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Cylinder valve outlets for gases and gas mixtures — Selection and dimensioning

Raccords de sortie de robinets de bouteilles à gaz et mélanges de gaz — Choix et dimensionnement

Reference number
ISO 5145:2014(E)

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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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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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*, Subcommittee SC 2, *Cylinder fittings*.

It also incorporates the Amendments ISO 5145:2004/Amd1:2006 and ISO 5145:2004/Amd1:2008. This third edition cancels and replaces the second edition (ISO 5145:2004), of which it constitutes a minor revision with the following changes:

— tolerances have been added.

Introduction

At the beginning of the 1960s, the members of ISO/TC 58/SC 2 were charged with the task of drafting an International Standard on gas cylinder valve outlets.

It soon became obvious that millions of different types of valve outlets are in use and the various countries concerned were not ready to give up their own systems. It was, therefore, only possible to draw up a list of the existing provisions, either standardized or in use, which was published as Technical Report ISO/TR 7470. The number and variety of such provisions give an idea of the complexity and scope of the task entrusted to ISO/TC 58/SC 2.

Towards the end of the 1970s, ISO/TC 58/SC 2 realized that the task at hand could only be achieved by adopting a long-term solution; this was to create an ideal system of valve outlets which would not be interchangeable with the existing systems. This system would be based on the four fundamental criteria of safety, simplicity, compactness, and tightness.

Two key actions were then undertaken in parallel:

— a classification and grouping of gases and gas mixtures;

— a practical definition of an original and non-interchangeable connection system.

ISO 5145 represents a synthesis of these two actions. It is a practical guide for the selection of cylinder valve outlets for gases and gas mixtures. In view of the fact that no country seemed ready to give up their national standards and to adopt an International Standard specifying the dimensions of gas cylinder valve outlets, it was agreed that this International Standard need not be complied with where a national standard predates it.

ISO 5145 presents a logical system for determining valve outlets for gas cylinders for all gases or gas mixtures. It is of special interest for those countries that have no national standards or regulations. Its provisions can be called for in the future in cases where a new gas or gas mixture is developed industrially.

The main purpose in standardizing valve outlets is to prevent the interconnection of non-compatible gases. The user is cautioned to ensure that a particular outlet connection when used is compatible with any other connections or gases that might be connected to that outlet. Because of the multiplicity of connections in use and the existence of many national standards, this concern cannot be overstated.

ISO 5145 thus represents a basis for international agreement in the more or less remote future.

The purpose of this International Standard is to fix some editorial mistakes and to incorporate into the main text ISO 5145:2004/Amd1:2006 and ISO 5145:2004/Amd1:2008. Annexes A, B, and C form an integral part of this International Standard.

Cylinder valve outlets for gases and gas mixtures — Selection and dimensioning

1 Scope

This International Standard establishes practical criteria for determining valve outlet connections for gas cylinders.

It applies to the selection of gas cylinder valve outlet connections and specifies the dimensions for a number of them.

This International Standard does not apply to connections used for cryogenic gas withdrawal or gases for breathing equipment, which are the subjects of other International Standards.

NOTE Other safeguard provisions like labelling or colour coding are not affected by this International Standard.

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 10286, *Gas cylinders — Terminology*

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

ISO 13338, *Determination of tissue corrosiveness of a gas or gas mixture*

3 Principle of the determination of valve outlets

3.1 Basic principle

This International Standard establishes a method of allocating to any gas or mixture of gases contained in cylinders four-digit codes numbers (FTSC). This code number categorizes the gas or gas mixture in terms of its physical-chemical properties and/or Flammability, Toxicity, State of the gas, and Corrosiveness (see A.1). FTSC is the abbreviation of these properties.

The FTSC code enables a gas or gas mixture to be assigned to one of the 15 "compatible" gas groups (see A.2). Valve outlet connections are allocated to each group (see Clause 5).

NOTE Attention is drawn to the fact that the only purpose of the numerical code is to group compatible gases together in order that the particular valve outlet assigned to each group can be selected. The code is only applicable for the valve outlet selection used in this International Standard and is not intended as an identification code.

3.2 Single gases

Pure gases are assigned to one of the first 14 gas groups, group 15 being reserved for specific gas mixtures. It is recognized that a "pure gas" can contain some impurities, but it is intended that this should not affect the valve outlet selection.

Five of these groups only contain one single gas and are assigned to individual named gases from which mixtures and other gases are excluded. These five groups are as follows:

a) group 2 - carbon dioxide;

b) group 5 - air;

c) group 10 - oxygen;

d) group 11 - nitrous oxide;

e) group 14 - acetylene.

3.3 Gas mixtures

3.3.1 Definition

For the purposes of this International standard, 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 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.

3.3.2 Assignment of a gas mixture to a group

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 A.1), depends on the flammability, oxidizing ability, toxicity, and corrosiveness of the final mixture. For the determination of flammability and oxidizing ability, use ISO 10156, for toxicity, use ISO 10298, and for corrosiveness, use ISO 13338.

Mixtures containing spontaneously flammable gases (i.e. pyrophoric gases such as silane on Table A.10) shall be considered as spontaneously flammable gas mixtures if the content of the pyrophoric gas(es) is more than 1,4 %.

4 Determination of connection

4.1 Connection

A connection is a mechanical device which conveys gas via a gas cylinder valve to a filling or use system without leakage to the atmosphere. It shall be robust and able to withstand repeated connection and disconnection. It shall be designed such that it can only be used for the group of gases to which it is allocated.

A connection comprises a minimum of three parts (see Figure 1):

a) a valve outlet - the part of the cylinder valve through which gas is discharged;

b) a connector - the part of the filling or use system through which the gas is conveyed;

c) a union nut - the means by which the connector is secured to the valve outlet and by which the seal is ensured.

The design of the double-recess type of connection is derived from the “step index principle”.

The step index system comprises a double recess (faucet) into the valve outlet, into which a spigot of two different diameters is designed to fit (see the figure in Table 1). The lengths of the recesses and spigots are the same for each connection but the diameters vary depending on the group of gases for which the recess or spigot is designed. The form, dimensions, and tolerances are illustrated in Table 1, which provides for 42 non-interchangeable connections.

Three nominal diameters (24 mm, 27 mm, and 30 mm) have been adopted for the connections (see Annex B). The thread is a Whitworth thread with a pitch of 2 mm (see Figure 2).

NOTE Internal “double-recess step index connections” are not used because of their excessive size.

The dimensions in Figure 2 shall be toleranced according to the general principles for thread dimensioning. The tolerances shall be chosen from applicable national standards, or if they do not exist, use the example provided in Figure 2. Bilateral tolerancing systems, such as those in ISO 2768, shall not be used.

4.2 Leak tightness

Leak tightness is achieved by sealing the end of the connector bearing on the conical part of the valve outlet connection. This seal is maintained by the union nut (see Annex B).

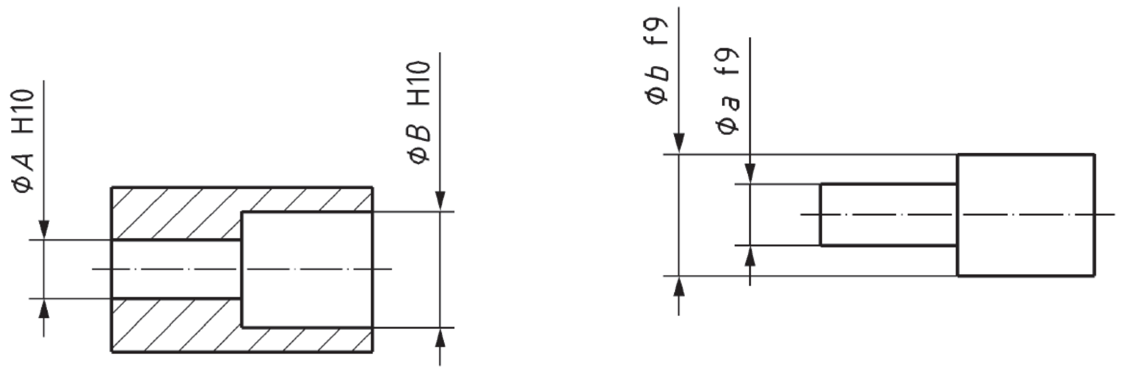
Other methods of sealing can be adopted provided the non-interchangeability between connector types is maintained.

