganese steels.*¹⁾

ISO/R 683/9, *Heat-treated steels, alloy steels and free-cutting steels — Part 9 : Wrought free-cutting steels.*¹⁾

ISO/R 683/11, *Heat-treated steels, alloy steels and free-cutting steels — Part 11 : Wrought case hardening steels.*¹⁾

ISO 683/12, *Heat-treated steels, alloy steels and free-cutting steels — Part 12 : Flame and induction hardening steels.*

ISO 683/14, *Heat-treated steels, alloy steels and free-cutting steels — Part 14 : Steels for hot-formed and heat-treated springs.*

ISO 683/18, *Heat-treated steels, alloy steels and free-cutting steels — Part 18 : Wrought unalloyed steels in the normalized, or normalized and cold-drawn, or hot-rolled and cold-drawn condition.*

ISO 1052, *Steels for general engineering purposes.*²⁾

ISO/R 1111/1, *Cold-reduced tinplate and cold-reduced black-plate — Part 1 : Sheet.*¹⁾

ISO 1111/2, *Cold-reduced tinplate and cold-reduced black-plate — Part 2 : Coil for subsequent cutting into sheet.*

ISO 2604, *Steel products for pressure purposes —*
Part 1 : Forgings.
Part 2 : Wrought seamless tubes.
Part 3 : Electric resistance and induction-welded tubes.
Part 4 : Plates.
Part 6 : Submerged arc longitudinally or spirally welded steel tubes.

ISO 3183, *Oil and natural gas industries — Steel line pipe.*

ISO 3573, *Hot-rolled carbon steel sheet of commercial and drawing qualities.*

ISO 3574, *Cold-reduced carbon steel sheet of commercial and drawing qualities.*

ISO 3575, *Continuous hot-dip zinc-coated carbon steel sheet of commercial, lock-forming and drawing qualities.*

ISO 3755, *Cast steels for general engineering purposes.*

ISO 3845, *Oil and natural gas industries — High-test steel line pipe.*³⁾

ISO 4948/1, *Steels — Classification — Part 1 : Classification of steels into unalloyed and alloy steels based on chemical composition.*³⁾

ISO 4950/2, *High yield strength flat steel products — Part 2 : Products supplied in the normalized or controlled rolled condition.*

ISO 4951, *High yield strength steel sections.*

ISO 4954, *Steel for cold heading and cold extruding.*

ISO 4957, *Tool steels.*

1) Under revision.

2) At present at the stage of draft. (Revision of ISO/R 1052-1969.)

3) At present at the stage of draft.

ISO 4995, *Hot-rolled steel sheet of structural quality.*

ISO 4996, *Hot-rolled steel sheet of high yield stress structural quality.*

ISO 4997, *Cold-reduced steel sheet of structural quality.*

ISO 5002, *Hot-rolled and cold-reduced electrolytic zinc coated carbon steel sheet of commercial and drawing qualities.*¹⁾

ISO 5003, *Flat bottom railway rails and special rail sections for switches and crossings of non-treated steel — Technical delivery requirements.*

3 Definitions

For definition of the terms "unalloyed steel" and "alloy steel", see ISO 4948/1.

4 Main classes of unalloyed steels

4.1 The main classes of unalloyed steels are given in table 1. The individual main classes are characterized by

- a) the main quality class (see 4.2), and
- b) the main characteristic (see 4.3)

of the steel.

4.2 Main quality classes

4.2.1 Subdivision

Unalloyed steels are subdivided into the following main quality classes :

- base steel (see 4.2.2);
- unalloyed quality steel (see 4.2.3);
- unalloyed special steel (see 4.2.4).

4.2.2 Base²⁾ steel

4.2.2.1 General description

The term "base steel" applies to all steels for which no quality requirement, which would necessitate special care during steel production, is specified.

1) At present at the stage of draft.

2) Other terms used until now are regular steels, commercial or merchant steel.

3) Annealing (for example stress-relieving treatment, softening, annealing or normalizing) is not to be considered as heat treatment.

