BRITISH STANDARD

BS EN 777-1:2009

Multi-burner gas-fired overhead radiant tube heater systems for non-domestic use

Part 1: System D — Safety

ICS 97.100.20

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National foreword

This British Standard is the UK implementation of EN 777-1:2009. It supersedes BS EN 777-1:1999 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GSE/20, Non-domestic space heaters (gas).

A list of organizations represented on this committee can be obtained on request to its secretary.

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Multi-burner gas-fired overhead radiant tube heater systems for non-domestic use - Part 1: System D - Safety

Tubes radiants suspendus à multi-brûleurs utilisant les combustibles gazeux à usage non-domestique - Partie 1 : Système D - Sécurité

Dunkelstrahlersysteme mit mehreren Brennern mit Gebläse für gewerbliche und industrielle Anwendung - Teil 1: System D - Sicherheit

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Foreword

This document (EN 777-1:2009) has been prepared by Technical Committee CEN/TC 180 “Domestic and non-domestic gas fired air heaters and non-domestic gas fired overhead radiant heaters”, 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of an identical text or by endorsement, at the latest by September 2009, and conflicting national standards shall be withdrawn at the latest by September 2009.

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

This document supersedes EN 777-1:1999.

This revision modifies EN 777-1:1999. It has been prepared to incorporate requirements for combustion products evacuation ducts, POCEDs, supplied as an integral part of the system to support the EU Directive 89/106/EEC on construction products under mandate M/105. To this end the systems within the scope of this standard are now defined as Type B_{52} rather than Type B_{22}.

Furthermore, the opportunity presented by this revision has been taken to update the standard in respect to EN 437:2003.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EC Directive(s).

For relationship with EC Directive(s), see informative Annexes ZA and ZB, which are integral parts of this document.

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

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1 Scope

This European Standard specifies the requirements and test methods for the construction, safety, classification and marking of non-domestic gas-fired overhead radiant tube heaters incorporated into a multi-burner system (called system D and referred to in the body of the text as the “system”) with each burner unit under the control of an automatic burner control system.

This standard is applicable to Type B_{52} systems (see 4.3) intended for use in other than domestic dwellings, in which the supply of combustion air and/or the evacuation of the products of combustion is achieved by mechanical means.

This standard is not applicable to:

a) systems designed for use in domestic dwelling;

b) outdoor systems;

c) systems of heat input in excess of 120 kW (based on the net calorific value of the appropriate reference test gas);

d) systems having a draught diverter;

e) systems having fully pre-mixed gas and air burners in which:

1) either the gas and all the combustion air are brought together just before the level of the combustion zone; or

2) the pre-mixing of the gas and all combustion air is carried out in a part of the burner upstream of the combustion zone;

f) systems that are designed for continuous condensation within the flue system under normal operating conditions;

g) systems having combustion products evacuation ducts that are non-metallic.

This standard is applicable to systems which are intended to be type tested. It also includes requirements concerning the evaluation of conformity, including factory production control, but these requirements only apply to POCEDs and their associated terminals.

NOTE Requirements for systems which are not intended to be type tested would need to be subject to further consideration.

Requirements concerning the rational use of energy have not been included in this European Standard.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the editions cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 88-1:2007, *Pressure regulators and associated safety devices for gas appliances - Part 1: Pressure regulators for inlet pressures up to and including 500 mbar*

EN 126:2004, *Multifunctional controls for gas burning appliances*

EN 161:2007, *Automatic shut-off valves for gas burners and gas appliances*

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EN 257, *Mechanical thermostats for gas-burning appliances*

EN 298:2003, *Automatic gas burner control systems gas burners and gas burning appliances with or without fans*

EN 437:2003, *Test gases - Test pressures - Appliance categories*

EN 10226-1:2004, *Pipe threads where pressure-tight joints are made on the threads – Part 1: Taper external threads and parallel internal threads - Dimensions, tolerances and designation*

EN 10226-2:2005, *Pipe threads where pressure tight joints are made on the threads – Part 2: Taper external threads and taper internal threads - Dimensions, tolerances and designation*

EN 60335-1:2002, H*ousehold and similar electrical appliances – Safety - Part 1: General requirements*

EN 60335-2-102:2006, H*ousehold and similar electrical appliances – Safety - Part 2-102: Particular requirements for gas, oil and solid-fuel burning having electrical connections*

EN 60529:1992, *Degrees of protection provided by enclosures (IP code)*

EN 60584-1:1995, *Thermocouples — Part 1: Reference tables*

EN 60584-2:1993, *Thermocouples — Part 2: Tolerances*

EN ISO 228-1:2003, *Pipe threads where pressure-tight joints are not made on the threads - Part 1: Dimensions, tolerances and designation (ISO 228-1:2000)*

EN ISO 3166-1:2006, *Codes for the representation of names of countries and their subdivisions – Part 1: Country codes (ISO 3166-1:2006)*

EN ISO 6976:2005, *Natural gas - Calculation of the calorific value, density, relative density and Wobbe index from composition (ISO 6976:1995 including Corrigendum 1:1997, Corrigendum 2:1997 and Corrigendum 3:1999)*

ISO 7005-1:1992, *Metallic flanges - Part 1: Steel flanges*

ISO 7005-2:1988, *Metallic flanges - Part 2: Cast iron flanges*

ISO 7005-3:1988, *Metallic flanges - Part 3: Copper flanges and composite flanges*

CR 1404:1994, *Determination of emissions from appliances burning gaseous fuels during type testing.*

3 Terms and definitions

For the purposes of this standard the following terms and definitions apply:

3.1 System and its constituent parts

3.1.1
overhead radiant tube heater
gas-fired appliance intended for installation above head level which is designed to heat the space beneath by radiation by means of a tube or tubes, heated by the internal passage of combustion products

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3.1.2
multi-burner systems
those radiant tube heater systems which employ two or more burner units with each unit incorporating independent flame monitoring.

NOTE The units may be located in one or more sections of tubing. One or more fans may be used to assist in the evacuation of products of combustion or the supply of combustion air

System D: system in which individual units without fans are connected to a common duct with a fan. Only one burner unit is situated in each branch tube (see Annex B).

Two arrangements of system D are recognized:

a) system D_1: having branched tubes which may be of such short length that the flame produced at the burner may extend into the common duct

b) system D_2: having branched tubes of sufficient length that the flame produced at the burner cannot extend into the common duct

3.1.3
branch tube
for the purposes of this part, a tube in which only one burner unit is situated and which only contains the products of combustion generated by this burner

3.1.4
common duct
duct which receives products of combustion from two or more branch tubes for the purposes of evacuation to the outside

3.1.5
individual burner unit
unit comprising a main burner and, if appropriate, an ignition burner. In addition, such components as are necessary to ignite the burner(s), monitor the flame and control the gas supply to the burner(s) are included in the unit

3.1.6
inlet connection
part of the system intended to be connected to the gas supply

3.1.7
mechanical joint (mechanical means of obtaining soundness)
means of ensuring the soundness of an assembly of several (generally metallic) parts without the use of liquids, pastes, tapes, etc.

