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Classification of steel based on chemical composition

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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.

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 documents 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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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 17, *[Steel]*.

This document cancels the first edition (ISO 4948-1:1982 and ISO 4948-2:1981).

Classification of steel based on chemical composition

1 Scope

This international standard provides guidance on the classification of the grades of steel included in the product standards of and addressed by TC17 and its subcommittees. These grades may include but are not limited to non-alloy and alloy steels.

The terms, special and quality steels are nowadays outdated. Nevertheless, they are used in standards and the market. And therefore they can be found in Annex A.

NOTE 1 This standard does not intend to give any commercial information including tariff, residual elements specification, and academic definitions for educational purposes.

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 database for use in standardization at the following addresses.

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

— IEC electropedia: available at http://www.electropedia.org/

4 Classification of steel

4.1 General

Classification is based on the cast (heat) analysis specified in the product standard, and is determined by the minimum value specified for each element. In the absence of a product standard, classification may be based on the actual cast (heat) analysis reported by the manufacturer.

Where for other than manganese (see NOTE[b)] of Table 1) a maximum value only is specified in the product standard or specification for the cast (heat) analysis, a value of 70 % of specified value shall be taken for classification. (see Examples 1 and 2).

Table 1 is applied for classification of non-alloy steels and alloy steels.

NOTE 1 The definition of steel is given in ISO 4885, clause 3.195.

NOTE 2 General issues for delivery requirements should be dealt in accordance with ISO 404.

NOTE 3 Unkess otherwise specified, unit of chemical composition is mass percentage.

4.2 Non-alloy steels

Non-alloy steels are those in which the percentage of each element is less than the limiting values specified in Table 1.

NOTE A small amount of alloying elements added to non-alloy steels may cause the product to be defined as a micro-alloy steels.

4.3 Alloy steels

NOTE Alloy steels may be divided conveniently into micro-alloy steels, low-alloy steels and high-alloy steels. The compositions limits are defined in the product standards.

4.3.1 Stainless steels

Steels that conforms to a specification that; requires, by mass percent, a minimum chromium content of 10,5 % or more, and a maximum carbon content of less than 1,20 %.

NOTE Stainless steels are classified into ferritic steels, martensitic steels, precipitation-hardening steels, austenitic steels, austenitic-ferritic (duplex) steels, creep-resisting steels and heat resisting steels according to their structure, composition and application.

4.3.2 Other alloy steels

Other alloy steels are those in which at least the percentage of one element is greater than or equal to the limiting value given in Table 1.

Table 1 — Boundaries between non-alloy and alloy steels

mass percentage

Element	Boundary
Al	0,30
B	0,0008
Bi	0,10
Cr	0,30
Co	0,30
Cu	0,40
Mn	1,65[b]
Mo	0,08
Ni	0,30
Nb	0,06
Pb	0,40
Se	0,10
Si	0,60 (for wrought [a])
	1,00 (for cast [a])
Te	0,10
Ti	0,05
W	0,30
V	0,10
Zr	0,05
Lanthanoide (each)	0,10

[a] Wrought steel products are products that have been subject to deformation by rolling, drawing, forging, extrusion or some other deformation or working process. Wrought products may include, bar, billet, strip, tube or wire. Cast products are products that have not been subject to deformation; for example;: ingot, continuous casting or a shaped casting".

[b] If only a maximum is specified for the manganese content, the boundary shall be at 1,80 %.

[c] Any other elements other than those listed in this Table except C, P, S and N.

Table 1 *(continued)*

Element	Boundary
Others excluding (C, P, S, N) [c]	0,10
[a] Wrought steel products are products that have been subject to deformation by rolling, drawing, forging, extrusion or some other deformation or working process. Wrought products may include, bar, billet, strip, tube or wire. Cast products are products that have not been subject to deformation; for example,: ingot, continuous casting or a shaped casting". [b] If only a maximum is specified for the manganese content, the boundary shall be at 1,80 %. [c] Any other elements other than those listed in this Table except C, P, S and N.	

NOTE According to the EU or other regulations, more than 0,05 % Pb is forbidden. There are exemption lists.

In the following examples, a specified value for chromium is used in order to illustrate the requirement of Section 3.1 of this standard. The same requirements are applied to all other elements.

