



BSI Standards Publication

Test gases – Test pressures – Appliance categories

National foreword

This British Standard is the UK implementation of EN 437:2018. It supersedes BS EN 437:2003+A1:2009, which is withdrawn.

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d'appareils

Prüfgase - Prüfdrücke - Gerätekategorien

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Contents

Page

European foreword.....	4
1 Scope.....	5
2 Normative references.....	5
3 Terms and definitions	5
4 Gases	8
4.1 Classification in gas families and groups.....	8
4.2 Test gases	9
5 Test pressures	13
6 Classification of appliances	15
6.1 Appliance categories.....	15
6.1.1 General.....	15
6.1.2 Category I	15
6.1.3 Category II.....	16
6.1.4 Category III	17
6.2 Operations permitted for a change of gas or pressure, adjustment and regulating devices.....	18
7 Choice of test gases and test pressures	18
8 Marking.....	19
Annex A (normative) Conditions for preparation of the test gases	20
Annex B (informative) National situations	21
B.1 General.....	21
B.2 Categories listed in the body of the standard marketed in the different countries.....	21
B.3 Appliance supply pressures corresponding to the categories given in B.1 and B.2	24
B.4 Special categories marketed nationally or locally.....	28
B.4.1 General.....	28
B.4.2 Categories	33
B.4.2.1 General.....	33
B.4.2.2 Category I	33
B.4.2.2.1 Appliances designed for the use of gases linked to the first family	33
B.4.2.2.2 Appliances designed for the use of gases of the second family and the gases linked to it.....	33
B.4.2.2.3 Appliances designed for the use of gases of the third family	35
B.4.2.3 Category II.....	35
B.4.2.3.1 Appliances designed to use gases of the first family or that are linked to it and gases of the second family or that are linked to it.....	35
B.4.2.3.2 Appliances designed for the use of gases of the second family or that are linked to it and gases of third family.....	36

B.4.2.4 Category III	38
B.5 Test gases and test pressures corresponding to the special categories given in B.4	40
B.6 Special conditions	47
B.7 National and local gas distribution specifications relevant for defining appliance categories given in B.4	54
Annex C (informative) Guidelines for extension to other categories.....	55
Annex D (informative) National situation of countries whose national bodies are CEN affiliate members	56
D.1 General.....	56
D.2 Categories listed in the body of the standard and marketed in the different countries.....	56
D.3 Supply pressures of the appliances	58
Annex E (informative) Relationship between the distributed gases and the corresponding test gases.....	59
Bibliography.....	60

European foreword

This document (EN 437:2018) has been prepared by Technical Committee CEN/TC 238 “Test gases, test pressures, appliance categories and gas appliance types”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2019, and conflicting national standards shall be withdrawn at the latest by May 2019.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights

This document supersedes EN 437:2003+A1:2009.

EN 437 is intended to provide all the CEN Technical Committees preparing standards on gas appliances with definitions for test gases, test pressures and categories of appliances for use by these committees within the limits of the scope defined in Clause 1.

The standard seeks to clarify the present situation with respect to test gases, test pressures and appliance categories.

The concern for clarity has led to the elucidation of numerous categories and national situations or conditions. The complexity of the standard is likely to increase as new members join the Union.

This standard can be considered as an important stage in the harmonization of test gases, test pressures and appliance categories and the quality of information on gas usage in Europe.

This revised European Standard incorporates the previously published amendment and includes new appliance categories, the reason for which is the introduction of modified appliance categories in countries, due to national changes in the gas distribution.

The standard also applies to countries whose national standardization body is affiliate member of CEN (see Annex D).

Annex B gives national situations relating to gases, gas pressures and appliance categories that apply nationally or locally. The information provided is included under the responsibility of the national standardization bodies. The tables of Annex B give the available information. Therefore Annex B is informative.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This document specifies the test gases, test pressures and categories of appliances relative to the use of gaseous fuels of the first, second and third families. It serves as a reference document in the specific standards for appliances that fall within the scope of the Council Directive on the approximation of the laws of Member States concerning gas appliances 2009/142/EC.

