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Gas cylinders — Gas properties and associated classification (FTSC) codes

Bouteilles à gaz — Propriétés des gaz et codes de classification associés (FTSC)

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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 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 meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword — Supplementary information.

The committee responsible for this document is ISO/TC 58, *Gas cylinders*, SC 2, *Cylinder fittings*.

Introduction

This International Standard establishes a method of allocating a four-digit code number (FTSC) to any gas, liquids that are transported under pressure or mixture of gases contained in cylinders. This code number categorizes the gas, liquids that are transported under pressure or gas mixture in terms of its physical-chemical properties and/or flammability, toxicity, state of the gas, and corrosiveness (see 4.1). FTSC is the abbreviation of these properties.

The FTSC code enables a gas, liquids that are transported under pressure or gas mixture to be assigned to one of the 15 “compatible” gas groups.

The FTSC codes and the method for their determination are currently given in ISO 5145:2014, Annex A for use in the selection of valve outlets. This annex from ISO 5145 will be removed when the present standard is published.

The properties and the selection criteria are aligned as appropriate with the Globally Harmonized System for the Classification and Labelling of Chemicals (GHS).

Gas cylinders — Gas properties and associated classification (FTSC) codes

1 Scope

This International Standard gives a list of FTSC (fire potential, i.e. "oxidizing potential and flammability", toxicity, state of the gas, and corrosiveness) codes determined according to the relevant properties of gases and of some liquids that are transported under pressure.

It does not cover gas material compatibility which is covered by ISO 11114 (all parts).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10156, *Gases and gas mixtures — Determination of fire potential and oxidizing ability for the selection of cylinder valve outlets*

ISO 10298, *Determination of toxicity of a gas or gas mixture*

ISO 10286:2015, *Gas cylinders — Terminology*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
gas mixture
combination of different single gases deliberately mixed in specified proportions

[SOURCE: ISO 10286:2015, definition 704]

3.2
liquefied gas
gas, which, when packaged for transport, is partially liquid (or solid) at temperature above −50 °C

[SOURCE: ISO 10286:2015, definition 706]

3.3
compressed gas
gas, which, when packaged under pressure for transport, is entirely gaseous at −50 °C

Note 1 to entry: This category includes all gases with a critical temperature less than or equal to −50 °C.

[SOURCE: ISO 10286:2015, definition 705]

3.4
lethal concentration 50
LC_{50}
concentration of a gas (or a gas mixture) in air administered by a single exposure during a short period of time (24 h or less) to a group of young adult albino rats (males and females) which leads to the death of half of the animals in at least 14 d

[SOURCE: ISO 10298:2010, definition 2.1]

4 Gas properties

4.1 Numerical gas code (FTSC)

4.1.1 General

The code number assigned to a gas or liquid is based on the following four physical-chemical properties:

a) Category I (F): fire potential, defining the gas behaviour with respect to combustion;

b) Category II (T): acute toxicity;

c) Category III (S): gas state, defining the physical state of the fluid in the cylinder at 15 °C within a given pressure range;

d) Category IV (C): corrosiveness (ability to damage or destroy living tissues: eyes, skin, and mucous membranes).

Each category is subdivided into different characteristics (subdivisions), each identified by a different digit. In this way, a gas in a given state is characterized by a series of four digits (one digit per category) as illustrated below.

4.1.2 Fire potential, category I

Subdivision 0: inert (any gas not classified under subdivisions 1 to 5 below);

Subdivision 1: supports combustion (gas having an oxidizing power equal to or less than a mixture containing 23,5 % of oxygen in nitrogen);

Subdivision 2: flammable (gas having flammability limits in air);

NOTE 1 See ISO 10156 for more information.

Subdivision 3: pyrophoric (spontaneously flammable);

Subdivision 4: oxidizing (gas having an oxidizing power greater than a mixture containing 23,5 % O_2 in N_2);

NOTE 2 See ISO 10156 for more information.

Subdivision 5: chemically unstable (flammable and subject to rapid decomposition or polymerization).

NOTE 3 When considering the properties of gases from subdivisions 1 and 4, the following applies:

a) Subdivision 4 considers the risk of accelerating combustion more than air does;

b) For gas material compatibility with gases under pressure of subdivisions 1 and 4, it is considered that the risk of ignition exists when the oxygen partial pressure is more than 30 bar;

c) For valves outlet selection (for example, see ISO 5145), the risk is to mix a flammable gas (subdivision 2 and/or 3) with a gas of subdivision 1 and/or 4.