4.2.2.2 Definition

Base steels are steels which simultaneously meet the following four conditions :

- a) The steel is unalloyed.
- b) No heat treatment³⁾ is specified.
- c) The characteristics, if specified in product standards or specifications, are as follows :

Minimum tensile strength : $\leq 690 \text{ N/mm}^2$

Minimum yield strength : $\leq 360 \text{ N/mm}^2$

Minimum elongation on ($L_0 = 5 d_0$) : $\leq 26 \%$

Minimum diameter of bending mandrel : $\geq 1 \times$ thickness of test piece

Minimum energy absorbed at 20 °C (on ISO V-notch test piece taken longitudinally) : $\leq 27 \text{ J}$

Maximum Rockwell hardness HRB : ≥ 60

Maximum carbon content : $\geq 0,10 \%$

Maximum phosphorus content : $\geq 0,050 \%$

Maximum sulphur content : $\geq 0,050 \%$

Maximum nitrogen content : $\geq 0,007 \%$

NOTE — The indicated mechanical characteristics correspond to the range of thicknesses from 3 to 16 mm and apply to test pieces taken in the longitudinal or transverse direction in accordance with the requirements of the relevant standard or specification.

- d) No other quality requirement is specified.

4.2.3 Unalloyed quality steel

4.2.3.1 General description

The term "unalloyed quality steel", applies to those unalloyed steels which require special care during production (for example by grain size control, decrease of sulphur and phosphorus content, improvement of surface finish or increased production control, etc.) to achieve, in comparison with base steels, special quality characteristics such as improved resistance against brittle fracture, improved cold-forming properties, etc.

However, requirements concerning careful production of these steels are less stringent than those for classical unalloyed special steels, i.e. steels with controlled hardenability.

4.2.3.2 Definition

Unalloyed quality steels are those unalloyed steels which are covered neither by the definition given in 4.2.2 for base steels nor by that given in 4.2.4 for unalloyed special steels.

4.2.3.3 Examples

See table 1, column Q.

4.2.4 Unalloyed special steel

4.2.4.1 General description

The term "unalloyed special steel" applies to those steels the production of which requires special care comparable in extent with the care necessary for the production of the classical special steels, i.e. unalloyed steels with controlled (special) hardenability requirements.

In view of their special manufacturing conditions, special steels are generally cleaner — especially from the point of view of inclusions — than quality steels.

4.2.4.2 Definition

The following unalloyed steels are special steels:

a) All unalloyed steels (including unalloyed free-cutting steels and tool steels) destined for heat treatment for which specific requirements for at least one of the following characteristics are to be observed :

- 1) Requirements concerning the impact properties in the quenched and tempered or simulated case-hardened condition.
- 2) Requirements concerning the hardening depth or surface hardness after hardening or hardening and tempering.
- 3) Requirements concerning limitation of surface discontinuities.
- 4) Requirements concerning limitation of the non-metallic inclusion content and/or the internal homogeneity.

b) All unalloyed steels **not** destined for heat treatment for which at least one of the following requirements is to be observed :

- 1) Requirements concerning limitation of the non-metallic inclusion content and/or the internal homogeneity, for example plates resistant to lamellar tearing.

2) The maximum phosphorus and/or sulphur content is limited as follows :

- for ladle analysis : $\leq 0,020$ %
- for product analysis : $\leq 0,025$ %

Examples : Certain steels for welding wire, steel for wire for tyres.

3) The contents of the following residual elements are simultaneously restricted as follows :

- Cu max., cast $\leq 0,10$ %
- Co max., cast $\leq 0,05$ %
- V max., cast $\leq 0,05$ %

4) The requirements for the surface quality are more stringent than those specified in ISO 4954 for cold-heading and cold-extruding steels.

Examples : Certain cold-forging, cold-drawing and plating qualities.

- c) Steels with a specified electrical conductivity ≥ 9 S/m or with specified magnetic properties, excepting magnetic sheet and strip for which only the maximum magnetic losses and the minimum magnetic induction, and not, for example, the permeability, is specified.