The standard makes recommendations for the use of the gases and pressures to be applied for the tests. The full procedure will be given in the corresponding appliance standards.

NOTE The test gases and the test pressures specified in this standard are in principle intended to be used with all the appliances in order to establish conformity with the corresponding standards.

However, the use of some test gases and test pressures may not be appropriate in the following cases:

- appliances with nominal heat input greater than 300 kW;
- appliances constructed on site;
- appliances in which the final design is influenced by the user;
- appliances constructed for use with high supply pressures (notably direct use of the saturated vapour pressure).

In these cases, the specific appliance standards may specify other test conditions in order to establish compliance with their requirements.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN ISO 3166-1:2014, *Codes for the representation of names of countries and their subdivisions — Part 1: Country codes (ISO 3166-1:2013)*

EN ISO 6976:2016, *Natural gas — Calculation of calorific values, density, relative density and Wobbe indices from composition (ISO 6976:2016)*

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:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

gas appliance

appliance burning gaseous fuels

Note 1 to entry For the purposes of this standard the term “gaseous fuels” means any fuel that is in the gaseous state at a temperature of 15 °C, and under a pressure of 1 bar.

3.2

distributed gases

gaseous fuels used on the territory of the CEN members and affiliated members

Note 1 to entry This definition corresponds to the one given in the Directive 2009/142/EC on gas appliances (article 2.2).

Note 2 to entry The list of CEN members is given in Annex B and the one of affiliated members is given in Annex D.

3.3

test gases

gases intended for the verification of the operational characteristics of gas appliances. They consist of reference gases and limit gases

3.4

reference gases

test gases with which appliances operate under nominal conditions when they are supplied at the corresponding normal pressure

3.5

limit gases

test gases representative of the extreme variations in the characteristics of the gases for which appliances have been designed

3.6

test pressures

gas pressures used to verify the operational characteristics of gas appliances. They consist of normal and limit pressures

Note 1 to entry The gas pressures used are expressed in millibars (mbar) $1 \text{ mbar} = 10^2 \text{ Pa}$.

3.7

normal pressure (p_n)

pressure under which the appliances operate in nominal conditions when they are supplied with the corresponding reference gas

3.8

limit pressures

maximum pressure: $p_{\max}$; minimum pressure: $p_{\min}$

pressures representative of the extreme variations in the appliance supply conditions

3.9

pressure couple

combination of two distinct gas distribution pressures applied by reason of the significant difference existing between the Wobbe indices within a single family or group in which

- the higher pressure corresponds only to gases of low Wobbe index;
- the lower pressure corresponds to gases of high Wobbe index.

Note 1 to entry The pressure couple is indicated by using the symbol ($\rightleftharpoons$).

3.10

reference conditions

these correspond to 15 °C, 1 013, 25 mbar, unless otherwise specified

3.11**relative density (d)**

ratio of the masses of equal volumes of dry gas and dry air under the same conditions of temperature and pressure: 15 °C or 0 °C and 1 013,25 mbar

3.12**calorific value**

quantity of heat produced by the complete combustion, at a constant pressure equal to 1 013,25 mbar, of a unit volume or mass of gas, the constituents of the combustible mixture being taken at reference conditions and the products of combustion being brought back to the same conditions

A distinction is made between:

- the gross calorific value H_g : the water produced by combustion is assumed to be condensed;
- the net calorific value H_i : the water produced by combustion is assumed to be in the vapour state

Note 1 to entry The calorific value is expressed:

- either in megajoules per cubic metre (MJ/m^3) of dry gas under the reference conditions;
- or in megajoules per kilogram (MJ/kg) of dry gas.

3.13**Wobbe index****gross Wobbe index W_g ; net Wobbe index W_i**

ratio of the calorific value of a gas per unit volume and the square root of its relative density under the same reference conditions. The Wobbe index is said to be gross or net according to whether the calorific value used is the gross or net calorific value

Note 1 to entry The Wobbe indices are expressed in megajoules per cubic metre (MJ/m^3) of dry gas under the reference conditions.