NOTE For example the following:

a) metal to metal joints;

b) conical joints;

c) toroidal sealing rings (“O” rings);

d) flat joints.

3.1.8
gas circuit
part of the burner unit that conveys or contains the gas between the burner unit gas inlet connection and the burner(s)

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3.1.9
restrictor
device with an orifice, which is placed in the gas circuit so as to create a pressure drop and thus reduce the gas pressure at the burner to a predetermined value for a given supply pressure and rate

3.1.10
gas rate adjuster
component allowing an authorized person to set the gas rate of the burner to a predetermined value according to the supply conditions

NOTE 1 Adjustment can be progressive (screw adjuster) or in discrete steps (by changing restrictors).

NOTE 2 The adjusting screw of an adjustable regulator is regarded as a gas rate adjuster.

NOTE 3 The action of adjusting this device is called “adjusting the gas rate”.

NOTE 4 A factory sealed gas rate adjuster is considered to be non-existent.

3.1.11
setting an adjuster
immobilizing a gas rate adjuster by such means as e.g. a screw after the gas rate has been adjusted by the manufacturer or installer

3.1.12
sealing an adjuster
term applied to any arrangement in respect of the adjuster such that any attempt to change the adjustment breaks the sealing device or sealing material and makes this interference apparent

NOTE A factory sealed adjuster, i.e. an adjuster sealed by the system manufacturer, is considered to be non-existent.

A regulator is considered to be non-existent if it has been factory sealed, i.e. by the system manufacturer in a position such that it is not operational in the range of the normal supply pressure corresponding to the system category.

3.1.13
putting an adjuster or a control out of service
adjuster or a control (of temperature, pressure, etc.) is said to be “put out of service” if it is put out of action and sealed in this position. The burner unit then functions as if this device has been removed

3.1.14
injector
component that admits the gas into a burner

3.1.15
main burner
burner that is intended to ensure the thermal function of the system and is generally called the burner

3.1.16
ignition device
means (e.g. flame, electrical ignition device or other device) used to ignite the gas at the ignition burner or at the main burner

NOTE This device can operate intermittently or permanently.

3.1.17
ignition burner
burner whose flame is intended to ignite another burner

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3.1.18
primary aeration adjuster
device enabling the primary air to be set at the desired value according to the supply conditions

3.1.19
combustion products circuit
circuit consisting of:

3.1.19.1
combustion chamber
enclosure inside which combustion of the air-gas mixture takes place

3.1.19.2
flue outlet
part of a Type B system that connects with a flue to evacuate the products of combustion

3.1.19.3
draught diverter
device placed in the combustion products circuit to reduce the influence of flue-pull and that of down-draught on the burner performance and combustion

3.1.19.4
POCED
combustion products evacuation duct that is intended to be used only with a specific appliance/system; this duct being either supplied with the appliance/system or specified in the manufacturer's instructions

3.1.20
range-rating device
component on the burner unit intended to be used by the installer to adjust the heat input of the burner unit, within a range of heat inputs stated by the manufacturer, to suit the actual heat requirements of the installation

This adjustment may be progressive (e.g. by use of a screw adjuster) or in discrete steps (e.g. by changing restrictors).

3.1.21
zero regulator
device which maintains a specified downstream pressure between it and a gas orifice at zero pressure within fixed limits independent of variation within a given range of upstream pressure and negative pressure downstream of the gas orifice

3.2 Adjusting, control and safety devices

3.2.1
automatic burner control system
system comprising at least a programming unit and all the elements of a flame detector device

The various functions of an automatic burner control system may be in one or more housings.

3.2.2
programming unit
device which reacts to signals from control and safety devices, gives control commands, controls the start-up sequence, supervises the burner operation and causes controlled shut-down, and if necessary safety shut-down and lock-out.

NOTE The programming unit follows a predetermined sequence of actions and always operates in conjunction with a flame detector device

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3.2.3
programme
sequence of control operations determined by the programming unit involving switching on, starting up, supervising and switching off the burner

3.2.4
flame detector
device by which the presence of a flame is detected and signalled

NOTE It can consist of a flame sensor, an amplifier and a relay for signal transmission. These parts, with the possible exception of the actual flame sensor, may be assembled in a single housing for use in conjunction with a programming unit.

3.2.5
flame signal
signal given by the flame detector device, normally when the flame sensor senses a flame

3.2.6
flame simulation
condition which occurs when the flame signal indicates the presence of a flame when in reality no flame is present

3.2.7
pressure regulator[1]
device which maintains the outlet pressure constant independent of the variations in inlet pressure within defined limits

3.2.8
adjustable pressure regulator
regulator provided with means for changing the outlet pressure setting

3.2.9
flame supervision device
device that, in response to a signal from the flame detector, keeps the gas supply open and shuts it off in the absence of the supervised flame

3.2.10
automatic shut-off valve
device that automatically opens, closes or varies the gas rate on a signal from the control circuit and/or the safety circuit

3.3 System operation

3.3.1
heat input
Q
quantity of energy used in unit time corresponding to the volumetric or mass flow rates: the calorific value used being the net or gross calorific value

NOTE The heat input is expressed in kilowatts (kW) [EN 437:2003].

3.3.2
nominal heat input
Q_n
value of the heat input (kW) declared by the manufacturer

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[1] The term “regulator” is used in this case and for a volume regulator.

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3.3.3
volume flow rate (*V*)
V
volume of gas consumed by the appliance in unit time during continuous operation

NOTE The volume flow rate is expressed in m^3/h, l/min, dm^3/h or dm^3/s [EN 437:2003].

3.3.4
mass flow rate
M
mass of gas consumed by the appliance in unit time during continuous operation

NOTE The mass flow rate is expressed in kg/h or g/h [EN 437:2003].

3.3.5
flame stability
characteristic of flames which remain on the burner ports or in the flame reception zone intended by the construction

3.3.6
flame lift
total or partial lifting of the base of the flame away from the burner port or the flame reception zone provided by the design

Flame lift may cause the flame to blow out, i.e. extinction of the air-gas mixture.