4.3 Main characteristics

4.3.1 For the purpose of this International Standard, main characteristics are considered to be those characteristics which are applied with a certain priority, for example in designation systems or for classification of steels.

4.3.2 For unalloyed steels, the classification according to main characteristics used in table 1 is as follows :

- a) Unalloyed steels with R_e max., R_m max., or HB max. (or maximum diameter of bending mandrel, etc.) as the main characteristic. (Example : Soft sheet for cold forming)
- b) Unalloyed steels with R_e min. or R_m min. as the main characteristic. (Examples : Structural steels including steels for ships, pipelines, pressure purposes and unalloyed steels with improved weather resistance)
- c) Unalloyed steels with the carbon content as the main characteristic, with the exception of the steels indicated under d) and e). (Examples : Steels for wire rod, steel for quenching and tempering, etc.)
- d) Unalloyed free cutting steels (% S min., cast $\geq 0,070$ % and/or additions of Pb, Bi, Te, Se or P)
- e) Unalloyed tool steels
- f) Unalloyed steels with particular specifications for magnetic or electrical properties (Examples : Magnetic sheet and strip, steel with permeability requirements for transmitters, telephone wire, etc.)
- g) Other unalloyed steels.

5 Main classes of alloy steels

5.1 The main classes of alloy steels are given in table 2. They are characterized by

- a) the main quality class (see 5.2) and
- b) the main characteristic (see 5.3)

of the steel.

5.2 Main quality classes

5.3.1 Alloyed quality steel

5.2.1.1 General description

The term "alloyed quality steel" applies to steels with low alloy contents which are manufactured in relatively large quantities and according to quality requirements which are, in comparison with those for alloyed special steels, relatively easy to fulfil.

5.2.1.2 Definition

The following alloy steels are quality steels :

5.2.1.2.1 Structural weldable fine grain steels with high yield strength, which simultaneously meet the following conditions :

- a) The specified minimum yield strength is less than 420 N/mm² (for thicknesses < 16 mm).
- b) The alloy contents, defined by a minimum value or the lower value of a range, are less than the values given in table 3.

If the alloying element is defined by a maximum value only, the class to which it belongs is given by the value corresponding to 70 % of this maximum value.

5.2.1.2.2 Steels which are only alloyed with copper and having a specified minimum copper content greater than or equal to 0,40 % but less than 0,50 %, or, if no minimum value is specified, a specified maximum copper content greater than or equal to 0,57 % but less than 0,70 %.

5.2.1.2.3 Alloy steels for rails.

5.2.1.2.4 Silico-manganese steels for springs or parts resistant to abrasion with P and S > 0,035 %.

5.2.1.2.5 Steels for sheets and strips containing only Si and/or Al as alloying element and with requirements for magnetic losses and for the minimum values for magnetic induction only (which means, for example, no requirements for permeability).

5.2.2 Alloyed special steel

All alloy steels, excluding those indicated in 5.2.1, are special steels.

5.3 Main characteristics

5.3.1 The general description given in 4.3.1 for the main characteristics of unalloyed steels applies also for alloy steels.

5.3.2 The criteria used for the main characteristics of alloy steels are characteristic applications, properties and/or alloy contents (see table 2).

Table 3 — High yield strength alloyed steels — Limiting contents of alloying elements for alloyed quality steels

| Alloying element | Limiting contents, % |
|------------------------------|----------------------|
| Chromium ¹⁾ | 0,50 |
| Copper ¹⁾ | 0,50 |
| Lanthanides | 0,06 |
| Manganese | 1,80 |
| Molybdenum ¹⁾ | 0,10 |
| Nickel ¹⁾ | 0,50 |
| Niobium ²⁾ | 0,08 |
| Titanium ²⁾ | 0,12 |
| Vanadium ²⁾ | 0,12 |
| Zirconium ²⁾ | 0,12 |
| Other elements not mentioned | (see table 1) |

1) When two, three or four of these elements are specified together in the steel under consideration, it is necessary to consider simultaneously :

- the limiting contents for each one of these elements;
- the limiting content for all these elements which should be taken as equal to 70 % of the sum of the limiting contents indicated for each one of the two, three or four elements in question.