No details of the external dimensions of the union nut are given since this will be subject to the method adopted for applying the sealing force (e.g. with a wrench or by hand).

This International Standard does not specify the choice of materials; however, it is necessary to employ materials for the O-ring, valve, and valve connector which are compatible with the gas content in the cylinder and the service for which they are intended.

Table 1 — Non-interchangeable combinations *A* + *B*

Dimensions in millimetres

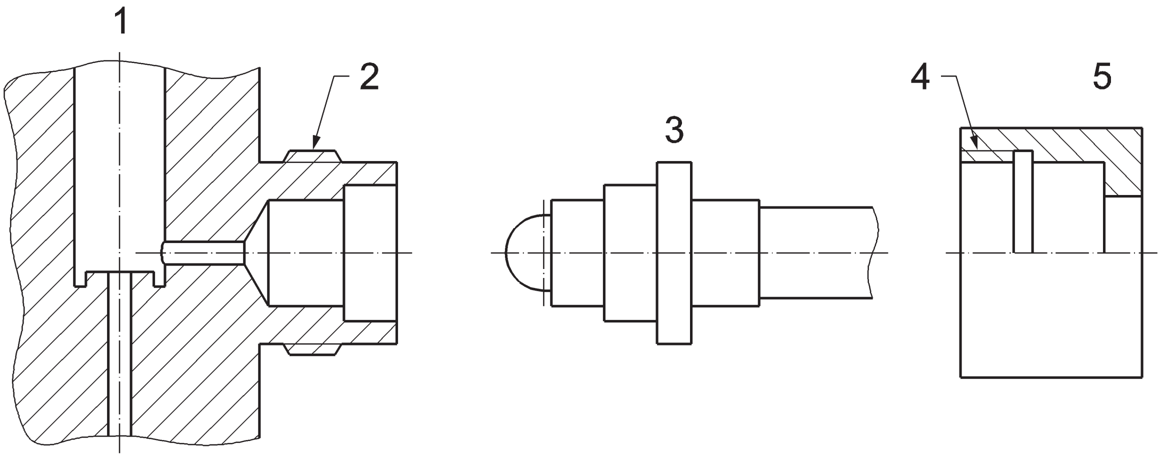


Female

Male

Nominal diameter of the connection = nominal thread diameter *D*, *d*	Constant *A* + *B*						Available combinations		
	28		32		36				
	A	*B*	*A*	*B*	*A*	*B*	Right-hand thread	Left-hand thread	Total of right- and left-hand threads
24	11,2 11,9 12,6 13,3 14	16,8 16,1 15,4 14,7 14	-	-	-	-	5	5	10
27	-	-	11,8 12,5 13,2 13,9 14,6 15,3 16	20,2 19,5 18,8 18,1 17,4 16,7 16	-	-	7	7	14
30	-	-	-	-	12,4 13,1 13,8 14,5 15,2 15,9 16,6 17,3 18	23,6 22,9 22,2 21,5 20,8 20,1 19,4 18,7 18	9	9	18
Total number of combinations							21	21	42

NOTE For the tolerances, see ISO 286-1 and ISO 286-2.



Key

1 valve

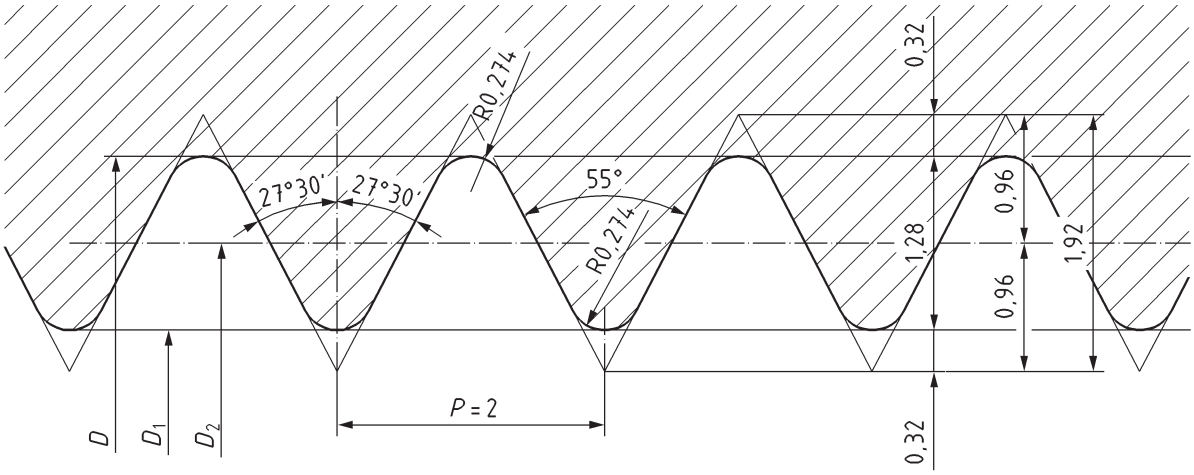
2 threads according to Figure 2

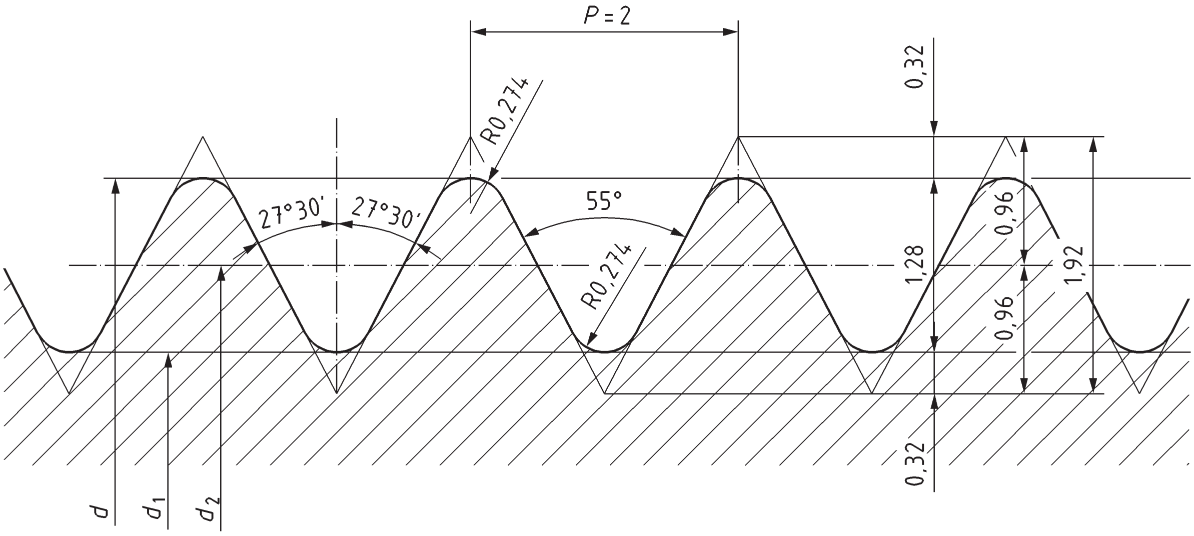
3 connector

4 threads according to Figure 2

5 union nut

Figure 1 — Principles for male and female connection





Nominal diameter = major diameter	D_t d	24	27	30
Pitch diameter	D_2 d_2	22,72	25,72	28,72
Minor diameter	D_1 d_1	21,44	24,44	27,44

Figure 2 — Basic dimensions of Whitworth threads with pitch *P* equal to 2 mm

Table 2 — Basic dimensions of Whitworth threads with pitch *P* equal to 2 mm

	Internal threads (union nut)	External thread (valve)
Nominal diameter = major diameter = D, d	D minimal (tolerances optional)	−38 −280
Pitch diameter = D_2, d_2	+224 +0	−38 −170
Minor diameter = D_1, d_1	+375 +0	D maximum (tolerances optional)

5 Marking

The outlets and the connections shall be marked with the number of the corresponding outlet as indicated in Table 3.

