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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)

FDIS stage

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: + 41 22 749 01 11
~~Email~~E-mail: copyright@iso.org
Website: ~~www.iso.org~~www.iso.org

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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 document 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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This document was prepared by Technical Committee ISO/TC 58, *Gas cylinders*, Subcommittee SC 2, *Cylinder fittings*~~.~~, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 23, *Transportable gas cylinders*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 14456:2015), which has been technically revised. It also incorporates the Amendment ISO 14456:2015/Amd 1:2019.

The main changes are as follows:

— ~~—~~corrections to CAS numbers and FTSC codes;

— ~~—~~consequential revisions as a result of a new edition of ISO 5145;

— ~~—~~addition of new FTSC codes for commonly used gases and liquids.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at ~~www.iso.org/members.html~~www.iso.org/members.html.

Introduction

This document establishes a method of allocating a four-digit code number (FTSC) to any gases and 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).4.1). FTSC is the abbreviation of these properties.

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

The properties and the selection criteria are aligned as appropriate with the Globally Harmonized System of Classification and Labelling of Chemicals (GHS).).[11]

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

1 Scope

This document gives a list of FTSC (fire potential, i.e. "oxidizing power 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 material compatibility with gases which is covered by the ISO 11114 series.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

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

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

— IEC Electropedia: available at https://www.electropedia.org/

3.1
gas mixture
combination of different single gases and/or liquids deliberately mixed in specified proportions resulting in a homogeneous gaseous mixture.

[SOURCE: ISO 10286:2021, 3.5.2, modified]

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

[SOURCE: ISO 10286:2021, 3.5.4]

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 10286:2021, 3.5.3]

3.4
lethal concentration 50
LC_{50}
concentration of a substance in air exposure to which, for a specified length of time, it is expected to cause the death of 50 % of the entire defined experimental animal population after a defined time period

Note 1 to entry: Lethal concentration is usually measured as ppm (volume fraction) or mg/m^3.

[SOURCE: ISO 10298:2018, 3.1, modified — Note 1 to entry has been added.]

4 Gas properties

54 - Numerical gas code (FTSC)

5.14.1 General

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

a) a) Categorycategory I (F): fire potential, i.e. “oxidizing power and flammability”, which defines the gas behaviour with respect to combustion;

b) b) Categorycategory II (T): acute toxicity;

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

d) d) Categorycategory IV (C): corrosiveness (ability to damage or destroy living tissues: eyes, skin and mucous membranes, or the potential for an acid/base chemical reaction).

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 in subclauses 4.1.2 to 4.1.5.

Annex AAnnex A includes examples of how FTSC codes are rationalized for new entries to this document.

~~5.2~~4.2 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) ~~a)~~ subdivision 4 considers the risk of accelerating combustion more than air does;

b) ~~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[1];

c) ~~c)~~ for valve 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.

~~5.3~~4.3 Acute toxicity, category II

Subdivision 0: supporting human life.

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

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

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

NOTE See ISO 10298 for more information. For LC_{50} values, see ISO 10298:2018, Table B.1.

~~5.4~~4.4 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.

[1] 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.

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 and up to 350 bar (North America) or above 250 bar up to 350 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 can 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.

Subdivision 7: high pressure range, the lower limit 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 ~~Table 2~~Table 2 to ~~Table 16,~~Table 16, 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 US.

~~5.5~~4.5 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. For corrosiveness subdivisions, see ISO 13338:2022, Table 1.

~~6~~5 List of gases and liquids with the corresponding FTSC codes

~~6.1~~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 to one of the 15 "compatible" gas groups listed in the table below.

NOTE The only purpose of the numerical code is to group compatible gases together in order that particular valve outlets can 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

Group	Characteristics
2[a]	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[a]	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[a]	Oxygen
11[a]	Nitrous oxide
12	Oxidizing, toxic, and/or corrosive gases and qualifying gas mixtures
13	Flammable gases and qualifying gas mixtures subject to decomposition or polymerization
14[a]	Acetylene
15	Oxidizing, non-toxic, and non-corrosive gas mixtures
[a] 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.	

~~6.2~~5.2 Assignment of a gas mixture to a group

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

NOTE This document 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),~~Table 1), depends on the flammability, oxidizing power, toxicity and corrosiveness of the final mixture. The determination of flammability and oxidizing power 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)~~Table 10) shall be considered as spontaneously flammable gas mixtures if the content of the pyrophoric gas(es) is more than 1 % (by volume).

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

~~6.3~~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 Registry Number®[~~2~~b]
Bromochlorodifluoromethane	0100	R12B1	353–59–3
Bromochloromethane[a]	0100	Halon, 1011	74–97–5
Bromotrifluoromethane	0100	Trifluorobromomethane, R13B1	75–63–8
Chlorodifluoromethane	0100	Monochlorodifluoromethane, R22	75–45–6
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	2837–89–0
1-Chloro-2,2,2-trifluoroethane	0100	R133a	75–88–7
Chlorotrifluoromethane	0100	Monochlorotrifluoromethane, R13	75–72–9
Chlorotrifluoromethane and Trifluoromethane	0100	R503	zeotropic mixture
1,2 - dibromo-1,1-difluoroethane[a]	0100		75-82-1
1, 2-Dibromotetrafluoroethane[a]	0100	R114B2	124–73–2
1, 2-Dichlorodifluoroethylene	0100	R1112a	79–35–6
Dichlorodifluoromethane	0100	R12	75–71–8
Dichlorodifluoromethane and 1,1-Difluoroethane	0100	R500	zeotropic mixture
Dichlorofluoromethane	0100	R21	75–43–4
1,2-Dichlorohexafluorocyclobutane[a]	0100	C316	356–18–3
1,1-Dichlorotetrafluoroethane	0100	R114a	374–07–2
1,2-Dichlorotetrafluoroethane	0100	R114	76–14–2
2,2-Dichloro-1,1,1–trifluoroethane[a]	0100	R123	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, R116	76–16–4
Hexafluoropropylene	0100	Hexafluoropropene, R1216	116–15–4
Methylene bromide[a]	0100	Dibromomethane	74-95-3
Octafluorobut-2-ene	0100	R1318	360–89–4
Octafluorocyclobutane	0100	Perfluorocyclobutane, RC318	115–25–3