2) The rule in note 1) is also applicable to these elements.

Table 1 — Main classes of unalloyed steels

| Main character- istic (see 4.3.2) | Main quality class | | | Examples |
|---|--|--|---|---|
| | B Base steel (see definition in 4.2.2.2) | Q Unalloyed quality steel (see definition in 4.2.3.2) | S Unalloyed special steel (see definition in 4.2.4.2) | |
| 1 R_e max., R_m max. or HB max. (Soft steels) | <p>a) Soft steel for sheet in commercial quality :</p> <p>ISO 3573, type HR 1 ISO 3574, type CR 1 ISO 3575, type Z1, ZF 1 ISO 5002, type ZE 01</p> | <p>a) Soft steel for sheet in lock-forming or drawing qualities :</p> <p>ISO 3573 ISO 3574 ISO 3575 ISO 5002</p> <p>} All types except those indicated in field B 1a</p> <p>b) Steels for tinplate and black-plate according to ISO/R 1111/1 and ISO 1111/2¹⁾.</p> <p>c) Cold-heading and cold-extruding steels not determined for heat treatment :</p> <p>ISO 4954; types of table 7, A1R to A5A1</p> | | <p>According to 4.2.4.2 b) 4)</p> |
| 2 R_e min. or R_m min. | <p>a) Concrete reinforcement steel²⁾</p> <p>b) Structural steels of quality O, A or B according to ISO 630, ISO 4995, ISO 4997, if for these no special requirements, for example cold flangeability, die forgeability, etc., are specified</p> <p>c) Steels for piling sections in accordance with 4.2.2.2</p> <p>d) Steels for general engineering purposes not determined for heat treatment :</p> <p>ISO 1052, types Fe 50-1 to Fe 70-2</p> | <p>a) Concrete reinforcement steels and unalloyed prestressing steels²⁾</p> <p>b) Structural steels of quality A or B of ISO 630, ISO 4995 or ISO 4997, if special requirements concerning, for example cold flangeability, die forgeability, etc. are specified</p> <p>Structural steels of quality C and D according to ISO 630, ISO 4995, ISO 4997</p> <p>Structural fine grain steels</p> <p>E 355 according to ISO 4950/2 E 355 according to ISO 4951 HS 355 according to ISO 4996³⁾</p> <p>c) Steels for piling sections not in accordance with 4.2.2.2</p> <p>d) Steels for oil and gas line pipe according to ISO 3183 and types E 29, E 32 and E 36, according to ISO 3845⁴⁾</p> <p>e) Steels for shipbuilding²⁾</p> <p>f) Unalloyed wrought steels²⁾ for pressure purposes according to ISO 2604, parts 1 to 4 and 6 and ISO 4978</p> <p>Fine grain steel²⁾</p> <p>Unalloyed cast steel²⁾</p> <p>g) Steels for gas cylinders⁵⁾</p> <p>h) Steels for rails according to ISO 5003</p> <p>j) Cast steels for general engineering purposes according to ISO 3755</p> | <p>a) Steel resistant to lamellar tearing</p> <p>b) Certain steels for nuclear pressure vessels</p> | <p>According to 4.2.4.2 b) 1)</p> <p>According to 4.2.4.2 b) 3)</p> |