3.3.7
light-back
entry of a flame into the body of the burner

3.3.8
light-back at the injector
ignition of the gas at the injector, either as a result of light-back into the burner or by the propagation of a flame outside the burner

3.3.9
sooting
phenomenon appearing during incomplete combustion and characterized by deposits of soot on the surfaces or parts in contact with the combustion products or with the flame

3.3.10
yellow tipping
yellowing of the tip of the blue cone of an aerated flame

3.3.11
purge
forced introduction of air through the combustion chamber and flue passages in order to displace any remaining fuel/air mixture and/or products of combustion

a) pre-purge: the purge which takes place between the start signal and the energizing of the ignition device

b) post-purge: the purge which takes place immediately following shut-down

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3.3.12
first safety time[2]
interval between the ignition burner valve, start gas valve or main gas valve, as applicable, being energized and the ignition burner valve, start gas valve or main gas valve, as applicable, being de-energized if the flame detector signals the absence of a flame at the end of this interval

3.3.13
second safety time
where there is a first safety time applicable to either an ignition burner or start gas flame only, the second safety time is the interval between the main gas valve being energized and the main gas valve being de-energized if the flame detector signals the absence of a flame at the end of this interval

3.3.14
extinction safety time
time which elapses between the moment when the supervised flame is extinguished and the moment when the automatic burner control system initiates shut-down of the burner by removing power to the automatic gas shut-off valves

3.3.15
start-gas flame
flame established at the start-gas rate either at the main burner or at a separate ignition burner

3.3.16
running condition of the system
condition in which the burner is in normal operation under the supervision of the programming unit and its flame detector device

3.3.17
controlled shut-down
process by which the power to the gas shut-off valve(s) is removed immediately, e.g. as a result of the action of a controlling function

3.3.18
safety shut-down
process which is effected immediately following the response of a safety control or sensor or the detection of a fault in the burner control system and which puts the burner unit out of operation by immediately removing the power to the gas shut-off valve(s) and the ignition device

3.3.19
non-volatile lock-out
safety shut-down condition of the burner unit, such that a restart can only be accomplished by a manual reset of the burner unit and by no other means

3.3.20
volatile lock-out
safety shut-down condition of the burner unit, such that a restart can only be accomplished by either the manual reset of the burner unit, or a failure of the mains electrical supply and its subsequent restoration

3.3.21
spark restoration
process by which, following the loss of the flame signal, the ignition device will be switched on again without the total interruption of the gas supply

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[2] Where there is no second safety time, this is called the safety time.

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NOTE This process ends with the restoration of the running condition or, if there is no flame signal at the end of the safety time, with volatile or non-volatile lockout.

3.3.22
automatic recycling
process by which, after a safety shut-down, a full start up sequence is automatically repeated

NOTE This process ends with the restoration of the running condition or, if there is no flame signal at the end of the safety time, or if the cause of the accidental interruption has not disappeared, with volatile or non-volatile lock out.

3.4 Gases

3.4.1
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:

a) the gross calorific value H_s in which the water produced by combustion is assumed to be condensed

b) the net calorific value H_i in which the water produced by combustion is assumed to be in the vapour state

NOTE The calorific value is expressed:

1) either in MJ/m^3 of dry gas at the reference conditions; or

2) in MJ/kg of dry gas [EN 437:2003].

3.4.2
relative density
d
ratio of the masses of equal volumes of dry gas and dry air at the same conditions of temperature and pressure

3.4.3
Wobbe index
gross Wobbe index: W_s and 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 The Wobbe index is expressed either in MJ/m^3 of dry gas at the reference conditions or in MJ/kg of dry gas [EN437:2003].

3.4.4
test pressure
gas pressures used to verify the operational characteristics of appliances using combustible gases. They consist of normal and limit pressures

NOTE Test pressures are expressed in mbar). 1 mbar = 10^2 Pa [EN 437:2003].

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3.4.5
normal pressure
p_n
pressure under which the appliances operate in nominal conditions when they are supplied with the corresponding reference gas

[EN 437:2003]

3.4.6
limit pressure
maximum limit pressure p_{max} and minimum limit pressure p_{min}
pressures representative of the extreme variations in the appliance supply conditions

[EN 437:2003]

3.4.7
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 :

a) the higher pressure corresponds only to gases of low Wobbe index

b) the lower pressure corresponds to gases of high Wobbe index

3.5 Conditions of operation and measurement

3.5.1
reference conditions
in this standard the following reference conditions apply:

a) for calorific values, temperature: 15 °C;

b) for gas and air volumes dry, brought to 15 °C and to an absolute pressure of 1 013,25 mbar.

3.5.2
cold condition
condition of the installation required for some tests and obtained by allowing the unlit burner unit to attain thermal equilibrium at room temperature

3.5.3
hot condition
condition of the installation required for some tests and obtained by heating to thermal equilibrium at the nominal heat input

3.5.4
equivalent resistance
resistance to flow in millibar, measured at the outlet of the system, which is equivalent to that of the actual flue

3.5.5
thermal equilibrium
operating state of the system corresponding to a particular setting of the input in which the flue gas temperature does not change by more than ±2 % (in °C) over a period of 10 min

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3.6 Country of destination

3.6.1
direct country of destination
country for which the system has been certified and which is specified by the manufacturer as the intended country of destination. At the time of putting the system on the market and/or installation, the system shall be capable of operating, without adjustment or modification, with one of the gases distributed in the country concerned, at the appropriate supply pressure

More than one country can be specified if the system, in its current state of adjustment, can be used in each of these countries.

3.6.2
indirect country of destination
country for which the system has been certified, but for which, in its present state of adjustment, it is not suitable. Subsequent modification or adjustment shall be made in order that it can be utilized safely and correctly in this country

4 Classification of systems

4.1 Classification according to the nature of the gases used (categories)

Gases are classified into three families, possibly divided into groups according to the value of the Wobbe index. Table 1 specifies the families and groups of gas used in this standard.

Table 1 — Gas classification

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

4.2 Classification according to the gases capable of being used

4.2.1 Category I: systems of category I are designed exclusively for the use of gases of a single family or of a single group.

a) Systems designed for use on first family gases only:

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

b) Systems designed for use on second family gases only:

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Category I_{2H}: systems using only gases of Group H of the second family at the prescribed supply pressures.

Category I_{2L}: systems using only gases of Group L of the second family at the prescribed pressures.

Category I_{2E}: systems using only gases of Group E of the second family at the prescribed pressures.

Category I_{2E+}: systems using only gases of Group E of the second family, and operating with a pressure couple without adjustment on the system. The system gas regulator, if it exists, is not operative in the range of the two normal pressures of the pressure couple.

c) Systems designed for use on third family gases only:

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

Category I_{3+}: systems capable of using the third family gases (propane and butane) and operating with a pressure couple without adjustment of the system. However, for certain types of system 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 system.

Category I_{3P}: systems using only gases of Group P of the third family (propane) at the prescribed pressure.

4.2.2 Category II: systems of category II are designed for use on gases of two families.

a) Systems designed for use on gases of the first and second families:

Category II_{1a2H}: systems 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}.

b) Systems designed for use on gases of the second and third families:

Category $II_{2H3B/P}$: systems 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+}: systems 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_{3+}.