3.14**heat input (Q)**

quantity of energy used in unit time corresponding to the volumetric or mass flow rates, the calorific value used being either the net or gross calorific value

Note 1 to entry The heat input is expressed in kilowatts (kW).

3.15**nominal heat input (Q_n)**

value of the heat input declared by the manufacturer

3.16**mass flow rate (M)**

mass of gas consumed by the appliance in unit time during continuous operation

Note 1 to entry The mass flow rate is expressed in kilograms per hour (kg/h) or grams per hour (g/h).

3.17**volume flow rate (V)**

volume of gas consumed by the appliance in unit time during continuous operation

Note 1 to entry The volume flow rate is expressed in cubic metres per hour (m^3/h), litres per minute (l/min), cubic decimetres per hour (dm^3/h) or cubic decimetres per second (dm^3/s).

3.18

gas family

group of gaseous fuels with similar burning behaviour linked together by a range of Wobbe indices (see Table 1)

3.19

gas group

specified range of Wobbe index within that of the family concerned (see Table 1); this range is determined on the general principle that appliances utilising this gas group would operate safely when burning all gases within this range without adjustments

Note 1 to entry Adjustment of the appliance may be permitted in accordance with the special national or local conditions that apply in some countries (see B.4). For gases corresponding to national or local conditions, see Tables B.5, B.6 and B.7.

3.20

appliance category

means of identifying the gas families and/or gas groups that a gas appliance is designed to utilize safely and to the desired performance level (see individual appliance standards)

Note 1 to entry General appliance categories are described in 6.1. Special appliance categories marketed nationally or locally are described in B.4 and Annex D.

4 Gases

4.1 Classification in gas families and groups

Gases are classified into three families, each family may be divided into groups, (themselves being divided into ranges, see Annex B), as a function of the Wobbe index, according to the values given in Table 1.

NOTE The classification given in Table 1 is used by Member states for the communication of the types of gas used in their territory according to Article 2.2 of the Gas Appliances Directive 2009/142/EC.

Table 1 — Classification of gas families and groups as a function of the Wobbe indices, dry gas at 15 °C and 1 013,25 mbar

Gas families and groups	Gross Wobbe index, dry gas at 15 °C and 1 013,25 mbar MJ/m ³	
	Minimum	Maximum
First family		
— Group a	22,4	24,8
Second family	39,1	54,7
— Group H	45,7	54,7
— Group L	39,1	44,8
— Group E	40,9	54,7
Third family	72,9	87,3
— Group B/P	72,9	87,3
— Group P	72,9	76,8
— Group B	81,8	87,3

4.2 Test gases

The composition and principal characteristics of the different test gases corresponding to the gas families or groups are given in Tables 2 and 3.

In particular cases specified in the individual appliance standards, gas G 24, whose characteristics are given in Table 3, may be used but only at the normal test pressure.

The calorific values of the third family gases, expressed in mega joules per cubic metre in Table 2, may also be expressed in mega joules per kilogram of dry gas, as shown in Table 3.

The values in Tables 2 and 3, measured and expressed at 15 °C, are derived from EN ISO 6976:2016.

The conditions for the preparation of the test gases are given in Annex A.

NOTE The characteristics for second family gases at reference conditions other than 15 °C for metering and 15 °C for combustion can be calculated using the coefficients given in EN ISO 13443:2005, Annex A (normative). As an example the characteristics of the reference gases of the second family at 0 °C for metering and for combustion and 1 013,25 mbar (dry gas) are given in Table 4.