4.1.3 Acute toxicity, category II

Subdivision 0: supporting human life;

Subdivision 1: non-toxic $LC_{50\ rat\ 1h}$ > 0,5 % by volume (5 000 ppm);

Subdivision 2: toxic; 0,02 % by volume (200 ppm) < $LC_{50\ rat\ 1h}$ ≤ 0,5 % by volume (5 000 ppm);

Subdivision 3: very toxic $LC_{50\ rat\ 1h}$ < 0,02 % by volume (200 ppm).

NOTE See ISO 10298 for more information.

4.1.4 State of the gas (in the cylinder at 15 °C), category III

All pressures for compressed gases are working pressures according to the definition given in ISO 10286.

For liquefied gases, this is the developed pressure at 65 °C (normally equal to the cylinder test pressure).

Subdivision 0: liquefied gas of 35 bar or less;

Subdivision 1: liquefied gas at a pressure greater than 35 bar;

Subdivision 2: liquid withdrawal – liquefied gas (optional);

Subdivision 3: dissolved gas;

Subdivision 4: gas phase withdrawal at 35 bar or less;

Subdivision 5: compressed gas between 35 bar and 250 bar (Europe);

Subdivision 6: compressed gas between 35 bar and 207 bar (North America);

Subdivision 7: compressed gas above 207 bar (North America) or 250 bar (Europe).

NOTE 1 Subdivisions 5 and 6 have been adopted as a result of a compromise between the European and the North American approach. The European preference for a limit of 250 bar reflects the current tendency towards higher pressure applications. The current North American practice requires a limit of 207 bar for which their pressure reducing valves are designed. This is the working pressure at the referenced temperature of 15 °C. Therefore, three pressure classes have been retained. Other jurisdictions might use different values.

Either subdivision 5 or subdivision 6 shall be used, never both. The selection of either subdivision will determine the applicable pressure for subdivision 7.

Subdivision 5 or 6: medium pressure range, each user being required to select one subdivision exclusively to determine the upper limit of the medium pressure range (i.e. 182 bar or 250 bar).

Subdivision 7: high pressure range, the lower limit (182 bar or 250 bar) of which depends on the subdivision selected for the medium pressure range.

After the introduction of subdivisions 5, 6, and 7, a number of pressure ranges have been (or are being) established to make the selection of the proper cylinder valve outlet connection (e.g. 500 bar, 800 bar, sub atmospheric pressure. These ranges have been chosen to protect downstream regulators and other ancillary equipment from over-pressurized conditions. Consequently, for the tables in 5.3, the third digit (S) used for all compressed gases is “5” to indicate that this is a compressed gas.

NOTE 2 Subdivisions 8 and 9 have been allocated for liquid withdrawal cylinders of cryogenic gases in the USA.

4.1.5 Corrosiveness, category IV

Subdivision 0: non-corrosive;

Subdivision 1: non-halogen acid forming;

Subdivision 2: basic;

Subdivision 3: halogen acid forming.

NOTE See ISO 13338 for more information.

5 List of gases and liquids with the corresponding FTSC codes

5.1 Basic principles and single gases

The FTSC code enables the assignment of any gas (including gas mixtures) or any liquid to be packaged under pressure one of the 15 "compatible" gas groups listed in the table below.

NOTE Attention is drawn to the fact that the only purpose of the numerical code is to group compatible gases together in order that particular valve outlets might be assigned to each group. Use of the code is limited only to the assignment of valve outlets.

Table 1 — Characteristics of groups

Group	Characteristics
1	Non-flammable, non-toxic gases and qualifying gas mixtures, less stable thermally than group 3
2[b]	Carbon dioxide
3	Non-flammable, non-toxic, and thermally stable gases (except carbon dioxide) and qualifying gas mixtures
4	Non-flammable, toxic, and corrosive (or corrosive by hydrolysis) gases and qualifying gas mixtures
5[b]	Air
6	Flammable and non-toxic gases and qualifying gas mixtures
7	Flammable, toxic, and corrosive (basic) gases and qualifying gas mixtures
8	Flammable, toxic, and corrosive (acidic) or non-corrosive gases and qualifying gas mixtures
9	Spontaneously flammable gases and qualifying gas mixtures
10[b]	Oxygen[a]
11[b]	Nitrous oxide
12	Oxidant, toxic, and/or corrosive gases and qualifying gas mixtures
13	Flammable gases and qualifying gas mixtures subject to decomposition or polymerization
14[b]	Acetylene
15	Oxidant, non-toxic, and non-corrosive gas mixtures

[a] In ISO 5145, characteristics of group 10 is "oxygen and high pressure oxidant". Terms and "high pressure oxidant" will be removed during the next revision of ISO 5145.