Category II_{2H3P}: systems 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 $II_{2L3B/P}$: systems 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}: systems capable of using gases of Group L 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_{2L}. The third family gases are used under the same conditions as for category I_{3P}.

Category $II_{2E3B/P}$: systems 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 $I_{3B/P}$.

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Category II_{2E+3+}: systems 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_{3+}.

Category II_{2E+3P}: systems 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_{3P}.

4.2.3 Category III: systems of Category III are designed for use on gases of the three families.

This category is not in general use.

Categories III Systems which are in use in certain countries are given in Annex A (see A.3).

4.3 Classification according to the mode of evacuation of the combustion products

4.3.1 General

Systems are classified into several types according to the method of evacuation of the combustion products and admission of the combustion air.

4.3.2 Type B

A system intended for connection to a flue which evacuates the products of combustion to the outside of the room containing the system. The combustion air is drawn directly from the room.

This standard applies to:

a) Type B_5: a Type B appliance, without a draught diverter, that is designed for connection via its flue duct to its flue terminal.

For systems in which the combustion air is supplied and/or in which the products of combustion are evacuated by mechanical means, two types are identified:

b) Type B_{52}: a Type B_5 system incorporating a fan downstream of the combustion chamber/heat exchanger (this type is covered by this standard);

c) Type B_{53}: a Type B_5 system incorporating a fan upstream of the combustion chamber/heat exchanger (this type is not covered by this standard).

5 Constructional requirements

5.1 General

5.1.1 Conversion to different gases

The only acceptable operations when converting from a gas of one group or family to a gas of another group or family and/or to adapt to different gas distribution pressures are given below for each category.

It is recommended that these operations should be possible without disconnecting the system.

5.1.1.1 Category I

a) Categories I_{2H}, I_{2L}, I_{2E}, I_{2E+}: no modification to the system;

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b) Category $I_{3B/P}$: no modification to the system;

c) Category I_{3+}: replacement of injectors or calibrated orifices but only in order to convert from one pressure couple to another (e.g. 28–30/37 mbar to 50/67 mbar);

d) Category I_{3P}: no modification to the system relative to a change of gas. For changing pressure, replacement of injectors and adjustment of gas rates.

5.1.1.2 Category II

5.1.1.2.1 Categories of systems designed for use with gases of the first and second families

Adjustment of the gas rate with, if necessary, a change of injector, restrictor or regulator.

Adjustment of the gas rate of the ignition burner, either by using an adjuster or by a change of injector or restrictor and, if necessary, a change of the complete ignition burner or of some of its parts.

Putting the regulator out of service under the conditions of 5.2.6.

Putting the gas rate adjuster(s) out of service under the conditions given in 5.2.1 and 5.2.2 if applicable.

The adjustments or component changes are only acceptable when converting from a gas of the first family to a gas of the second family or vice versa.

5.1.1.2.2 Categories of systems designed for use with gases of the second and third families

Adjustment of the gas rate with, if necessary, a change of injector, restrictor or regulator.

Adjustment of the gas rate of the ignition burner, either by using an adjuster or by a change of injector or restrictor and if necessary, a change of the complete ignition burner or of some of its parts.

Putting the regulator out of service under the conditions of 5.2.6.

Putting the gas rate adjuster(s) out of service under the conditions given in 5.2.1 and 5.2.2 if applicable.

The adjustments or component changes are only acceptable when:

a) converting from a gas of the second family to a gas of the third family or vice versa;

b) converting from one butane/propane pressure couple to another (e.g. 28–30/37 mbar to 50/67 mbar).

5.1.1.3 Category III

Category III systems which are in use in certain countries are given in Annex A (see A.3.2.3).

5.1.2 Materials and method of construction

The quality and thickness of materials used in the construction of a system including its POCED shall be:

a) such that the construction and performance characteristics are not altered so as to affect the safe operation of the system in normal conditions of use and of maintenance by the user;

b) such as to ensure a reasonable operating life.

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In particular, when the system is installed according to the manufacturer's instructions, all the components shall withstand the mechanical, chemical and thermal conditions to which they may be subjected when used in a manner which can be reasonably foreseen.

Copper shall not be used for gas carrying parts where the temperature is likely to exceed 100 °C.

Asbestos or materials containing asbestos shall not be used.

Solder that has a melting point below 450 °C after application shall not be used for gas-carrying parts.

5.1.3 Accessibility for maintenance and use

Components and controls shall be arranged such that any adjustment, maintenance or exchange is easy without removing the radiant tube from the installed position. Where necessary, access doors or removable panels shall be provided.

Parts that are intended to be removable for maintenance or cleaning shall be readily accessible, shall be simple to assemble correctly and difficult to assemble incorrectly. Such parts shall be difficult to assemble incorrectly where incorrect assembly would create a hazardous condition or result in damage to the system and its controls.

Parts of the system which are not intended to be removed by the user and for which removal would affect safety shall be capable of removal only with the aid of tools.

5.1.4 Means of sealing

5.1.4.1 Soundness of the gas circuit

Holes for screws, studs, etc. intended for the assembly of components shall not open into the gasways. The wall thickness between holes (including threads) and gasways shall be not less than 1 mm.

The soundness of components and assemblies connected to the gas circuit and likely to be dismantled for routine maintenance at the consumer's premises shall be assured by means of mechanical joints, (e.g. metal to metal joints, O-ring joints or packing) but excluding the use of any sealing compound such as tape, mastic or paste. The soundness shall be maintained after dismantling and re-assembly.

Sealing compounds may be used for permanent threaded assemblies. The sealing material shall remain effective under normal conditions of system use.

5.1.4.2 Soundness of the combustion circuit

The soundness of the combustion circuit of the system shall be effected by mechanical means only, with the exception of those parts which do not require to be disconnected for routine maintenance, and which may be joined with mastic or paste in such a way that permanent soundness is assured under normal conditions of use (see 8.2.2.1 c).

5.1.5 Supply of combustion air and evacuation of combustion products

5.1.5.1 Air inlets

All openings for the supply of air into the system shall be adequately protected against inadvertent blockage. In addition, such openings shall not permit the entry of a ball of 16 mm diameter applied with a force of 5 N. The cross-section of the air passageway(s) shall not be adjustable.

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5.1.5.2 Combustion circuit

The cross section of the combustion circuit shall be adjustable by means of one or more dampers to permit individual sections of the system to be adjusted within prescribed limits of suction in the combustion circuit, as declared by the manufacturer for the correct operation of the system.

Each damper shall be supplied by the manufacturer and once adjusted shall be capable of being locked and sealed in position.

With the damper in its fully closed position, there shall be at least 2 % of the cross-sectional area of the tube open to permit the venting of any gas build up.