Table 2 — Characteristics of the test gases ^a for the first and second families, gas dry at 15 °C and 1 013,25 mbar

Gas family and Group	Test gases	Designation	Composition by volume % ^c	W_i MJ/m ³	H_i MJ/m ³	W_s MJ/m ³	H_s MJ/m ³	d
Gases of the first family ^b								
Group a	Reference gas	G 110	CH ₄ = 26 H ₂ = 50 N ₂ = 24	21,76	13,95	24,75	15,87	0,411
	Incomplete combustion, flame lift and sooting limit gas							
	Light back limit gas	G 112	CH ₄ = 17 H ₂ = 59 N ₂ = 24	19,48	11,81	22,36	13,56	0,367
Gases of the second family ^b								
Group H	Reference gas	G 20	CH ₄ = 100	45,67	34,02	50,72	37,78	0,555
	Incomplete combustion and sooting limit gas	G 21	CH ₄ = 87 C ₃ H ₈ = 13	49,60	41,01	54,69	45,28	0,684
	Light back limit gas	G 222	CH ₄ = 77 H ₂ = 23	42,87	28,53	47,87	31,86	0,443
	Flame lift limit gas	G 23	CH ₄ = 92,5 N ₂ = 7,5	41,11	31,46	45,66	34,95	0,586
	Over heating limit gas ^d	G 24	CH ₄ = 68 C ₃ H ₈ = 12 H ₂ = 20	47,01	35,70	52,09	39,55	0,577
Group L	Reference gas light back limit gas	G 25	CH ₄ = 86 N ₂ = 14	37,38	29,25	41,52	32,49	0,612

Gas family and Group	Test gases	Designation	Composition by volume % ^c	W_i MJ/m ³	H_i MJ/m ³	W_s MJ/m ³	H_s MJ/m ³	d
	Incomplete combustion and sooting limit gas	G 26	CH ₄ = 80 C ₃ H ₈ = 7 N ₂ = 13	40,52	33,36	44,83	36,91	0,678
	Flame lift limit gas	G 27	CH ₄ = 82 N ₂ = 18	35,17	27,89	39,06	30,98	0,629
Group E	Reference gas	G 20	CH ₄ = 100	45,67	34,02	50,72	37,78	0,555
	Incomplete combustion and sooting limit gas	G 21	CH ₄ = 87 C ₃ H ₈ = 13	49,60	41,01	54,76	45,28	0,684
	Light back limit gas	G 222	CH ₄ = 77 H ₂ = 23	42,87	28,53	47,87	31,86	0,443
	Flame lift limit gas	G 231	CH ₄ = 85 N ₂ = 15	36,82	28,91	40,90	32,11	0,617
	Over heating limit gas ^d	G 24	CH ₄ = 68 C ₃ H ₈ = 12 H ₂ = 20	47,01	35,70	52,09	39,55	0,577

^a For gases used nationally or locally, see B.5.

^b For other groups, see B.5.

^c See also Annex A.

^d Limit gas used only for certain types of appliance, specified in the individual appliance standards (e.g. fully premixed burners, forced draught burners, ...).

Table 3 — Characteristics of the test gases^a for the third family, gas dry at 15 °C and 1 013,25 mbar

NOTE The characteristics for second family gases at reference conditions other than 15 °C for metering and 15 °C for combustion can be calculated using the coefficients given in EN ISO 13443:2005, Annex A (normative). As an example the characteristics of the reference gases of the second family at 0 °C for metering and for combustion and 1 013,25 mbar (dry gas) are given in Table 4.

Gas family and Group	Test gases	Designation	Composition by volume	W_i	H_i		W_s	H_s		d
			% c	MJ/m ³	MJ/m ³	MJ/kg	MJ/m ³	MJ/m ³	MJ/kg	
Gases of the third family ^b										
Groups B/ P and B	Reference gas	G 30	n- C ₄ H ₁₀ = 50	80,58	116,09	45,65	87,33	125,81	49,47	2,075
	Incomplete combustion and sooting limit gas		i- C ₄ H ₁₀ = 50							
	Flame lift limit gas	G 31	C ₃ H ₈ = 100	70,69	88,00	46,34	76,84	95,65	50,37	1,550
	Light back limit gas	G 32	C ₃ H ₆ = 100	68,14	82,78	45,77	72,86	88,52	48,94	1,476
Group P	Reference gas, Incomplete combustion, flame lift and sooting ^a limit gas	G 31	C ₃ H ₈ = 100	70,69	88,00	46,34	76,84	95,65	50,37	1,550
	Light back and sooting limit gas ^d	G 32	C ₃ H ₆ = 100	68,14	82,78	45,77	72,86	88,52	48,94	1,476

^a For gases used nationally or locally, see B.5.