Table 1 (concluded)

| Main characteristic (see 4.3.2) | Main quality class | | | Examples |
|---|--|---|--|--|
| | B Base steel (see definition in 4.2.2.2) | Q Unalloyed quality steel (see definition in 4.2.3.2) | S Unalloyed special steel (see definition in 4.2.4.2) | |
| 3 % C | | a) Unalloyed steel for wire, types mainly defined by composition with % C _{max.} < 0,10 and/or with 0,020 < % P _{max.} and % S _{max.} < 0,050 b) Unalloyed steels for quenching and tempering : Types of ISO/R 683/1, 3, 5 and ISO 683/18 not covered in field S 3b. c) Case-hardening steels 1b, 2b, 3b according to ISO/R 683/11. d) Unalloyed spring steel : Type 1 according to ISO 683/14. | a) Steels for welding wire with P _{max.} , cast and/or S _{max.} , cast ≤ 0,020 %. b) Unalloyed steels for quenching and tempering : Grades e and ea according to ISO/R 683/1, 3 and ISO 683/18. Grades 1, 1a, 2 and 2a according to ISO/R 683/5. c) Case hardening steels 1, 1a, 2, 2a, 3, 3a according to ISO/R 683/11. d) Unalloyed spring steel : Type 2 according to ISO 683/14. e) Flame and induction hardening steel : Types 1 to 5 according to ISO 683/12. f) Cold-heading and cold-extruding steels : B1, B2, B3, C1 to C6, C10 and C11 according to ISO 4954. | According to 4.2.4.2 b) 2) According to 4.2.4.2 a) 1) and/or a) 4) 6) According to 4.2.4.2 a) 1) and/or a) 4) 6) According to 4.2.4.2 a) 4) 6) According to 4.2.4.2 a) 2) According to 4.2.4.2 a) 1), a) 3), a) 4) and partly a) 2) |
| 4 Free-cutting steels | | a) All steels according to ISO/R 683/9. | Free-cutting steels determined for heat treatment with specified impact properties. | According to 4.2.4.2 a) 1) |
| 5 Tool steels | | | All unalloyed tool steels of ISO 4957. | According to 4.2.4.2 a) 2) and a) 4) 6) |
| 6 Steels with specified magnetic or electrical properties | | a) Unalloyed steels with a specified conductivity < 9 S/m. b) Unalloyed steel for magnetic sheet and strip [see the exception in 4.2.4.2 c)]. | a) Unalloyed steels with a specified conductivity ≥ 9 S/m. b) Unalloyed steel with specified magnetic properties according to 4.2.4.2 c). | According to 4.2.4.2 c) |
| 7 Others | Steel for fencing wire ²⁾ | | | |

1) ISO 1111 specifies only the HR 30T hardness and this with values which are obviously higher than that of 60 HRB given in 4.2.2.2. These steels are, however, normally made with carbon contents of under 0,10 % and, from their quality, are comparable with the soft steels for sheets in drawing quality. Consequently, they were classified as quality.

2) An International Standard dealing with this type of steel is in preparation.

3) On the basis of the rather incomplete specifications for the chemical composition in ISO 4996, all steels covered by that International Standard (HS 355 to HS 490) would be unalloyed quality steels. It was, however, assumed that, for these steels, the same classification as for the equivalent types in ISO 4950/2 is justified.

4) The indications for the chemical composition in ISO 3845 seem incomplete. The classification into unalloyed and alloyed fine grain steels was therefore based on the composition specified for the comparable types in ISO 4950/2.

5) These steels will form the subject of ISO 4978.

6) Although the mentioned International Standards do not yet expressly cover specifications concerning the limitations of the non-metallic inclusion content and/or the internal homogeneity of the steels, their maximum sulphur and phosphorus content of 0,035 % is regarded here as an indication that *de facto* such limitations are to be observed in the manufacture of these steels.