5.1.5.3 Flue outlet

The POCED shall either be supplied with the appliance by the manufacturer or specified in the manufacturer's instructions. The specification shall include a description of the duct including any bends, its materials of construction and any critical tolerances (e.g. in length, diameter, thickness, insertion depth).

The manufacturer shall state the minimum and maximum equivalent resistance. The manufacturer's instructions shall give details for calculating the equivalent resistance (e.g. the allowance to be made for bends).

Where the appliance is intended to be fitted to a flue having a wall termination, the manufacturer shall either supply a flue terminal or state the type of termination which shall be used. The design of this shall be such that it will not allow entry of a ball of 16 mm diameter applied with a force of 5 N.

If the POCED is capable of being installed in accordance with the manufacturer's instructions such that its outlet, when fitted with any terminal supplied with the appliance, or specified in the manufacturer's instructions, extends beyond the external surface of a building by more than 1,5 m, this duct shall not undergo any permanent distortion when subjected to the wind load test specified in 4.3.2 of EN 1859:2000.

5.1.6 Inlet connections

The burner unit inlet connection shall be one of the following types:

a) a thread conforming to EN ISO 228-1:2003. In this case the end of the gas inlet connection shall have a flat annular surface at least 3 mm wide for thread sizes 1/2 and 3/8 and at least 2,5 mm wide for thread size 1/4, to allow the interposition of a sealing washer. Moreover, when the end of the gas inlet connection has a thread of nominal size 1/2, it shall be possible to insert a gauge of 12,3 mm diameter to a depth of at least 4 mm;

b) thread conforming to EN 10226-1:2004 or EN 10226-2:2005;

c) a compression fitting suitable for copper tube;

d) a straight tube at least 30 mm long, the end of which is cylindrical, smooth and clean, to allow connection by means of a compression fitting as specified in 5.1.6 c;

e) a flange to ISO 7005-1:1992, ISO 7005-2:1988 or ISO 7005-3:1988.

NOTE The conditions of inlet connections prevailing in the various countries are given in A.5.

The gas inlet connection shall be so secured that connections to the gas supply can be made without disturbing any controls or gas-carrying components of the system.

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5.1.7 Confirmation of operation

On each burner unit means shall be provided to allow observation of any ignition burner flame during commissioning and servicing. If the means of observation is a viewing port, it shall, when located in an area of high temperature, be covered with heat resistant glass or equivalent material and sealed with a suitable heat resistant sealant.

It shall at all times be possible for the user to ascertain visually whether a burner unit is in operation or has gone to volatile or non-volatile lock-out where:

a) mirrors or windows are used, their optical properties shall not have deteriorated at the completion of all the tests specified in this standard;

b) indicator lights are used their purpose shall be clearly and permanently identified on the system, or on the plate or label required by 8.1.2. The indicator lighting circuitry shall be so designed and arranged that:

1) it indicates when a supervised flame is present and, in the case of a supervised ignition burner, it also indicates when the main burner is in operation;

2) any failure arising in the indicator lighting circuitry shall either not affect the operation of any safety device or prevent the operation of the system.

5.1.8 Electrical equipment

The electrical equipment of the system shall be so designed and constructed as to obviate hazards of electrical origin and shall comply with the requirements of EN 60335-2-102:2006 which cover such hazards.

If the system is fitted with electronic components or electronic systems providing a safety function, these shall comply with the relevant requirements of EN 298:2003 with regard to electromagnetic compatibility immunity levels.

If the manufacturer specifies the nature of the electrical protection of the system on the data plate, this specification shall comply with EN 60529:1992:

a) to give the degree of personal protection against contact with dangerous electrical components inside the system case;

b) to give the degree of electrical protection, inside the system case, against harmful actions due to water penetration.

5.1.9 Operational safety in the event of fluctuation, interruption and restoration of the auxiliary energy

Interruption and subsequent restoration of the electricity supply at any time during the starting up or operation of the system shall result in the continued safe operation, volatile lock-out, non-volatile lock-out, or safety shut-down followed by automatic recycling.

Interruption and subsequent restoration of the electricity supply shall not override any “lock-out” condition except where the system is intended to be reset by means of switching off and on the electricity supply to the system, e.g. volatile lock-out. Such re-setting shall only be possible if any interruption and subsequent restoration of the electricity supply cannot give rise to a hazardous system condition.

NOTE Requirements relating to the continued and safe operation of the system in the event of normal and abnormal fluctuation of auxiliary energy is specified in 6.6.1 d).

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5.1.10 Motors and fans

The direction of rotation of motors and fans shall be clearly marked.

Belt drives, where used, shall be so designed or positioned as to afford protection to the operator.

Means shall be provided to facilitate adjustment of belt tension. Access to such means shall be possible only with the use of commonly available tools.

Motors and fans shall be mounted in such a way as to minimize noise and vibration.

Lubrication points, if provided, shall be readily accessible.

5.2 Requirements for adjusting, control and safety devices

5.2.1 General

The functioning of any safety device shall not be overruled by that of any control device.

The system shall not incorporate any controls which need to be manipulated by the user when the system is in normal operation.

5.2.2 Gas rate adjusters

Systems in categories I_{2H}, I_{2L}, I_{2E}, I_{2E+}, $I_{3B/P}$, I_{3P}, $II_{2H3B/P}$, II_{2H3+}, II_{2H3P}, $II_{2L3B/P}$, $II_{2E3B/P}$, II_{2E+3+}, and II_{2E+3P} shall not be fitted with a gas rate adjuster. However, regulated systems in all of these categories except II_{2E+3+} may have a gas rate adjuster consisting of an adjusting screw on the gas regulator.

Systems in category II_{1a2H} shall have a gas rate adjuster for first family gases.

For systems in category II_{2H3+} having a gas rate adjuster, it shall be possible to put these devices out of service when these systems are supplied with a third family gas. This also applies to systems in category II_{1a2H} when they are supplied with a second family gas. For systems in category II_{2E+3P} having a gas rate adjuster, it shall be possible to put these devices out of service fully or partially (see 5.2.6) when these systems are supplied with a second family gas.

The adjusters shall be adjustable only with a tool and they shall be capable of being set in the operating position.

5.2.3 Range-rating devices

A range-rating device on a system is optional.

For systems in category II_{1a2H} the gas rate adjuster and the range-rating device may be one and the same. However, if the gas rate adjuster has to be sealed, either completely or partially, when the system is supplied with a second family gas, the gas rate adjuster or its sealed part shall no longer be used by the installer as a range-rating device.

5.2.4 Aeration adjusters

Aeration adjusters are not permitted.

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5.2.5 Manual controls

5.2.5.1 Application

Manual valves, push buttons or electrical switches that are essential for normal operation and commissioning of the system shall either be provided with the system or specified in the manufacturer's installation instructions.