^b For other groups, see B.5.

^c See also Annex A.

^d Limit gas used only for certain types of appliance, specified in the individual appliance standards (e.g. fully premixed burners, forced draught burners, ...).

Table 4 — Characteristics of the reference gases of the second family at 0 °C and 1 013,25 mbar

Gas group	Test gas	Designation	Composition by volume %	W_i MJ/m ³	H_i MJ/m ³	W_s MJ/m ³	H_s MJ/m ³	d
Group H	Reference gas	G 20	CH ₄ = 100	48,20	35,90	53,61	39,94	0,555
Group L	Reference gas, light back limit gas	G 25	CH ₄ = 86 N ₂ = 14	39,45	30,87	43,88	34,34	0,613
Group E	Reference gas	G 20	CH ₄ = 100	48,20	35,90	53,61	39,94	0,555

5 Test pressures

The values of the test pressures, i.e. the static pressure to be applied at the gas inlet connection to the appliance whilst in operation, are given in Tables 5 and 6.

NOTE The test conditions are specified in the individual appliance standards.

However:

- for the combustion test in still air with G 21 the appliance is first adjusted on G 20 to give an increase of 5 % in the nominal heat input where a gas pressure governor exists, and an increase of 7,5 % in the absence of a governor. Gas G 21 is then substituted for G 20 without altering this adjustment;
- tests for ignition and crosslighting should be carried out at an inlet pressure of 0,7 times the normal pressure (p_n) using the reference gas(es) for the first and second families.

Table 5 — Test pressures where no pressure couple exists ^a

Pressures in millibars

Appliance categories having as index	Test gas	P_n	P_{min}	P_{max}
1 st family 1a	G 110 G 112	8	6	15
2 nd family 2H	G 20, G 21, G 222, G 23	20	17	25
2 nd family 2L	G 25, G 26, G 27	25	20	30
2 nd family 2E	G 20, G 21, G 222, G 231	20	17	25
2 nd family 2N d	G 20, G 21, G 222, G 231, G 25, G 26, G 27 ^a	20	17	30
	G 25, G 26, G 27	25	20	30
3 rd family 3B/P	G 30, G 31, G 32	29 ^b	25	35
	G 30, G 31, G 32	50	42,5	57,5
3 rd family, 3P	G 31, G 32	30	25	35
3 rd family 3P	G 31, G 32	37	25	45
	G 31, G 32	50	42,5	57,5
3 rd family 3B ^c	G 30, G 31, G 32	29	20	35

^a For test pressures corresponding to gases distributed nationally or locally, refer to Table B.5.

^b Appliances of this category may be used, without adjustment, at the specified supply pressures of 28 mbar to 30 mbar.

^c The tests with G 31 and G 32 are carried out at the normal pressure only ($p_n = 29$ mbar), these test gases being more severe than any gas distributed. This condition covers the normal variations in the gas supply.

^d See definition in 6.1.2.3.

Table 6 — Test pressures where a pressure couple exists

Pressures in millibars

Appliance categories having as index	Test gas	p_n	p_{min}	p_{max}
2 nd family: 2E+ (20↔25 couple)	G 20, G 21, G 222, G 231	20	17	25
	G25, G26, G27	(25) ^a	20 ^b	30
3 rd family: 3+ (28–30↔37 couple)	G 30	29 ^c	20	35
	G 31, G 32	37	25	45
3 rd family: 3+ (50↔67 couple)	G 30	50	42,5	57,5
	G 31, G 32	67	50	80
3 rd family: 3+ (112↔148 couple)	G 30	112	60	140
	G 31, G32	148	100	180
^a This pressure corresponds to the use of low Wobbe index gas but in principle no test is carried out at this pressure. ^b See B.6. ^c Appliances of this category may be used without adjustment at the specified supply pressures of 28 mbar to 30 mbar.				