[b] Groups 2, 5, 10, 11, and 14 only contain one single gas and are assigned to individual named gases from which mixtures and other gases are excluded.

5.2 Assignment of a gas mixture to a group

For the purposes of this International Standard, a gas mixture is defined as an intentional combination of two or more gases, which might be either in the gaseous phase or liquefied under pressure when in a gas cylinder.

NOTE This International Standard does not attempt to identify gas mixtures which can be safely and satisfactorily prepared; this is the responsibility of the gas manufacturer. It does not describe any methods or techniques for preparing gas mixtures.

The principle of allocation of a four-digit numerical code (FTSC) to gas mixtures is the same as that for single gases. The allocation of the FTSC code to a gas mixture, which allows the assignment of this mixture to one of the group of gases and gas mixtures (see Table 1), depends on the flammability, oxidizing ability,

toxicity, and corrosiveness of the final mixture. The determination of flammability and oxidizing ability is given in ISO 10156, that of toxicity in ISO 10298, and that for corrosiveness in ISO 13338.

Mixtures containing spontaneously flammable gases (i.e. pyrophoric gases such as silane in Table 10) shall be considered as spontaneously flammable gas mixtures if the content of the pyrophoric gas(es) is more than 1 % (by volume).

NOTE Tables 2 to 15 are based on, but have been expanded, from ISO 5145. These tables will be removed when this International Standard has been published and ISO 5145 will be revised.

Table 16 gives the complete list of gases in alphabetical order.

5.3 Tables of compatible groups of gases and liquids

Table 2 — Gases and gas/liquid mixtures belonging to group 1 (non-flammable, non-toxic gases and gas mixtures, less stable thermally than group 3)

Gas	FTSC code	Synonym	CAS Number
Bromochlorodifluoromethane	0100	R12B 1	353–59–3
Bromochloromethane[a]	0100	Halon 1011	74–97–5
Bromotrifluoromethane	0100	Trifluorobromomethane R13B1	75–63–8
Chlorodifluoromethane	0100	Monochlorodifluoromethane R22	75–46–6
Chlorodifluoromethane and Chloropentafluoroethane	0100	R502	azeotropic mixture
Chloroheptafluorocyclobutane[a]	0100	C317	377–41–3
Chloropentafluoroethane	0100	Monochloropentafluoroethane R115	76–15–3
1-Chloro-1,2,2,2-tetrafluoroethane	0100	R124	28–37–89–0
1-Chloro-2,2,2-trifluoroethane	0100	R 133a	75–88–7
Chlorotrifluoromethane	0100	Monochlorotrifluoromethane R1 3	75–72–9
Chlorotrifluoromethane and Trifluoromethane	0100	R503	azeotropic mixture
1, 2-Dibromotetrafluoroethane[a]	0100	R114B2	174–73–2
1, 2-Dichlorodifluoroethylene	0100	R1112a	79–35–6
Dichlorodifluoromethane	0100	R12	75–71–8
Dichlorodifluoromethane and 1,1-Difluoroethane	0100	R500	azeotropic mixture
Dichlorofluoromethane	0100	R21	75–43–4
1,2-Dichlorohexafluorocyclobutane[a]	0100	C316	356–18–3
1,1-Dichlorotetrafluoroethane	0100	R1 14a	374–07–2
1,2-Dichlorotetrafluoroethane	0100	R 114	76–14–2
2,2-Dichloro-1,1,1–trifluoro ethane[a]	0100	R 123	306–83–2
Difluoromethane, Pentafluoroethane, and 1,1,1,2-Tetrafluoroethane	0100	R407A, R407B, R407C	zeotropic mixture
Heptafluoropropane	0100	R227	431–89–0
Hexafluoroethane	0100	Perfluoroethane R1 16	76–16–4
Hexafluoropropylene	0100	Hexafluoropropene R 1216	116–15–4

[a] Some products, being liquid at normal ambient conditions, are included since they might be supplied in non-pressurized containers. They are included in this grouping because valve outlets are necessary when these products are supplied together with a propellant in a pressurized container.