5.2.5.2 Manual valves

Manual valves shall be of the 90° turn type.

Manual valves shall be so designed or positioned as to prevent inadvertent operation but shall be easy to operate when required. They shall be so designed that in operation the OPEN and CLOSED positions are readily distinguishable.

When a system isolating valve is provided as an integral part of the system, it shall be capable of operating at a pressure equal to 1,5 times the maximum supply pressure and shall be readily accessible.

Manual valves used solely for OPEN/CLOSED operation shall be provided with positive stops at the OPEN and CLOSED positions.

5.2.6 Regulators

Regulators shall comply with EN 88-1:2007.

Unless a zero regulator is fitted, for a system burning first or second family gases, the gas supply to the burner and any ignition burner shall be under the control of an integral regulator fitted upstream of the automatic shut-off valves unless it is incorporated in a multifunctional control.

For a system burning third family gases, the fitting of a regulator is optional.

The design and accessibility of the regulator shall be such that it can be easily adjusted or put out of service for use with another gas, but precautions shall be taken to make unauthorized interference with the adjustment difficult.

However, for systems in categories I_{2E+}, II_{2E+3+} and II_{2E+3P} the gas regulator shall not be operational in the range of the two normal pressures of the second family pressure couple, i.e. 20 mbar to 25 mbar. For systems in categories II_{2E+3+} and II_{2E+3P}, it shall be possible to put the regulator partially out of service when they are supplied with second family gases, such that the regulator is not operational in the range of the two normal pressures of the second family pressure couple, i.e. 20 mbar to 25 mbar.

5.2.7 Multifunctional controls

Multifunctional controls shall comply with EN 126:2004.

5.2.8 Automatic shut-off valves

Automatic shut-off valves shall comply with EN 161:2007.

The gas supply to the main burner shall be under the control of two automatic shut-off valves connected in the gas line in series; one being of Class A or Class B, the other being of Class A, Class B, Class C or Class J. If a valve of Class J is utilized, a strainer shall be used such that it does not pass a 0,2 mm pin gauge. This strainer shall be fitted upstream of the Class J valve.

The start gas supply shall be under the control of one automatic shut-off valve of either Class A or Class B.

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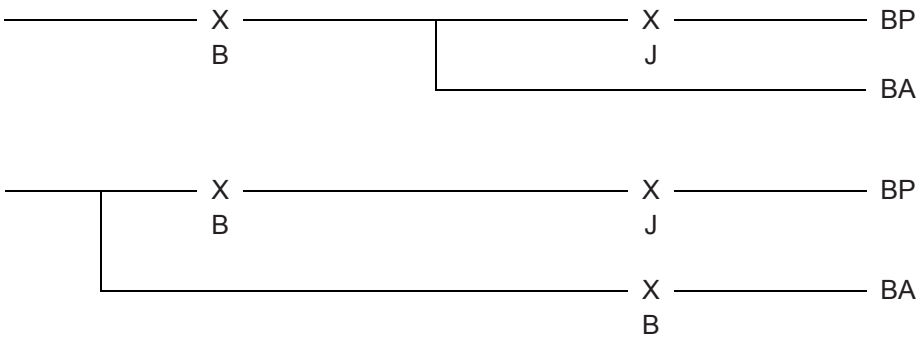
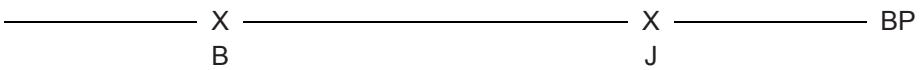
This valve may be the upstream valve in the gas supply to the main burner where it is of Class B and the start gas supply is taken from immediately downstream of this valve. Where the start gas supply is under the control of a single automatic shut-off valve, the heat input at the time of ignition shall not exceed 1 kW or 5 % of the main burner heat input, whichever is the smaller.

The arrangements shown in Figure 1 are given as examples. Any other arrangement giving at least equivalent level of safety is permissible.



a) Systems with an ignition burner of heat input not exceeding 1 kW or 5 % of the main burner heat input



b) Systems with direct ignition of the main burner

Key
BA Ignition burner
BP Main burner

Figure 1 — Automatic shut-off valve configuration

5.2.9 Gas strainers

A strainer shall be fitted at the inlet of any burner unit incorporating an automatic shut-off valve(s) to prevent the ingress of foreign matter. The strainer may be integral with the upstream automatic shut-off valve. The maximum strainer hole dimension shall not be greater than 1,5 mm and the mesh shall not permit a 1 mm pin gauge to pass through it.

In gas circuits incorporating more than one automatic shut-off valve, only one strainer need be fitted, provided it gives adequate protection to all valves.

For valves incorporating a shearing action (self-cleaning), and for valves of size ½ (or DN15) and below, the strainer may be omitted.

Where a regulator is fitted upstream of the automatic shut-off valve(s), the strainer may be fitted upstream of the regulator.

5.2.10 Thermostats

Integral mechanical thermostats shall comply with EN 257.

5.2.11 Air proving device

Each burner unit shall be fitted with a suitable device for proving adequate air flow during the pre-purge, ignition and operation of the unit (see 6.6.1 e and 6.6.2).

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The sensor shall be located at each burner unit.

The air proving device shall be proved in the no air-flow state prior to start up of the system. Failure to prove the device in the no air-flow state shall prevent start up of the system.

Air-flow failure at any time during the pre-purge, ignition and operation of the burner shall cause non-volatile lock-out, volatile lock-out or safety shut-down such that re-start may only take place following automatic recycling.

The system control shall be designed such that there is at least one check of the pressure switch in the "no air-flow" state every 24 h.

5.2.12 Automatic burner control system

5.2.12.1 General

Each burner unit shall be fitted with an automatic burner control system complying with EN 298:2003.

5.2.12.2 Manually operated devices

The operation of push buttons, switches, etc., incorrectly or out of sequence shall not adversely affect the safety of the automatic burner control system.

Under the test conditions described in 7.2.1, the rapid (on and off) operation of any start switch shall not set up a hazardous condition.

5.2.12.3 Pre-purging

Immediately before any attempt at ignition or the opening of automatic shut-off valves, the system shall be purged.

Under the test conditions described in 7.2.2, the purge period shall be at least 10 s.

5.2.12.4 Flame detector

On each burner unit, the flame detector system shall incorporate a means to prevent the energization of any gas valve and of the ignition device if a flame or flame simulating condition is present during the start-up period.

Upon flame failure in the running condition the flame detector shall cause one of the following:

a) volatile lock-out; or

b) non-volatile lock-out; or

c) one of the following provided that such attempts cannot give rise to a hazardous condition:

1) safety shut-down followed by automatic recycling; or

2) spark restoration.