6 Classification of appliances

6.1 Appliance categories

6.1.1 General

Appliances are classified into categories defined according to the gases and the pressures for which they are designed.

The definition of the categories follows from 6.1.2, 6.1.3 and 6.1.4.

In each country, taking account of the local gas distribution conditions (gas composition and supply pressures), only some of the categories defined in 6.1.2, 6.1.3 and 6.1.4 are marketed. In addition, some of these categories are used only for certain types of appliance as specified in the individual standards.

The conditions concerning the marketing of these appliance categories in each country and the corresponding supply pressures are given in Tables B.1, B.2 and B.3 (see also B.4 for the categories marketed locally and nationally, corresponding to the gases and specific supply pressures given in Table B.5; B.6 gives the particular conditions specific to certain countries).

NOTE See also Annex C - Guidelines for extension to other categories.

6.1.2 Category I

6.1.2.1 General

Appliances of category I are designed exclusively for the use of gases of a single family or of a single group.

6.1.2.2 Appliances designed for use on first family gases only

Category I_{1a}: appliances using only gases of group a of the first family at the prescribed supply pressure (this category is not used).

6.1.2.3 Appliances designed for use on second family gases only

Category I_{2H}: appliance using only gases of group H of the second family at the prescribed supply pressure.

Category I_{2L}: appliances using only gases of group L of the second family at the prescribed supply pressure.

Category I_{2E}: appliances using only gases of group E of the second family at the prescribed supply pressure.

Category I_{2E+}: appliances using only gases of group E of the second family, and operating with a pressure couple without adjustment on the appliance. The appliance gas pressure regulating device, if it exists, is not operative at pressures in between the two normal pressures of the pressure couple.

Category I_{2N}: appliances using only second family gases at the prescribed supply pressure and that automatically adapt to all gases of the second family.

Category I_{2R}: appliances having a pressure regulator which can be manually adjusted in order to utilize each of the following gas groups: H, E, L, K and LL (see also Table B.6).

6.1.2.4 Appliances designed for use on 3rd family gases only

Category I_{3B/p}: appliances capable of using the third family gases (propane and butane) at the prescribed supply pressure.

Category I₃₊: appliances capable of using gases of the third family (propane and butane) and operating with a pressure couple without adjustment of the appliance. However, for certain types of appliance specified in the particular standards, adjustment of the primary combustion air may be permitted when changing from propane to butane and vice versa. No gas pressure regulating device is permitted on the appliance.

Category I_{3p}: appliances using only gases of group P of the third family (propane) at the prescribed supply pressure.

Category I_{3B}: appliances using only gases of group B of the third family (butane) at the prescribed supply pressure.

Category I_{3R}: appliances having a pressure governor using all the gases of the third family which can be adjusted manually in order to utilize the various gases of a group of the third family under the local condition of distribution (see Table B.7).

6.1.3 Category II

6.1.3.1 General

Appliances of category II are designed for use on gases of two families:

6.1.3.2 Appliances designed for use on gases of the first and second families

Category II_{1a2H}: appliances capable of using gases of group a of the first family and gases of group H of the second family. The first family gases are used under the same conditions as for category I_{1a}. The second family gases are used under the same conditions as for category I_{2H}.

6.1.3.3 Appliances designed for use on gases of the second and third families

Category II_{2H3B/p}: appliances capable of using gases of group H of the second family and gases of the third family. The second family gases are used under the same conditions as for category I_{2H}. The third family gases are used under the same conditions as for category I_{3B/p}.

Category II_{2H3+}: appliances capable of using gases of group H of the second family and gases of the third family. The second family gases are used under the same conditions as for category I_{2H}. The third family gases are used under the same conditions as for category I₃₊.