EXAMPLE 1 When a minimum value of 0,30 % for chromium is specified, the steel is classified as alloy steel, regardless of the fact whether there is also a specified maximum value for the steel or not, because this specified minimum value of 0,30 % is not less than the boundary value of 0,30 % given in Table 1.

EXAMPLE 2 When only a maximum value of chromium of 0,35 % is specified, the steel is classified as non-alloy steel, because 70 % of the specified maximum value of 0,35 % is less than the boundary value of 0,30% given in Table 1.

Annex A
(informative)

Definition and classification of steel grades according to quality and special steels

A.1 Non-alloy quality steels

A.1.1 General description

Non-alloy quality steels are steel grades for which generally property requirements such as toughness, grain size control and/or formability are specified.

A.1.1.1 Definition

Non-alloy quality steels are non-alloy steels other than those defined in A.2.1.2 as non-alloy special steels. Non-alloy electrical steels are defined as: non-alloy quality steels with specified requirements for maximum values of specific total loss or minimum values of magnetic induction, polarization or permeability.

A.1.2 Alloy quality steels

A.1.2.1 General description

Alloy quality steels are steel grades for which requirements exist with regard to, for example, toughness, grain size control and/or formability.

Alloy quality steels are not generally intended for quenching and tempering or for surface hardening.

A.1.2.2 Definition

Alloy quality steels are those listed in A.1.2.2.1 to A.1.2.2.5.

A.1.2.2.1 Weldable fine-grained structural steels, including steels for pressure vessels and tubes, other than those defined in A.1.2.2.3, which meet all of the following conditions:

— specified minimum yield strength: < 380 N/mm^2 for thicknesses ≤ 16 mm;

— alloying contents are less than the limiting values given in Table A.1;

— specified minimum impact strength on Charpy-V-notch test pieces at -50°C: ≤ 27 J for test pieces taken in the longitudinal direction or ≤ 16 J for test pieces taken in the transverse direction. If no impact value at -50 °C is specified, then a value specified for temperatures between -50 °C and -60 °C shall be used.

Table A.1 — Weldable fine grained alloy steels - Chemical composition boundary between quality steels and special steels

mass percentage

Specified element		Limiting value
Cr	Chromium	0,50
Cu	Copper	0,50

Table A.1 *(continued)*

Specified element		Limiting value
Mn	Manganese	1,80
Mo	Molybdenum	0,10
Nb	Niobium	0,08
Ni	Nickel	0,50
Ti	Titanium	0,12
V	Vanadium	0,12
Zr	Zirconium	0,12

A.1.2.2.2 Alloy steels for rails, sheet piling and mining frames.

A.1.2.2.3 Alloy steels for hot and cold rolled flat products in severe cold forming applications[1)], containing grain-refining elements such as boron, niobium, titanium, vanadium and/or zirconium, or "dual phase" steels[2)].

A.1.2.2.4 Alloy steels in which copper is the only specified alloy element.

A.1.2.2.5 Alloy electrical steels are steels mainly containing silicon or silicon and aluminium as alloying elements to meet specified requirements for maximum values of specific total loss or minimum values of magnetic induction, polarization or permeability.

A.2 Special steels

A.2.1 Non-alloy special steels

A.2.1.1 General description

Non-alloy special steels have a higher degree of cleanness than quality steels particularly in respect of non-metallic inclusions. In most cases, they are intended for quenching and tempering or surface hardening and are characterized by consistent response to such treatment. Precise control of chemical composition and special care in manufacture and process control ensure improved properties to meet exacting requirements. These properties, which are generally in combination and within closely controlled limits, include a high or closely controlled yield strength or hardenability values sometimes associated with suitability for cold forming, welding or toughness.

A.2.1.2 Definition

Non-alloy special steels are steel grades which comply with one or more of the following requirements:

— specified minimum impact strength in the quenched and tempered condition;

— specified hardness penetration depth or surface hardness in the quenched, quenched and tempered or surface-hardened conditions;

— particularly low contents of non-metallic inclusions are specified;

NOTE This class includes grades where the product standard or specification specifies such limitations of inclusions subject to agreement at the time of ordering. However, specified through thickness reduction or area properties do not change the classification of the original steel.

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1) Does not include steels for pressure vessels or tubes.

2) "Dual phase" steels have a microstructure which is essentially ferritic, with about 10 % to 35 % of martensite in small isolated areas uniformly dispersed throughout.