The time for the flame detector system to de-energize the burner automatic shut-off valves upon flame failure shall not exceed 2 s. This shall be verified under the test conditions described in 7.2.4. Notwithstanding this requirement, where a spark restoration system is used, this time may be extended to allow for the re-ignition attempt but shall not exceed the first safety time.

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5.2.12.5 Start-gas flame establishment

The start-gas flame shall be established either at the main burner or at a separate ignition burner.

The first safety time shall be not more than 20 s. The safety time shall be specified by the system manufacturer and verified under the test conditions described in 7.2.3.

The ignition spark (or other means of ignition) shall not be energized before the completion of the pre-purge period and shall be de-energized at or before the end of the first safety time.

The start-gas automatic shut-off valve(s) shall not be energized before the ignition spark (or other means of ignition) is energized.

If the start-gas flame is not detected by the end of the first safety time, volatile or non-volatile lock-out shall result.

The main gas automatic shut-off valves shall not be energized to admit the main gas flow to the burner until after the start-gas flame has been detected.

The upstream automatic shut-off valve in the main gas supply may be opened to permit start-gas flow where the start-gas supply is taken from downstream of the first main gas automatic shut-off valve.

5.2.12.6 Direct main burner flame establishment

The safety time shall be not more than 10 s. The safety time shall be specified by the system manufacturer and verified under the test conditions described in 7.2.3.

The ignition spark (or other means of ignition) shall not be energized before the completion of the pre-purge period and shall be de-energized at or before the end of the safety time.

Where a hot surface ignition device is used, the ignition device shall be so energized that the ignition source is capable of igniting incoming gas before the gas valves are opened.

The main gas valves shall not be energized before the ignition spark (or other means of ignition) is energized. If the main flame is not detected by the end of the main flame ignition period, volatile or non-volatile lock-out shall result.

5.2.12.7 Shut-down

The flame detector device and the air proving device shall affect closure of all automatic shut-off valves in the burner unit concerned. On shut-down the fan shall not be de-energized before the automatic shut-off valves. Post-purging is optional.

5.2.12.8 Facility for remote control

Where the system is capable of being controlled remotely by means of thermostats or a time control, electrical connection of these controls shall be possible without disturbing any internal connection in the system.

5.3 Ignition devices

5.3.1 General

When installed in accordance with manufacturer's instructions, it shall be possible to light the system from an easily accessible position by means of an electrical or other convenient ignition device incorporated in the system.

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Ignition burners and ignition devices shall be protected by design and position against diminution or extinction resulting from e.g. draughts, products of combustion, overheating, condensation, corrosion or matter falling from above.

Ignition burners, ignition devices and their mountings shall be so designed that they can only be located rigidly and correctly in relation to every component and burner with which they are designed to operate.

5.3.2 Ignition device for the main burner

Each main burner shall be fitted with an ignition burner or other ignition device for direct ignition.

5.3.3 Ignition burners

If different ignition burners are used when the system is converted from one gas to another, they shall be marked, easy to substitute for one another and easy to fit. The same applies to injectors where only they have to be changed. Injectors shall carry an indelible means of identification and shall only be removable with the aid of a tool.

Ignition burners shall be protected against blockage by gas-borne particulate matter.

5.4 Main burners

The cross-sectional area of the flame ports shall not be adjustable.

The burners shall be so located and arranged that misalignment cannot occur. It shall not be possible to remove the burner assembly without the use of tools.

5.5 Pressure test points

5.5.1 Gas pressure test-point

Each burner unit shall be fitted with at least two pressure test points. One shall be fitted upstream of the first control and safety device and the other downstream of the last gas flow rate control and in a position carefully selected so as to permit measurements to be made.

The test points shall have an external diameter of ($9^{0}_{-0,5}$) mm and a useful length of at least 10 mm to enable a tube to be fitted. The minimum diameter of the bore shall not exceed 1 mm.

5.5.2 Air pressure test-point

In addition, a pressure test point shall be fitted for the measurement of suction in each branch tube (see 8.2.2.1n).

5.6 Injectors

Every injector and removable restrictor shall carry an indelible means of identification. It shall be possible to change injectors and restrictors without having to move the tube assembly from its installed position. However, injectors shall only be removable with the aid of a tool.

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6 Operational requirements

6.1 Soundness

6.1.1 Soundness of the gas circuit

The gas circuit shall be sound. It is deemed to be sound if, under the conditions described in 7.3.1.1, the leakage of air does not exceed 100 cm^3/h irrespective of the number of components, whether mounted in series or parallel on the burner unit.

6.1.2 Soundness of the combustion circuit

The soundness of the combustion circuit upstream of the fan shall be verified in accordance with the requirements in 6.7.

When tested under the conditions of 7.3.1.2, the air leakage rate from any part of the combustion circuit, including its POCED, that is downstream of the fan shall not exceed 0,10 m3/h per kW of the nominal heat input.

6.2 Heat inputs

6.2.1 Nominal heat input

When measured under the conditions described in 7.3.2.2, the heat input obtained at the normal pressure shall be within ± 5 % of the nominal heat input.

6.2.2 Start gas heat input

When measured under the conditions described in 7.3.2.3 the heat input obtained at normal pressure shall be within ± 5 % of the start gas heat input declared by the manufacturer.

However, this tolerance is extended to within ± 10 % where the injector has a diameter of 0,5 mm or less.

6.2.3 Effectiveness of the range-rating device

For burner units fitted with a range-rating device distinct from a gas rate adjuster, it shall be checked under the conditions described in 7.3.2.4 that:

a) with the range-rating device in the position giving the maximum rate, the nominal heat input is obtained to within ± 5 %; and

b) with the range-rating device in the position giving the minimum rate, the heat input is within ± 5 % of the minimum heat input stated by the manufacturer.

6.3 Limiting temperatures

6.3.1 Wall and ceiling temperatures

When the system is tested under the conditions described in 7.3.3.1, the wall and ceiling temperatures shall not exceed the ambient temperature by more than 50 K.

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6.3.2 Component temperatures

When the system is tested under the conditions described in 7.3.3.2 the maximum temperature of the system components shall not exceed the maximum temperature specified by the individual component manufacturer.

6.3.3 POCED

When the appliance is tested under the conditions of 7.3.3.3.1, the external temperature of any part of the POCED, which when installed in accordance with the manufacturer's instructions is capable of being less than 25 mm from combustible parts of the fabric of a building, shall not exceed the ambient temperature by more than 50 K.

If, in accordance with the manufacturer's installation instructions, the POCED is required to be enclosed within another duct, a sleeve or insulation when it passes through a combustible wall or ceiling, the external temperatures of this duct, sleeve or insulation shall not exceed the ambient temperature by more than 50 K under the conditions of 7.3.3.3.2.