Table 3 — Marking

DN	A	B	Mark number	
			Left hand	Right hand
24	11,2	16,8	6	1
	11,9	16,1	7	2
	12,6	15,4	8	3
	13,3	14,7	9	4
	14	14	10	5
27	11,8	20,2	18	11
	12,5	19,5	19	12
	13,2	18,8	20	13
	13,9	18,1	21	14
	14,6	17,4	22	15
	15,3	16,7	23	16
	16	16	24	17
30	12,4	23,6	34	25
	13,1	22,9	35	26
	13,8	22,2	36	27
	14,5	21,5	37	28
	15,2	20,8	38	29
	15,9	20,1	39	30
	16,6	19,4	40	31
	17,3	18,7	41	32
	18	18	42	33

6 Allocation of connections

The allocation of 33 connections from the 42 that are available is shown in Table 4. Table 5 shows that each group of gases has been established in accordance with

a) the FTSC code,

b) the gases for other groups which can be component parts of the mixture of which the final properties are similar to those of that group, and

c) the connection(s) which is (are) allocated to the group.

In Table 4, the numbers of the outlets are added in bold font. To refer to one of these outlets, use e.g. ISO 5145 N° 2 for oxygen (4050 industrial).

Table 4 — Allocation of valve outlets for gases and gas mixtures by connection mark number

Nominal diameter of the connection														
24					27					30				
A-B combination mm	Left-hand thread		Right-hand thread		*A-B* combination mm	Left-hand thread		Right-hand thread		*A-B* combination mm	Left-hand thread		Right-hand thread	
	Group (utilization)[a]	Gas or gas mixture (FTSC code)	Group (utilization)[a]	Gas or gas mixture (FTSC code)		Group (utilization)[a]	Gas or gas mixture (FTSC code)	Group (utilization)[a]	Gas or gas mixture (FTSC code)		Group (utilization)[a]	Gas or gas mixture (FTSC code)	Group (utilization)[a]	Gas or gas mixture (FTSC code)
11,2–16,8	8 (M)[a]	Medical cyclopropane (2100) **N°6**	3 (M)	Helium (0150) and Xenon (0110) **N°1**	11,8–20,2		**N°18**	3 (M) (I)	Nitrogen (0150) **N°11**	12,4–23,6		**N°34**	3 (M)	Helium-oxygen or Nitrogen – oxygen mixtures (O_2 < 20 %) **N°25**
11,9–16,1		**N°7**	10 (I)	Oxygen (4050) **N°2**	12,5–19,5		**N°19**	12 (I)	(4153 ; 4203; 4300; 4301; 4303; 4330; 4343;4351) **N°12**	13,1–22,9		**N°35**	15 (M)	$O_2 + N_2$ (O_2 > 23,5 %) or O_2 + He (O_2 ≥ 20 %) mixtures **N°26**
12,6–15,4		**N°8**	15 (M)	Medicinal air and synthetic medicinal air (20 % ≤ O_2 ≤ 23,5 %) **N°3**	13,2–18,8		**N°20**	15 (M)	50 % O_2-50 % N_2O mixture **N°13**	13,8–22,2		**N°36**	15 (M)	O_2-CO_2 mixture (CO_2 ≤ 7 %) **N°27**
13,3–14,7	6 (I)	(2150) except H_2 **N°9**	3 (I) (M)	Inert gases and gas mixtures (0150) except for He and N_2 **N°4**	13,9–18,1	13 (I)	(5100; 5200; 5300; 5301; 5350) **N°21**	5 (I)	Air (1050) **N°14**	14,5–21,5		**N°37**	15 (M)	O_2-CO_2 mixture (CO_2 > 7 %) Air + He + CO (CO < 1 %) mixture **N°28**

[a] I for industrial applications; M for medical applications.

Table 4 — *(continued)*

Nominal diameter of the connection														
24					27					30				
***A-B* combination** mm	**Left-hand thread**		**Right-hand thread**		***A-B* combination** mm	**Left-hand thread**		**Right-hand thread**		***A-B* combination** mm	**Left-hand thread**		**Right-hand thread**	
	Group (utilization)[a]	**Gas or gas mixture (FTSC code)**	**Group (utilization)**[a]	**Gas or gas mixture (FTSC code)**		**Group (utilization)**[a]	**Gas or gas mixture (FTSC code)**	**Group (utilization)**[a]	**Gas or gas mixture (FTSC code)**		**Group (utilization)**[a]	**Gas or gas mixture (FTSC code)**	**Group (utilization)**[a]	**Gas or gas mixture (FTSC code)**
14–14	6 (I)[a]	Hydrogen (2150) **N°10**	10 (M)	Oxygen (4050) **N°5**	14,6–17,4	9 (I)	(3300; 3310; 3150) **N°22**	4 (I)	(0200; 0201; 0203; 0213; 0300; 0303; 0253) **N°15**	15,2–20,8	6 (I)	(2170) **N°38**	3 (M)	N + NO mixture (100 < NO < 1 000 ppm) **N°29**
					15,3–16,7	8 (I)	Carbon monoxide (2250) **N°23**	11 (M)	Nitrous oxide (4110) **N°16**	15,9–20,1	8 (I)	(2200; 2201;2203; 2300; 2301) **N°39**	3 (I)	(0170) **N°30**
					16–16	6 (I)	Commercial butane and propane (2100) **N°24**	2 (M)	Carbon Dioxide (0110) **N°17**	16,6–19,4	7 (I)	(2102) **N°40**	5 (I)	(1070) **N°31**
										17,3–18,7	6 (I)	(2100; 2110) (except commercial butane and propane) **N°41**	10 (I)	(4070) **N°32**
										18–18	14 (I)	Acetylene (5130) **N°42**	1 (M)	SF_6, C_2F_6, C_3F_8
													1 (I)	(0100) **N°33**

[a] I for industrial applications; M for medical applications.

Table 5 — Allocation of valve outlets by gas group

Group no.	Gas and gas mixture characteristics at 15 °C	Allocation of outlet connections							
		Single gases, main FTSC codes	Right-hand (RH) or left-hand (LH) thread	Nominal diameter of the connection					
				24		27		30	
				A-B combination mm	Gases and gas mixtures and/or FTSC code	*A-B* combination mm	Gases and gas mixtures and/or FTSC code	*A-B* combination mm	Gases and gas mixtures and/or FTSC code
1	Non-flammable and non-toxic gases; less stable thermally than group 3	0100	RH					18–18 **N°33**	0100 SF6, C2F6, C3F8
2	Carbon dioxide	0110	RH			16–16 (M) **N°17**	0110		
3	Non-flammable, non-toxic, and thermally stable gases (except carbon dioxide)	0150 0170 0110 (xenon)	RH	11,2–16,8 **N°1**	Helium and Xenon	11,8–20,2	Nitrogen (M) (I)	12,4–23,6 **N°25**	Helium-oxygen or Nitrogen – oxygen mixtures (O_2 < 20 %)
				13,3–14,7 **N°4**	Inert gas and gas mixtures			15,9–20,1 30	0170
								15,2–20,8 **N°29**	N_2 + NO mixture (100 < NO < 1 000 ppm)
4	Non-flammable, toxic, and corrosive or corrosive by hydrolysis gases	0200; 0201; 0203; 0213; 0300; 0303; 0253	RH			14,6–17,4 **N°15**	0200; 0201; 0203; 0213; 0300; 0303; 0253		
5	Air only[b]	1050 1070	RH			13,9–18,1 **N°14**	1050 Air (I)	16,6–19,4 **N°31**	1070 Air (I)

[a] Caution: This valve outlet is used for two different applications (oxidising, toxic and/or corrosive gases, and medicinal breathable application). However, these applications are so different that this is found acceptable (toxic gas will never be distributed in a hospital).

[b] For medical application, see group 15.