Category II_{2H3P}: appliances capable of using gases of group H of the second family and gases of group P of the third family. The second family gases are used under the same conditions as for category I_{2H}. The third family gases are used under the same conditions as for category I_{3P}.

Category II_{2L3B/p}: appliances capable of using gases of group L of the second family and gases of the third family. The second family gases are used under the same conditions as for category I_{2L}. The third family gases are used under the same conditions as for category I_{3B/p}.

Category II_{2L3P}: appliances capable of using the gases of group L of the second family and gases of Group P of the third family. The second family gases are under the same conditions as for category I_{2L}. The third family gases are used under the same conditions as for category I_{3P}.

Category II_{2E3B/p}: appliances capable of using gases of group E of the second family and gases of the third family. The second family gases are used under the same conditions as for category I_{2E}. The third family gases are used under the same conditions as for category I_{3B/p}.

Category II_{2E+3B/p}: appliances capable of using gases of group E of the second family and gases of the third family. The second family gases are used under the same conditions as for category I_{2E+}. The third family gases are used under the same conditions as for category I_{3B/p}.

Category II_{2E+3+}: appliances capable of using gases of Group E of the second family and gases of the third family. The second family gases are used under the same conditions as for category I_{2E+}. The third family gases are used under the same conditions as for category I₃₊.

Category II_{2E+3P}: appliances capable of using gases of group E of the second family and gases of group P of the third family. The second family gases are used under the same conditions as for category I_{2E+}. The third family gases are used under the same conditions as for category I_{3P}.

Category II_{2R3R}: appliances having a pressure governor using all the gases of the second family and/or gases linked to the second family and all the gases of the third family which can be adjusted manually in order to utilize the various gases of a group of the second family under the local conditions of distribution. The second family gases are used under the same conditions as for category I_{2R}. The third family gases are used under the same conditions as for category I_{3R} (see Tables B.6 to B.8)

6.1.4 Category III

Appliances of category III are designed for use on gases of three families.

This category is not in general use.

The categories III accepted in specific countries are given in Annex B (see B.4).

6.2 Operations permitted for a change of gas or pressure, adjustment and regulating devices

The individual appliance standards will specify:

- the operations permitted for a change of gas or of pressure;

As far as possible the permitted conversion operations should be limited so as to ensure that the conversion may be effected without difficulty.

- the conditions applicable to adjustment and regulation devices.

7 Choice of test gases and test pressures

According to the appliance category:

- the tests are carried out with the gases given in Table 7;
- the test pressures are chosen from Tables 5 and 6, as appropriate, as a function of the test gas and in accordance with the requirements given in the individual appliance standards.

Table 7 — Test gases corresponding to the appliance categories a, b

Category	Reference gas	Incomplete combustion limit gas	Light back limit gas	Lift limit gas	Sooting limit gas
I ₂ H	G 20	G 21	G 222	G 23	G 21
I ₂ L	G 25	G 26	G 25	G 27	G 26
I ₂ E	G 20	G 21	G 222	G 231	G 21
I ₂ E+	G 20 G 25	G 21 G 26	G 222 G 25	G 231 G 27	G 21 G 26
I ₂ N	G 20 c d G 25 c d	G 21 d G 26 d	G 222 d G 25 d	G 231 d G 27 d	G 21 d G 26 d
I ₂ R ^e					
I ₃ B/P, I ₃ +	G 30	G 30	G 32	G 31	G 30
I ₃ P	G 31	G 31	G 32	G 31	G 31, G 32
I ₃ B	G 30	G 30	G 32	G 31	G 30
I ₃ R ^f					
II _{1a2} H	G 110, G 20	G 21	G 112	G 23	G 21
II ₂ H ₃ B/P, II ₂ H ₃ +	G 20, G 30	G 21	G 222, G 32	G 23, G 31	G 30
II ₂ H ₃ P	G 20, G 31	G 21	G 222, G 32	G 23, G 31	G 31, G 32
II ₂ L ₃ B/P	G 25, G 30	G 26	G 32	G 27, G 31	G 30