6.4 Ignition, cross-lighting and flame stability

6.4.1 Ignition and cross-lighting

Under the test conditions described in 7.3.4.1.1, correct and smooth ignition and cross-lighting shall be assured.

When the gas rate of any ignition burner is reduced under the test conditions described in 7.3.4.1.2 to the minimum required to hold open the gas supply to the main burner, correct and smooth ignition of the main burner shall be assured and without undue noise.

Where the gas line is designed such that the gas supply to the ignition burner is taken from between the main burner gas valves, it shall be verified that ignition of the ignition burner under the test conditions described in 7.3.4.1.3 does not give rise to a hazardous situation.

Under the test conditions described in 7.3.4.1.4 ignition of any ignition burner, or the main burner where this is ignited directly, shall be safe and without undue noise when ignition is delayed by up to 50 % longer than the safety time declared by the manufacturer.

6.4.2 Flame stability

Under the test conditions described in 7.3.4.2 the flames shall be stable. A slight tendency to lift at the moment of ignition is acceptable but the flames shall be stable in normal operation.

6.5 Pressure regulator

When tested in accordance with the conditions given in 7.3.5 the rate shall not differ by more than +7,5 % and -10 % for first family gases, and by more than ± 5 % for second and third family gases, from the initial rate obtained under those conditions.

6.6 Combustion

6.6.1 All systems (still air conditions)

When supplied with reference gas under the conditions described in 7.3.6.2:

a) for Test No. 1, the CO concentration in the dry, air-free products of combustion shall not exceed 0,1 %;

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b) for Test No. 2, the CO concentration in the dry, air-free products of combustion shall not exceed 0,2 %;

c) for Test No. 3, the CO concentration in the dry, air-free products of combustion shall not exceed 0,2 %.

In addition, when supplied with the sooting limit gas under the same conditions and the system is operated for 3 cycles of 30 min on and 30 min off, there shall be no significant deposit of soot on the inside of the radiant tube and fan.

When supplied with reference gas at normal pressure and the supply voltage is varied under the conditions described in 7.3.6.2:

d) for Test No. 4, the CO concentration in the dry, air-free products of combustion shall not exceed 0,2 %.

Under these conditions, it shall be verified that the system ignites and continues to operate.

When supplied with reference gas at the normal pressure and the fan voltage is reduced under the conditions described in 7.3.6.2:

e) for Test No. 5, the CO concentration in the dry, air-free products of combustion shall not exceed 0,2 %.

6.6.2 Supplementary tests under special conditions

When supplied with reference gas under the conditions described in 7.3.6.3, the CO concentration in the dry air-free products of combustion shall not exceed 0,2 %.

In addition, under the conditions described in 7.3.6.3 a) and 7.3.6.3 1 at the point of shut-off, the increase in pressure at the outlet of the installation shall not be less than 0,75 mbar for systems having a wall termination, and 0,5 mbar for systems having a vertical flue.

6.7 Prolonged performance

After the system has been tested under the conditions described in 7.3.7, the following requirements shall be met :

a) the requirements of 6.6.1 a);

b) whilst the requirements in 6.7 a) are being verified, there shall be no significant deposition of soot or any appreciable distortion or disturbance of the flames;

c) there shall be no sign of leakage of combustion products from the combustion chamber, flue connections etc;

d) there shall be no breakdown or distortion in any part of the system that could affect its safety;

e) there shall be no significant deterioration in the external surface of the radiant tube for example flaking or excessive oxidation;

f) there shall be no signs of other corrosion that will adversely affect the life of the system;

g) following inspection at the end of the test there shall be no evidence of corrosion at the outlet bend and within any POCED.

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6.8 Measurement of oxides of Nitrogen, NO_x

The manufacturer shall declare the NO_x class in Table 2 that is applicable to the system.

When measured in accordance with the method of test in 7.4.1, the NO_x concentration(s) in the dry, air-free products of combustion shall be such that the weighted NO_x value, determined as appropriate in accordance with 7.4.2, does not exceed the maximum NO_x concentration of the NO_x class declared by the manufacturer.

Table 2 — NO_x classes

NO_x Class	**Maximum NO_x concentration** mg/kWh
1	260
2	200
3	150
4	100

7 Test methods

7.1 General

7.1.1 Characteristics of test gases (Reference and limit gases)

Systems are intended for use with gases of different qualities. One of the aims of this standard is to check that the performance of a system is satisfactory for each family or group of gases for which it is designed and for the pressure for which it is designed, if necessary using the adjusting devices.

The test gases, test pressures and system categories given here are in accordance with those specified in EN 437:2003.

The characteristics of the reference and limit gases are given in Tables 4 and 5. The values in Table 4, measured and expressed at 15 °C, are derived from ISO 6976:1995.

7.1.2 Conditions for preparation of the test gases

The composition of gases used for the tests shall be as close as possible to those given in Table 4. For the constitution of these gases, the following rules shall be observed:

a) the Wobbe index of the gas used shall be within ± 2 % of the value in Table 4 for the corresponding test gas (this tolerance includes the errors due to measuring instruments);

b) the constituents used for the preparation of the mixtures shall have at least the purity shown in Table 3.

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Table 3 — Test gas purity

Gas	Purity %
Nitrogen (N_2)	99
Hydrogen (H_2)	99
Methane (CH_4)	95 [a)]
Propene (C_3H_6)	95 [a)]
Propane (C_3H_8)	95 [a)]
Butane[3] (C_4H_{10})	95 [a)]
[a)] With a total concentration of H_2, CO and O_2 below 1 % and a total concentration of N_2 and CO_2 below 2 %.	

However, these requirements are not obligatory for each of the components if the final mixture has a composition identical to that of a mixture which would have been made from components satisfying the conditions of Table 3. One can therefore, in order to make up a mixture, start with a gas already containing, in suitable proportions, several constituents of the final mixture.

For gases of the second family:

c) for the tests carried out with reference gases G 20 or G 25, a gas belonging respectively to either Group H or Group L or Group E, may be used even if its composition does not satisfy the above conditions, provided that after the addition of either propane or nitrogen as appropriate, the final mixture has a Wobbe index within ± 2 % of the value given in Table 4 for the corresponding reference gas;

d) for preparation of the limit gases another may be used as the base gas instead of methane:

1) for limit gases G 21, G 222 and G 23 a natural gas of Group H may be used;

2) for limit gases G 27 and G 231 a natural gas of Group H or of Group L or of Group E may be used;

3) for the limit gas G 26 a natural gas of Group L may be used.

In all cases the final mixture obtained by adding propane or nitrogen shall have a Wobbe index within ± 2 % of the value given in Table 4 for the corresponding limit gas and the hydrogen content of the final mixture, where appropriate, shall be as given in Table 4.

[3] Any mixture of iso/n butane can be used.

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