Table 5 — *(continued)*

Group no.	Gas and gas mixture characteristics at 15 °C	Allocation of outlet connections							
		Single gases, main FTSC codes	Right-hand (RH) or left-hand (LH) thread	Nominal diameter of the connection					
				24		27		30	
				A-B combination mm	Gases and gas mixtures and/or FTSC code	*A-B* combination mm	Gases and gas mixtures and/or FTSC code	*A-B* combination mm	Gases and gas mixtures and/or FTSC code
6	Flammable and non-toxic gases	2100; 2110; 2150; 2170	LH	14–14 **N°10**	H_2 ≤ 250 bar	16–16 **N°24**	Commercial butane, and propane 2100	15,2–20 0,8 **N°38**	2170
				13,3–14,7 **N°9**	2150 (except H_2)			17,3–18,7 **N°41**	2100; 2110 except commercial butane and propane
7	Flammable and corrosive (basic gases)	2102	LH					16,6–19,4 **N°40**	2102
8	Flammable, toxic, and corrosive (acidic) or non-corrosive gases	2200	LH	11,2–16,8 **N°6**	Medical Cyclopropane	15,3–16,7 **N°23**	Carbon monoxide 2250	15,9–20,1 **N°39**	2200; 2201; 2203; 2300; 2301
9	Spontaneously flammable gases	3150; 3300; 3310	LH			14,6–17,4 **N°22**	3150; 3300; 3310		
10	Oxygen and high-pressure oxidant	4050 4070	RH	4050 (M)	14–14 oxygen (M) **N°5**			17,3–18,7 **N°32**	4070 including high-pressure oxidant
				4050 (I)	11,9–16,1 **N°2**				

[a] Caution: This valve outlet is used for two different applications (oxidising, toxic and/or corrosive gases, and medicinal breathable application). However, these applications are so different that this is found acceptable (toxic gas will never be distributed in a hospital).

[b] For medical application, see group 15.

Table 5 — (continued)

Group no.	Gas and gas mixture characteristics at 15 °C	Allocation of outlet connections							
		Single gases, main FTSC codes	Right-hand (RH) or left-hand (LH) thread	Nominal diameter of the connection					
				24		27		30	
				A-B combination mm	Gases and gas mixtures and/or FTSC code	*A-B* combination mm	Gases and gas mixtures and/or FTSC code	*A-B* combination mm	Gases and gas mixtures and/or FTSC code
11	Nitrous oxide	4110	RH			4110 (M)	15,3–16,7 **N°16**		
12	Oxidant, toxic, and corrosive gases	4203; 4300; 4301; 4303; 4330; 4343; 4351	RH			4203; 4300; 4301; 4303; 4330; 4343; 4351	12,5–19,5 **N°12**[a]		
13	Flammable gases subject to decomposition or polymerization	5100; 5200; 5300; 5301; 5350	LH			5100; 5200; 5300; 5301; 5350	13,9–18,1 **N°21**		
14	Acetylene only	5130	LH					5130 (Acetylene)	18–18 **N°42**
15	Oxidant, non-toxic, and non-corrosive gas mixtures		RH	Medicinal air and synthetic medicinal air (M)	12,6–15,4 **N°3**	50 % N_2O-50 % O_2 mixture (M)	13,2–18,8 **N°13**	O_2 + N_2 or O_2- + He mixtures	13,1–22,9 **N°26**
						Air and breathable gases with oxygen content of more than 20 % and less than 23,5 % +He+CO (CO < 1 %) mixture (M)	12,5–19,5 **N°28**[a]	O_2-CO_2 (CO_2 ≤ 7 %) (M)	13,8–22,2 **N°27**
								CO_2-O_2 (CO_2 > 7 %) (M)	14,5–21,5 **N°28**

[a] Caution: This valve outlet is used for two different applications (oxidising, toxic and/or corrosive gases, and medicinal breathable application). However, these applications are so different that this is found acceptable (toxic gas will never be distributed in a hospital).

[b] For medical application, see group 15.

Annex A
(normative)

Gas groups

A.1 Numerical gas code (FTSC)

A.1.1 General

The code number assigned to each gas is based on the following four physico-chemical criteria.

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

(T) Category II: toxicity.

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

(C) Category IV: corrosiveness (with respect to living tissue).

Each category is subdivided into different characteristics, 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.

A.1.2 Fire potential, category I

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

Subdivision 1: supports combustion (oxidizing gas having an oxipotential equal to or less than that of air).

Subdivision 2: flammable (gas having flammable limits in air).

Subdivision 3: spontaneously flammable.

Subdivision 4: highly oxidizing (oxidizing gas having an oxipotential greater than that of air).

Subdivision 5: flammable and subject to decomposition or polymerization.

A.1.3 Toxicity, category II

Subdivision 0: supporting human life.

Subdivision 1: non-toxic LC 50 > 0, 5 % by volume (for LC 50, see the definition in ISO 10298).

Subdivision 2: toxic; 0,02 % by volume < LC50 ≤ 0, 5 % by volume.

Subdivision 3: very toxic LC 50 ≤ 0,02 % by volume.

A.1.4 Gas state (in the cylinder at 15 °C), category III

Subdivision 0: liquefied gas at 35 bars or less.

Subdivision 1: liquefied gas at over 35 bars.

Subdivision 2: liquid withdrawal — liquefied gas (optional)

Subdivision 3: dissolved gas.

Subdivision 4: gas phase withdrawal at 35 bars or less.

Subdivision 5: compressed gas between 35 bars and 250 bars (Europe).

Subdivision 6: compressed gas between 35 bars and 182 bars (North America).

Subdivision 7: compressed gas above 182 bars (North America) or 250 bars (Europe).

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

Subdivisions 5 and 6 have been adopted as a result of a compromise between the European and the North American proposals. The European preference for a limit of 250 bars reflects the current tendency towards higher pressure applications. The current North American practice requires a limit of 182 bars 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:

Subdivision 4: 35 bars or less — gas only (including cryogenic gas withdrawal);

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

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

A number of pressure ranges have been established to safeguard the selection of the proper cylinder valve outlet connection. These ranges have been chosen to protect downstream regulators and other ancillary equipment from over-pressurized conditions.

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

All pressures are working pressures defined in ISO 10286.

A.1.5 Corrosiveness, category IV

Subdivision 0: non-corrosive;

Subdivision 1: non-halogen-acid forming;

Subdivision 2: basic;

Subdivision 3: halogen-acid forming.

A.2 Grouping of gases

A.2.1 General

The characteristics of each gas group are summarized in Table A.1.

Table A.1 — Gas group characteristics

Group	Characteristics
1	Non-flammable, non-toxic gases, and qualifying gas mixtures; less stable thermally than group 3
2	Carbon dioxide
3	Non-flammable, non-toxic and thermally stable gases (except carbon dioxide), and qualifying gas mixtures

Table A.1 *(continued)*

Group	Characteristics
4	Non-flammable, toxic and corrosive (or corrosive by hydrolysis) gases, and qualifying gas mixtures
5	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	Oxygen and high-pressure oxidant
11	Nitrous oxide
12	Oxidant, toxic and/or corrosive gases, and qualifying gas mixtures
13	Flammable gases and qualifying gas mixtures subject to decomposition or polymerisation
14	Acetylene
15	Oxidant, non-toxic and non-corrosive gas mixtures

Summaries of the gases and gas mixtures belonging to each group are given in A.2.1 to A.2.15.

NOTE For compressed gases given in the following tables (Tables A.2 to A.15), the third digit used in this International Standard is a 5. Most of these gases can be filled in a gas cylinder at a different pressure and, consequently, Figures 6 or 7 are then to be used. For liquefied gases, the third digit used in this International Standard is 0 or 1 (in accordance with the pressure). Most of these gases can be used with a liquid withdrawn and, consequently, the corresponding subdivision 2 is then to be used (whatever is the pressure).

A.2.2 Group 1 gases and gas mixtures

Table A.2 — Gases and gas mixtures belonging to group 1

Gas	FTSC code	Synonym
Bromochlorodifluoromethane	0100	R12B1
Bromochloromethane	0100	Halon 1011
Bromotrifluoromethane	0100	Trifluorobromomethane R13B1
Chlorodifluoromethane	0100	Monochlorodifluoromethane R22
Chloroheptafluorocyclobutane [a]	0100	C317
Chloropentafluoroethane	0100	Monochloropentafluoroethane R115
1 - Chloro-1,2,2,2-tetrafluoroethane	0100	R124
1 - Chloro-2,2,2-trifluoroethane	0100	R 133a
Chlorotrifluoromethane	0100	Monochlorotrifluoromethane R13
1,2-Dibromotetrafluoroethane [a]	0100	R114B2
1,2-Dichlorodifluoroethylene	0100	R1112a
Dichlorodifluoromethane	0100	R12
Dichlorofluoromethane	0100	R21
1,2-Dichlorohexafluorocyclobutane[a]	0100	C316
1,1 - Dichlorotetrafluoroethane	0100	R114a
1,2- Dichlorotetrafluoroethane	0100	R 114
2,2- Dichloro-1,1,1 –trifluoro ethane[a]	0100	R 123

[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 pressure container.