~~[2] Chemical Abstracts Service (CAS) Registry Number® is a trademark of the American Chemical Society (ACS). This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.~~

Gas	FTSC code	Synonym	CAS Registry Number®~~2~~[b]
Octafluoropropane	0100	Perfluoropropane, R218	76–19–7
Pentachlorofluoroethane[a]	0100		29756–45–4
Pentafluoroethane	0100	R125	354–33–6
Pentafluoroethane, 1,1,1-Trifluoroethane, and 1,1,1,2-Tetrafluoroethane	0100	R404A	zeotropic mixture
Pentafluoroethyliodide[a]	0100		354–64–3
Perfluorobutane	0100	R610	355–25–9
Sulfur hexafluoride	0100		2551–62–4
1,1,1,2-Tetrachlorodifluoroethane (solid)	0100	R112a	76–11–9
1,1,2,2-Tetrachlorodifluoroethane[a]	0100	R112	76–12–0
Tetrachloromethane[a]	0100	Carbon tetrachloride	56-23-5
1,1,2,2-Tetrafluoro-1-chloroethane	0100	R124a	354–25–6
1,1,1,2-Tetrafluoroethane	0100	R134a	811–97–2
1,1,2-Trichloroethene [a]	0100	Trichloroethylene	79-01-6
Trichlorofluoromethane[a]	0100	Trichloromonofluoromethane, R11	75–69–4
1,1,1-Trichlorotrifluoroethane[a]	0100	R113a	354–58–5
1,1,2-Trichlorotrifluoroethane[a]	0100	R113	76–13–1
Trifluoromethane	0100	Fluoroform, R23	75–46–7

[a] Some products, being liquid at normal ambient conditions, are included since they can 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.

[b] Chemical Abstracts Service (CAS) Registry Number® is a trademark of the American Chemical Society (ACS). This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

Table 3 — Gases belonging to group 2 (carbon dioxide)

Gas	FTSC code	Synonym	CAS Number
Carbon dioxide	0110	Carbonic acid anhydride, R744	124–38–9

Table 4 — Gases and gas mixtures belonging to group 3 (non-flammable, non-toxic, and thermally stable gases and gas mixtures)

Gas	FTSC code	Synonym	CAS Number
Argon	0150		7440–37–1
Helium	0150		7440–59–7
Krypton	0150		7439–90–9

Gas	FTSC code	Synonym	CAS Number
Neon	0150		7440–01–9
Nitrogen	0150		7727–37–9
Xenon	0110[a]		7440–63–3
Tetrafluoromethane	0150	Carbon tetrafluoride, R14	75–73–0
[a] FTSC code due to the gas having a critical temperature above 15 °C.			

Table 5 — Gases and gas mixtures belonging to group 4 (non-flammable, toxic, and corrosive (or corrosive by hydrolysis) gases and gas mixtures)

Gas	FTSC code[c]	Synonym	CAS Number
Antimony pentafluoride[a]	0303		7783–70–2
Arsenic pentafluoride	0303		7784-36-3
Boron trichloride	0203	Boron chloride	10294–34–5
Boron trifluoride	0253	Boron fluoride	7637–07–2
Bromoacetone[a]	(0303)-**2203**[b]		598–31–2
Bromodifluoromethane	0100	R22B1	1511-62-2
Carbonyl fluoride	0213	Fluorophosgene	353–50–4
Cyanogen chloride	0303		506–77–4
Deuterium chloride	0213		7698–05–7
Deuterium fluoride	0203		14333–26–7
Dibromodifluoromethane[a]	0100	R12B2	75–61–6
Dichloro-2-chlorovinyl arsine[a]	0303	Lewisite	541–25–3
Diphosgene[a]	0303		503–38–8
Ethyldichloroarsine[a]	0303		598–14–1
Germanium tetrachloride[a]	0203	Germanium chloride	10038-98-9
Germanium tetrafluoride	0203	Germanium fluoride	7783-58-6
Hexafluoroacetone	0203	1,1,1,3,3,3,-hexafluoro-2-propanone	684–16–2
Hydrogen bromide	0203	Hydrobromic acid (anhydrous)	10035–10–6
Hydrogen chloride	0213	Hydrochloric acid (anhydrous)	7647–01–0
Hydrogen fluoride[a]	0203	Hydrofluoric acid (anhydrous)	7664–39–3
Hydrogen iodide	0203	Hydroiodic acid (anhydrous)	10034–85–2
Iodotrifluoromethane	(0200)-**0100**[b]	Trifluoromethyl iodide	2314–97–8