Table 2 — Classes of alloy steels

| Main classes | 1 | | 2 | 3 | Special steels (see 5.2.2) | | | 5 | 6 | |
|---|---|--|--|---|---|---------------|-----------|----------------------------------|---------------------------|---------------|
| | Quality steel (see 5.2.1) | | | | Corrosion-, heat-, and creep-resisting steels ²⁾ | | | | | Tool steels |
| Main application characteristic | Structural steel | Others | Structural steel | Engineering ¹⁾ (other than in column 4 and field 61) | 41 Ferritic or 42 Martensitic | | | 51 For hot and cold work | | |
| Examples for a further classification of steel according to other characteristics than those mentioned above | 11 Normalized weldable fine grain structural steels with R_e and $< 420 \text{ N/mm}^2$ and alloy contents lower than indicated in table 3 | 13 Steels for rails | 21 Alloyed weldable structural fine grain steels other than indicated in field 11 | 31 Mn (x) | 41 Ferritic or 42 Martensitic | | | 511 Cr (x) | 61 Bearing steels | |
| | 12 Weather-resistant steels according to 5.2.1.2.2 | 14 Si Mn spring and wear-resistant steels with $P_{min.}$, cast and $S_{min.}$, cast $> 0,035 \%$ (see 5.2.1.2.4) | 15 Magnetic sheet and strip (see 5.2.1.2.5) | 22 Weather-resistant steels other than indicated in field 12 | 32 Cr (x) | 43 Austenitic | | | 512 Ni (x) CrNi (x) | 52 High speed |
| | | 12 Weather-resistant steels according to 5.2.1.2.2 | | 33 CrMo (x) | 43 Austenitic | | | 513 Mo (x) CrMo (x) | | |
| | 12 Weather-resistant steels according to 5.2.1.2.2 | 15 Magnetic sheet and strip (see 5.2.1.2.5) | 15 Magnetic sheet and strip (see 5.2.1.2.5) | 34 CrNiMo (x) NiCrMo (x) | 43 Austenitic | | | 514 V (x) Cr V (x) | 516 Others | |
| | | | | 35 Ni (x) | 43 Austenitic | | | 515 W (x), Cr (x), CrW (x) | | |
| | 12 Weather-resistant steels according to 5.2.1.2.2 | 15 Magnetic sheet and strip (see 5.2.1.2.5) | 15 Magnetic sheet and strip (see 5.2.1.2.5) | 36 Others Mo (x), Si (x), etc. | 43 Austenitic | | | 521 Mo | 62 Physical steels | |
| | | | | 36 Others Mo (x), Si (x), etc. | 43 Austenitic | | | 522 W | | |
| | 12 Weather-resistant steels according to 5.2.1.2.2 | 15 Magnetic sheet and strip (see 5.2.1.2.5) | 15 Magnetic sheet and strip (see 5.2.1.2.5) | 36 Others Mo (x), Si (x), etc. | 43 Austenitic | | | 521 Mo | 62 Physical steels | |
| | | | | | 43 Austenitic | | | 522 W | | |
| | 12 Weather-resistant steels according to 5.2.1.2.2 | 15 Magnetic sheet and strip (see 5.2.1.2.5) | 15 Magnetic sheet and strip (see 5.2.1.2.5) | 36 Others Mo (x), Si (x), etc. | 43 Austenitic | | | 521 Mo | 62 Physical steels | |
| 43 Austenitic | | | | | 522 W | | | | | |
| 12 Weather-resistant steels according to 5.2.1.2.2 | 15 Magnetic sheet and strip (see 5.2.1.2.5) | 15 Magnetic sheet and strip (see 5.2.1.2.5) | 36 Others Mo (x), Si (x), etc. | 43 Austenitic | | | 521 Mo | 62 Physical steels | | |
| | | | | 43 Austenitic | | | 522 W | | | |
| 12 Weather-resistant steels according to 5.2.1.2.2 | 15 Magnetic sheet and strip (see 5.2.1.2.5) | 15 Magnetic sheet and strip (see 5.2.1.2.5) | 36 Others Mo (x), Si (x), etc. | 43 Austenitic | | | 521 Mo | 62 Physical steels | | |
| | | | | 43 Austenitic | | | 522 W | | | |

1) An (x) indicates that alloys with additional alloying elements should also, in so far as there are no special classes provided for them, be covered by the relevant class. Thus, Cr (x) in field 32 means, for example, that a CrV or a CrAlMo-structural steel should also be classified under group 32.

2) With a mean chromium content $\geq 10,8 \%$.