Table A.2 *(continued)*

Gas	FTSC code	Synonym
Hexafluoroethane	0100	Perfluoroethane R116
Hexafluoropropylene	0100	Hexafluoropropene R 1216
Octafluorocyclobutane	0100	Perfluorocyclobutane RC 318
Octafluoropropane	0100	Perfluoropropane R 218
Pentachlorofluoroethane	0100	
Pentafluoroethane	0100	R125
Pentafluoroethyliodide	0100	
Perfluorobutane	0100	
Sulfur hexafluoride	0100	
1,1,1,2-Tetrachlorodifluoroethane	0100	R112a
1,1,2,2-Tetrachlorodifluoroethane	0100	R112
1,1,2,2- Tetrafluoro-1-chloro ethane	0100	
Trichlorofluoromethane [a]	0110	Trichloromonofluoromethane R11
1,1,1-Trichlorotrifluoroethane[a]	0100	R113a
1,1-Trichlorotrifluoroethane[a]	0100	R113
Trifluoromethane	0100	Fluoroform R23

[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 pressure container.

For gas mixtures, see 3.3.2.

A.2.3 Group 2 gases

Table A.3 — Gases belonging to group 2

Gas	FTSC code	Synonym
Carbon dioxide	0110	Carbonic acid R744 anhydride

A.2.4 Group 3 gases and gas mixtures

Table A.4 — Gases and gas mixtures belonging to group 3

Gas	FTSC code[a]	Synonym
Argon	0150	
Helium	0150	
Krypton	0150	
Neon	0150	
Nitrogen	0150	
Xenon	0110	
Tetrafluoromethane	0150	Carbon tetrafluoride R14

[a] FTSC code due to the critical point of the gas 5 above 15 °C.

For gas mixtures, see 3.3.2.

A.2.5 Group 4 gases and gas mixtures

Table A.5 — Gases and gas mixtures belonging to group 4

Gas	FTSC code	Synonym
Antimony pentafluoride[a]	0303	
Boron trichloride	0203	Boron chloride
Boron trifluoride	0253	Boron fluoride
Bromoacetone[a]	2203	
Carbonyl-fluoride	0213	
Cyanogen chloride	0303	
Deuterium chloride	0213	
Deuterium fluoride	0203	
Dibromodifluoromethane[a]	0100	R12B2
Dichloro-2-chlorovinyl arsine	0303	Lewisite
Diphosgene [a]	0303	
Ethyldichloroarsine[a]	0303	
Hexafluoroacetone	0203	Hexafluorropropane-2perfluoroacetone
Hydrogen bromide	0203	Hydrobromic acid (anhydrous)
Hydrogen chloride	0213	Hydrochloric acid (anhydrous)
Hydrogen fluoride[a]	0203	Hydrofluoric acid (anhydrous)
Hydrogen iodide	0203	Hydroiodic acid (anhydrous)
Iodotrifluoromethane	0200–**0100**[b]	Trifluoromethyl iodide
Methyl bromide	2200	Bromomethane
Methyldichloroarsine	0303	
Mustard gas	2303	
Nitrosyl chloride	0303	
Perfluoro-2-butene	0200–**0100**[b]	
Phenylcarbylamine Chloride	2303	
Phosgene	0303	Carbonyl chloride
Phosphorus pentafluoride	0203	
Phosphorus trifluoride	0203	
Silicon tetrachloride	0203	
Silicon tetrafluoride[a]	0253	Tetrafluorosilane R764
Sulfur dioxide	0201	
Sulfur tetrafluoride	0303	
Sulfuryl fluoride	0300	
Tungsten hexafluoride	0303	
Uranium hexafluoride	0303	

[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 pressure container.

[b] To be consistent with ISO 10298, the former FTSC code is completed by the new one in bold figures corresponding to the new toxicity level.

For gas mixtures, see 3.3.2.

A.2.6 Group 5 gases

Table A.6 — Gases belonging to group 5

Gas	FTSC code	Synonym
Air	1050	

A.2.7 Group 6 gases and gas mixtures

Table A.7 — Gases and gas mixtures belonging to group 6

Gas	FTSC code	Synonym
Allene	2100	Propadiene
Bromotrifluoro ethylene	2100	R 113B1
Butane	2100	
1 – Butene	2100	Butylene
2 – Butene	2100	Butylene
1-Chloro-1,1-difluoroethane	2100	R142b
Chlorofluoromethane	2100	
Deuterium	2150	
1,1-Difluoroethane	2100	Ethylidene fluoride R 152a
Difluoromethane	2110	Methylene fluoride R 32
1,1-Difluoroethylene	2110	Vinylidene fluoride R1132a
Dimethylether	2100	Methyl ether
2,2-Dimethylpropane[a]	2100	Tetramethylmethane
Ethane	2110	R170
Ethylacetylene	2100	1-Butyne
Ethylchloride[a]	2100	Chloroethane R160
Ethylene	2150	Ethene
Ethyl ether[a]	2100	R1150
Hydrogen	2150	
Isobutane	2100	Trimethylmethane R601
Isobutylene	2100	2-Methylpropene
Methane	2150	R50
Methylacetylene[a]	2100	Allylene; Propyne
3-Methyl-1-butene[a]	2100	Isoamylene:Isopropylethylene
Methyl ethyl ether	2100	Ethyl methyl ether
Methyl fluoride	2110	Fluoromethane R41
Natural gas	2150	
Propane	2100	R290
Propylene	2100	Propene R1270
1,1,1-Trifluoroethane	2100	R143a

[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 pressure container.

For gas mixtures, see 3.3.2.

A.2.8 Group 7 gases and gas mixtures

Table A.8 — Gases and gas mixtures belonging to group 7

Gas	FTSC code	Synonym
Ammonia	2902	R717
Dimethylamine	2902	
Monoethylamine[a]	2102	Ethylamine R631
Monomethylamine	2902	Methylamine R630
Trimethylamine	2902	

[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 pressure container.

For gas mixtures, see 3.3.2.

A.2.9 Group 8 gases and gas mixtures

Table A.9 — Gases and gas mixtures belonging to group 8

Gas	FTSC code	Synonym
Arsine	2300	
Carbon monoxide	2250	
Carbonyl sulfide	2201	Carbonoxylsulfide
Chloromethane	2200–**2100**[b]	Methyl chloride R40
Coal gas	Mixture	
Cyanogen	2200	
Cyclopropane	2200–**2100**[b]	Trimethylene
Deuterium selenide	2301	
Deuterium sulfide	2201	
Dichlorosilane[a]	2203	
Dimethylsilane	2300–**2100**[b]	
Fluoroethane	2300–**2100**[b]	Ethyl fluoride
Germane	2300	
Heptafluorobutyronitrile[a]	2300	
Hexafluorocyclobutene	2100	
Hyrogen selenide	2301	
Hydrogen sulfide[a]	2201	
Methyl mercaptan	2201	Methanethiol
Methylsilane	2300–**2100**[b]	
Nickel carbonyl[a]	2300	Nickel tetracarbonyle
Pentafluoropropionitrile	2300	
Tetraethyl lead	2300	
Tetramethyl lead	2200	
Trifluoroacetonitrile	2200	

[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 pressure container.

[b] To be consistent with ISO 10298, the former FTSC code is completed by the new one in bold figures corresponding to the new toxicity level.

Table A.9 *(continued)*

Gas	FTSC code	Synonym
Trifluoroethylene	2200	
Trimethylsilane	2300–**2100**[b]	

[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 pressure container.

[b] To be consistent with ISO 10298, the former FTSC code is completed by the new one in bold figures corresponding to the new toxicity level.

For gas mixtures, see 3.3.2.

A.2.10 Group 9 gases and gas mixtures

Table A.10 — Gases and gas mixtures belonging to group 9

Gas	FTSC code	Synonym
Diethylzinc[a]	3300	
Pentaborane[a]	3300	
Phosphine	3310	
Silane	3150	Silicone tetrahydride
Triethyl aluminium[a]	3300	
Triethyl borane,	3200	
Trimethylstibine[a]	3300	

[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 pressure container.

For gas mixtures, see 3.3.2.

A.2.11 Group 10 gases

Table A.11 — Gases belonging to group 10

Gas	FTSC code	Synonym
Oxygen	4050	

A.2.12 Group 11 gases

Table A.12 — Gases belonging to group 11

Gas	FTSC code	Synonym
Nitrous oxide	4110	

A.2.13 Group 12 gases and gas mixtures

Table A.13 — Gases and gas mixtures belonging to group 12

Gas	FTSC Code	Synonym
Bis-trifluoromethylperoxide	4300	

[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 pressure container.

Table A.13 *(continued)*

Gas	FTSC Code	Synonym
Bromine pentafluoride[a]	4303	
Bromine trifluoride[a]	4303	
Chlorine	4203	
Chlorine pentafluoride	4303	
Chlorine trifluoride	4203	
Fluorine	4343	
Iodine pentafluoride	4303	
Nitric oxide	4351	Nitrogen(II) oxide
Nitrogen dioxide[a]	4301	Liquid dioxide Nitrogen tetraoxide Nitrogen (IV) oxide Dinitrogenetetraoxide Nitrogen peroxide
Nitrogen trifluoride	4150	
Nitrogen trioxide	4301	Nitrogen sesquioxide Dinitrogen trioxide Nitrogen(III) oxide
Oxygen difluoride	4343	
Ozone	4330	
Tetrafluorohydrazine	4343	

[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 pressure container.

For gas mixtures, see 3.3.2.

A.2.14 Group 13 gases and gas mixtures

Table A.14 — Gases and gas mixtures belonging to group 13

Gas	FTSC code	Synonym
1,3-Butadiene, stabilized	5100	
Chlorotrifluoroethylene, stabilized	5200	R1113
Diborane	5350	
Ethylene oxide	5200	Oxirane
Hydrogen cyanide, stabilized[a]	5301	Hydrocyanic acid (anhydrous)
Propylene oxide	5100	Methyl oxirane
Stibine Tetrafluoroethylene, stabilized	5300 5100	Antimony hydride
Vinyl bromide, stabilized[a]	5100	
Vinyl chloride, stabilized	5100	Chloroethylene R1140

[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 pressure container.

Table A.14 *(continued)*

Gas	FTSC code	Synonym
Vinyl fluoride, stabilized	5100	Fluoroethylene R1141
Methyl vinyl ether, stabilized	5100	Methoxyethylene
[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 pressure container.		

For gas mixtures, see 3.3.2.

A.2.15 Group 14 gases

Table A.15 — Gases belonging to group 14

Gas	FTSC code	Synonym
Acetylene	5130	Ethyne

A.3 Group 15 gas mixtures (normally medical)

For gas mixtures, see 3.3.2 for general applications.

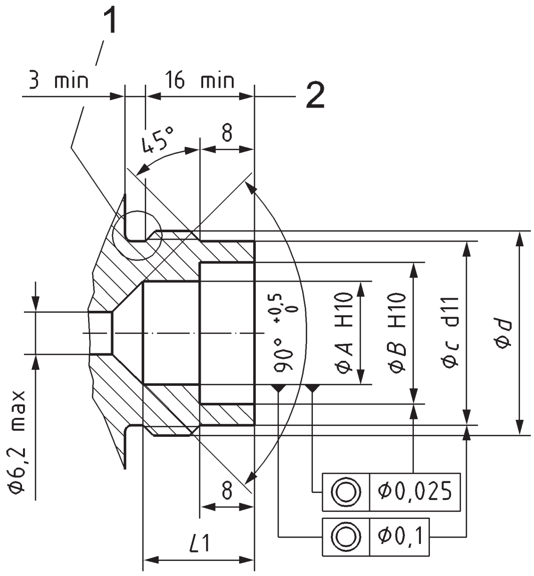
Annex B
(normative)

Connections

B.1 Valve outlets

See Figure B.1 and Table B.1.

Dimensions in millimetres



Key

1 with/without undercut

2 fully formed thread

NOTE The tolerance on lengths are ±0,1 mm.

Figure B.1 — Valve outlet

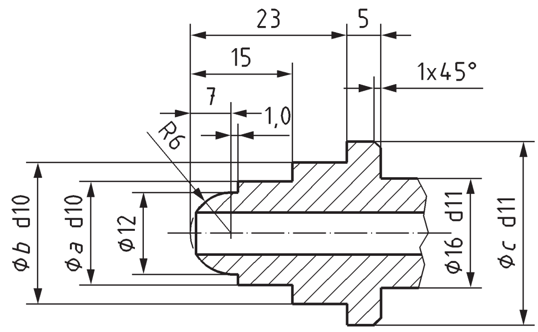
Table B.1 — Dimensions of valve outlets

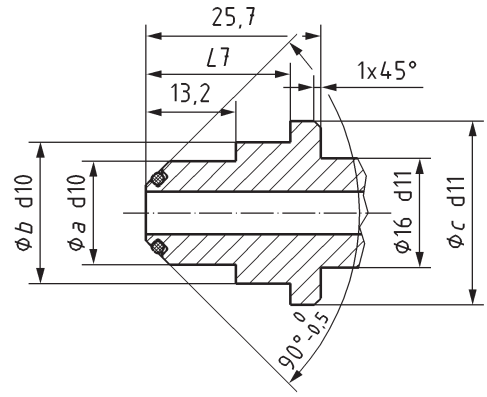
Thread, left and right hand *(d)*	(A/a) - (B/b) (mm)	Constant	(C/c) (mm)	$L1$ (mm)
W24x2	11,2–16,8	28	21	17,6
	11,9–16,1			17,3
	12,6–15,4			17
	13,3–14,7			16,6
	14–14			16,3
W27x2	11,8–20,2	32	24	17,4
	12,5–19,5			17
	13,2–18,8			16,7
	13,9–18,1			16,3
	14,6–17,4			16
	15,3–16,7			15,6
	16–16			15,3
W30x2	12,4–23,6	36	27	17,8
	13,1–22,9			17,4
	13,8–22,2			17
	14,5–21,5			16,7
	15,2–20,8			16,3
	15,9–20,1			16
	16,6–19,4			15,7
	17,3–18,7			15,3
	18–18			15

B.2 Connectors

See Figure B.2, Table B.2, and Figure B.4.

Dimensions in millimetres





NOTE If spherical end connectors (hard seat connectors) are used, similar dimensions will be used and recommendation of Annex C followed.

Figure B.2 — Connectors

Table B.2 — Dimensions of connectors

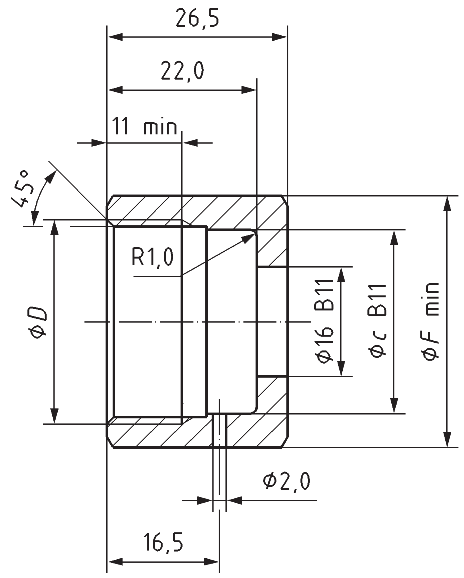
Thread, left and right (*d*)	**(*A*/*a*) – (*B*/*b*)** (mm)	**Constant** *A*+*B*	**(*C*/*c*)** (mm)	***L*7** (mm)
*W*24x2	11,2–16,8	28	21	21,5
	11,9–16,1			21,5
	12,6–15,4			21,2
	13,3–14,7			21,2
	14–14			21,2
*W*27x2	11,8–20,2	32	24	21,5
	12,5–19,5			21,2
	13,2–18,8			21,2
	13,9–18,1			21,2
	14,6–17,4			21,2
	15,3–16,7			21,2
	16–16			21,2
*W*30x2	12,4–23,6	36	27	21,2
	13,1–22,9			21,2
	13,8–22,2			21,2
	14,5–21,5			21,2
	15,2–20,8			21,2
	15,9–20,1			21,2
	16,6–19,4			21,2
	17,3–18,7			21,2
	18–18			21,2

NOTE The tolerance on lengths is ±0,1 mm.

B.3 Union nut

See Figure B.3 and Table B.3.

Dimensions in millimetres



NOTE The tolerance on lengths is ±0,1 mm.

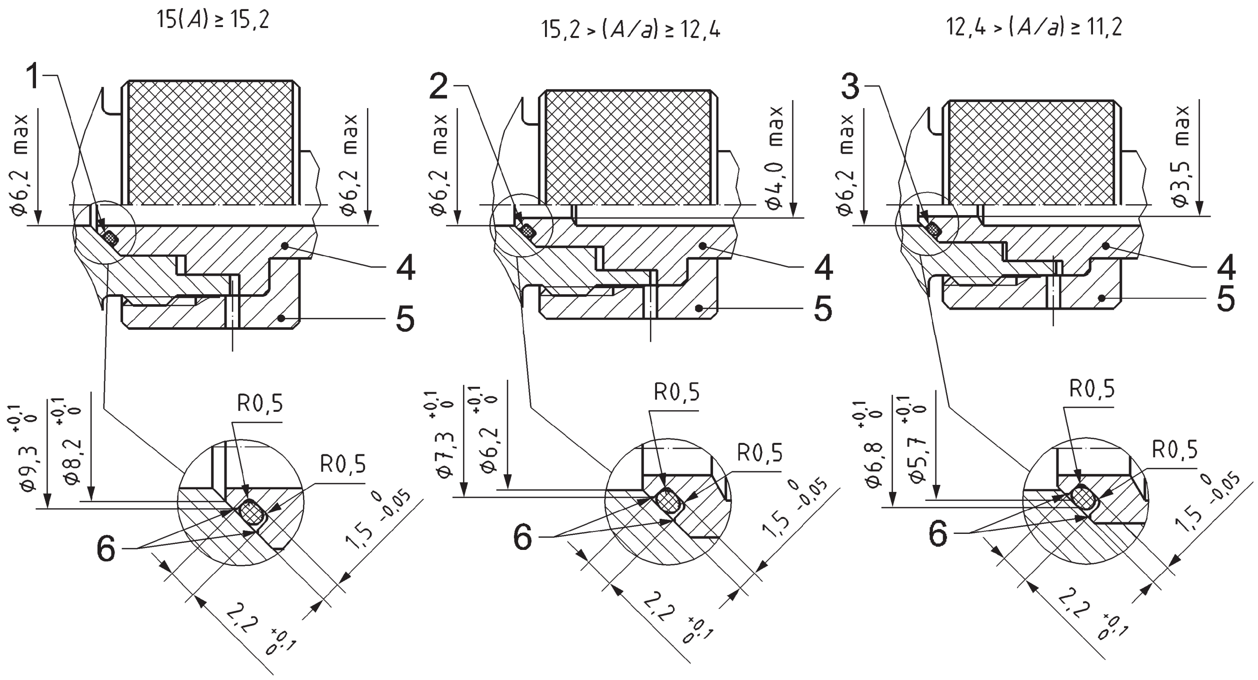
Figure B.3 — Union nut

Table B.3 — Dimensions of the union nut (in millimetre)

Nominal thread diameter *D* = nominal diameter of the connection	*C*	*f*
24	21	31
27	24	34
30	27	37

NOTE The tolerance on lengths is ±0,1 mm.

B.4 Metal on elastomer seal - O-ring / groove details



Key

1, 2, and 3 O-rings

4 nipple

5 nut

6 chamfer 0,2 mm

A See Table 1.

The dimensions of the O-rings for the nipple are generally the following:

For 1: 7,66 × Ø 1,78

For 2: 6,07 × Ø 1,78

For 3: 5,28 × Ø 1,78

The hardness is 80 Shore A.

Figure B.4 — Examples of mounting the O-ring groove

Annex C
(normative)

Use of connection nuts requiring tools

For connectors using a nut which can be tightened with a tool, there is a possibility that the threading system can be overstressed accidentally when using such a tool to tighten the connection.

If a nut which can be tightened with a tool is to be used, it shall be marked “30 N.m max”.

Use of the alternative soft sealing connector (elastomeric) which seals handtight with a nut that requires no tool is recommended where safety and operational concerns permit.

NOTE The hard seat connection design normally requires no more than 15 N.m of torque to be applied for a seal to be made.

Annex D
(informative)

Examples of allocation cylinder valve outlets for the use of medical gases

D.1 Scope

This annex gives examples of how to allocate cylinder valve outlets in the case of gases for medical use to ensure patient safety. Such gases are treated differently depending on whether they are gases for inhalation or for other purposes. Allocation is based on the pharmacological and therapeutic properties of the gases and not physical aspects such as pressure definitions.

The following definitions apply.

D.1.1 Gas for medical use

Any gas or mixture of gases intended to be administered to patients for therapeutic, diagnostic, or prophylactic purposes, with or without pharmacological action, or to be used for surgical tools. It covers so respectively both medicinal and medical gases.

D.1.2 Medicinal gas

Any gas or mixture of gases intended to be administered to patients for therapeutic, diagnostic, or prophylactic purposes using pharmacological action and classified as a medicinal product, e.g. according to article 1.2 of Council Directive 2001/83/EC for European Parliament and of the Council of November 2001 on the community code relating to medicinal products for human use.

D.1.3 Gas for inhalation

Medicinal gas intended for introduction into the body through respiration. The gas is administrated alone directly or after mixing at the point of use with oxygen or air.

D.1.4 Medicinal gas mixture containing oxygen

Gas mixture which oxygen content is to be taken in account in order to limit the duration of the inhalation under standard atmospheric conditions, for example, binary mixtures (from nitrogen, helium, nitrous oxide, carbon dioxide) or ternary mixtures or more used e.g. for lung function testing (LFT). Medicinal gas mixtures containing oxygen can be classified as follows:

— hypoxic mixtures: mixtures with lower than normal O_2 content: gas with O_2 < 20 %[1)] for short term inhalation;

— hyperoxic mixtures: mixtures with greater than normal O_2 content: gas with O_2 > 23,5 % for continuous inhalation;

— normoxic mixtures: mixtures with normal O_2: 20 %[1)] ≤ O_2 ≤ 23,5 % for continuous inhalation.

1) 19,5 % for some national pharmacopoeia.

D.1.5 Analytical gas

Gas which is used for analysis calibration or for purposes for supplying energy (flame, oven, etc.) and other similar purposes (for example, gas chromatography, atomic absorption spectrophotometer) in biological or pharmaceutical or research laboratories.

D.1.6 Breathable gas

Gas supporting life to be used in a breathing or a diving apparatus in a non-standard atmospheric medium such as water, high altitude, space or confined or polluted medium but not for therapeutic, diagnostic, or prophylactic uses. For example, air, oxygen, and gas mixtures (nitrogen/oxygen, helium/oxygen, nitrogen/helium/oxygen, etc.) with normal or greater than normal oxygen content.

D.2 Rules of safety

In hospitals, the simultaneous presence of medicinal, medical, analytical, and industrial gas cylinders increases the risk of occurrence of serious safety issues for the patient.

1) All staff involved in the administration of gases for medical use shall be appropriately trained to ensure that the correct gas is used.

2) The different gases and gas mixtures shall be easily identified and stored in a separated area.

3) Labelling and colour coding of the gas cylinder shall be checked before use.

4) As a general rule, cylinders containing non-breathable gases for industrial or medical use shall not be fitted with the same valve outlet connection as those that medical gases used for breathing. This then preserves the integrity of the gas specific safety system (designed to prevent the delivery of non-breathing or hypoxic gas mixtures) and thus protects against the possibility of inadvertently connecting such gases to breathing medical device delivery systems.

D.3 Rules for outlet allocation

A number of valve outlets have already been allocated for the commonly used gases for medical use. The allocation of valve outlets from the limited possibilities comes from risk analysis, mainly asphyxia, in case of connection with gases with lower than 20 % oxygen[2] content resulting from the simultaneous presence of industrial gases and gases for medical use in hospitals, and also the presence in gas mixtures of components limiting the duration of inhalation.

Where there is no specific allocation to a given gas or gas mixture, the following rules can be applied:

— For oxygen-enriched ternary or higher gas mixtures intended for inhalation without a specific valve outlet allocation, the following logical sketch (see Figure D.1) allows to determine the valve outlet allocation as a function of the type of gas according to Table D.1;

— For other gases or gas mixtures, the shared valve outlet assigned to an FTSC gas group according to Tables 4 and 5 can be proposed, e.g. N°4 (see Table 5), for all inert gases and gas mixtures of FTSC code 0150 (except inert gases and gas mixtures that have a specific valve outlet such as N_2, He, NO/N_2 (100 < NO < 1 000 ppm), or 1050.

Table D.1 lists the maximum thresholds for the components used in oxygen-enriched pre-mixed gases for short-term and continuous inhalation under standard atmospheric conditions.

Figure D.1 is a logical flowchart for the selection of valve outlets for gases used for medical use.

2) 19,5 % oxygen for some national pharmacopoeia.

Table D.1 — Maximum thresholds for the components used in oxygen-enriched pre-mixed gases for short-term and continuous inhalation in standard atmospheric conditions

Chemical Symbol	N_2O	CO	CO_2	NO	C_2H_2	H_2	CH_4
LC 50	—	3 760 ppm	—	115 ppm	—	—	—
Medical use	Anaesthesia or analgesia if 50/50	LFT premixture	LFT premixture	Neonatal intensive care In premixture with N_2	LFT premixture	Gut function testing in premixture with air Gas for calibration	LFT premixture
Recommended maximum % v/v for continuous inhalation	80 %	0,4 %	7 %	0,1 %	0,4 %	Not applicable	0,4 %

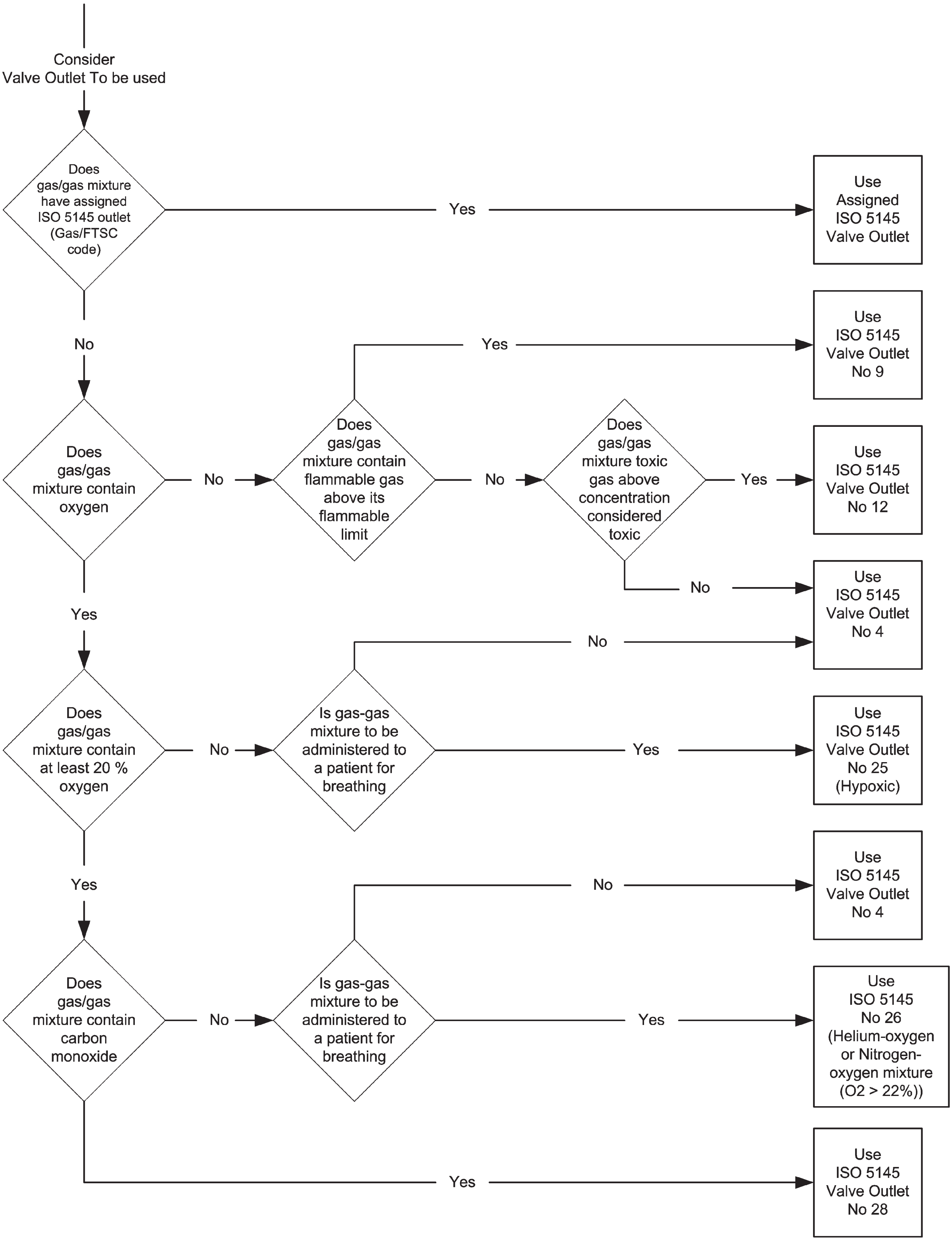


Figure D.1 — Flowchart for the selection of valve outlets for gases used for medical use

D.4 Examples of valve outlets selected with the help of the flowchart (Figure D.1)

D.4.1 Example 1: Anaerobic Cellular Culture (not for breathing)

Typical mixture composition: 10 % H_2, 5 % CO_2, Balance N_2

Does gas or gas mixture have an assigned outlet (Gas/FTSC code)?	No
Does gas contain oxygen?	No
Does gas contain a flammable component above its flammable limit?	Yes
Outlet Allocation	**Outlet 9**

D.4.2 Example 2: Toxic Hypoxic Gas /Gas Mixture

Typical composition: 100 % Nitric Oxide – NO

Does gas or gas mixture have an assigned outlet (Gas/FTSC code)?	Yes
Outlet Allocation	**Outlet 12**

D.4.3 Example 3: Hypoxic Lung Function Test Mixture (with no flammable components)

Typical mixture composition: 4 % CO_2, 16 % O_2, Balance N_2

Does gas or gas mixture have an assigned outlet (Gas/FTSC code)?	No
Does gas contain oxygen?	Yes
Is Oxygen content at least 20 % oxygen?	No
Is gas to be administered for breathing?	Yes
Outlet Allocation	**Outlet 25**

D.4.4 Example 4: Non-hypoxic Lung Function Test Mixture (with no flammable components)

Typical mixture composition: 9 % He, 35 % O_2, Balance N_2

Does gas or gas mixture have an assigned outlet (Gas/FTSC code)?	No
Does gas contain oxygen?	Yes
Is oxygen content at least 20 % oxygen?	Yes
Does gas contain carbon monoxide?	No
Is gas to be administered for breathing?	Yes
Outlet Allocation	**Outlet 26** **(non-hypoxic)**

D.4.5 Example 5: Calibration Gas for Blood Gas Analysis

Typical mixture composition: 5 % CO_2, 20 % O_2, Balance N_2

Does gas or gas mixture have an assigned outlet (Gas/FTSC code)?	No
Does gas contain oxygen?	Yes
Is oxygen content at least 20 % Oxygen?	Yes
Does gas contain carbon monoxide?	No
Is gas to be administered for breathing?	No
Outlet Allocation	**Outlet 4**

D.4.6 Example 6: Non-hypoxic Lung Function Test Mixture (with no flammable components)

Typical mixture composition: 0,3 % C_2H_2, 0,3 % CO, 0,3 % CH_4, 21 % O_2, Balance N_2

Does gas or gas mixture have an assigned outlet (Gas/FTSC code)?	No
Does gas contain oxygen?	Yes
Is oxygen content at least 20 % Oxygen?	Yes
Does gas contain carbon monoxide?	Yes
Outlet Allocation	**Outlet 28**

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