

Automatic forced draught burners for gaseous fuels

ICS 27.060.20; 97.100.20

National foreword

This British Standard is the UK implementation of EN 676:2003+A2:2008. It supersedes BS EN 676:2003 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by A1 A1.

The UK participation in its preparation was entrusted to Technical Committee GSE/27, Automatic gas burners.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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English Version

Automatic forced draught burners for gaseous fuels

Brûleurs automatiques à air soufflé pour combustibles gazeux

Automatische Brenner mit Gebläse für gasförmige Brennstoffe

This European Standard was approved by CEN on 3 April 2003 and includes Amendment 1 approved by CEN on 1 April 2008 and Amendment 2 approved by CEN on 1 April 2008.

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Foreword

This document (EN 676:2003+A2:2008) has been prepared by Technical Committee CEN/TC 131 "Gas burners using fans", the secretariat of which is held by DIN.

This document shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2008 and conflicting national standards shall be withdrawn at the latest by June 2010.

This document includes Amendment 1, approved by CEN on 2008-04-01 and Amendment 2, approved by CEN on 2008-04-01.

This document supersedes A2 EN 676:2003 A2.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1 A1 and A2 A2.

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 EU Directive(s).

For relationship with EU Directive(s), see informative A2 Annexes ZB, ZC, ZD and ZE A2, which are integral parts of this document.

A1 *deleted text* A1

According to edition 1996 the following fundamental changes are given:

- revisions for special applications;
- implementation of NO_x-classes and forming of arithmetic average values for determining the NO_x-values;
- implementation of appliance categories for forced draught burners.

A2 Following a request from CEN/TC 131, CEN has agreed to defer the date of withdrawal of EN 676:2003 for a transition period of 2 years. A2

A2 Annexes A, B, C, D, E, F, G, H, I, ZA, ZB, ZC, ZD and ZE are informative. A2

A1 Annexes J and K are normative. A1

This document includes a Bibliography.

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 United Kingdom.

Introduction

This European Standard is primarily intended for automatic forced draught gas burners having a combustion air fan, operated with gaseous fuels, and intended to be marketed as a complete assembly.

EN 437 sets out a system of classification of appliances into categories defined according to the gases and pressures for which they are designed.

Such a system of classification, when applied to forced draught burners, can lead to difficulties in defining the precise category to which a particular burner should be allocated. For example many burners are designed to operate on a wide range of fuel gases with little or no modification other than adjustment of air supply.

The technical committee responsible for the standard decided that the following appliance categories for forced draught burners should apply:

- single categories: I_{2R} for natural gas and I_{3R} for liquefied petroleum gas;
- dual category: II_{2R/3R} for natural and liquefied petroleum gas.

All the burners of this standard marked with these categories are commissioned on site and the measured values are recorded in a commissioning report.

However it should be noted that the Gas Appliance Directive requires the specification of the type of gas and the supply pressure used as well as the burner category.

Forced draught gas burners according to this standard are often used in industrial applications. The safety principles are the same as for forced draught gas burners used for household/commercial applications. Industrial forced draught gas burners however should operate safely in their industrial environment and the risks involved can differ from those for household applications. These industrial forced draught gas burners can be characterized by the ability to withstand industrial environmental influences, like moisture, high temperature, electrical and magnetic phenomena, vibrations, etc.

Principal requirements for installation and construction of gas burners and industrial thermal processing are covered by EN 746-family.

Special requirements for forced draught burners for industrial premises will be given as a note with the addition "Industrial application".

Further information and application limitation for EN 676 forced draught burners which are used for industrial application are given in informative annex I.

A1 This document is a type C standard as stated in EN ISO 12100-1 and EN ISO 12100-2.

The machinery concerned and the extent to which hazards, hazardous situations and hazardous events are covered are indicated in the scope of this document.

When provisions of this type C standard are different from those which are stated in type A or B standards, the provisions of this type C standard take precedence over the provisions of the other standard, for machines that have been designed and built according to the provisions of this type C standard. **A1**

1 Scope

[A1] This European Standard specifies the terminology, the general requirements for the construction and operation of automatic forced draught gas burners and also the provision of control and safety devices, and the test procedure for these burners. **[A1]**

This standard is applicable to

- **[A1]** automatic gas burners with a combustion air fan (hereinafter called "burners") as described in 3.1.2 and gas line components, intended for use in appliances of different types, and that are operated with gaseous fuels; **[A1]**
- total pre-mixed burners and nozzle mixed burners.

The standard is applicable to

- **[A1]** single burners with a single combustion chamber; **[A1]**
- single-fuel and dual-fuel burners when operating only on gas;
- **[A1]** gas function of dual-fuel burners designed to operate simultaneously on gaseous and liquid fuels. **[A1]**

[A1] This European Standard deals with all significant machine hazards, hazardous situations and events relevant to burners, when they are used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer, see Annex J.

This European Standard specifies the requirements to be met by the manufacturer to ensure the safety during commissioning, start-up, operation, shut-down and maintenance.

This European Standard does not deal with hazards due to specific applications.

This European Standard is not applicable to automatic forced draught gas burners which are manufactured before the date of its publication as EN. **[A1]**

[A2] This European Standard does not apply to burners specifically designed for use in industrial processes carried out on industrial premises.

This European Standard deals also with the additional requirements for the burners in the scope with pressurised parts and /or firing pressurised bodies, see Annex K. **[A2]**

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

[A2] EN 88-1, *Pressure regulators and associated safety devices for gas appliances — Part 1: Pressure regulators for inlet pressures up to and including 500 mbar*

EN 88-2 *Pressure regulators and associated safety devices for gas appliances — Part 2: Pressure regulators for inlet pressures above 500 mbar up to and including 5 bar* **[A2]**

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

EN 267, *Forced draught oil burners — Definitions, requirements, testing, marking*

EN 294, *Safety of machinery — Safety distance to prevent danger zones from being reached by the upper limbs* ^{A1}

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

EN 334, *Gas pressure regulators for inlet pressures up to 100 bar*

EN 953, *Safety of machinery — Guards - General requirements for the design and construction of fixed and movable guards*

EN 1088:1995, *Safety of machinery — Interlocking devices associated with guards — Principles for design and selection* ^{A1}

EN 1092-1, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 1: Steel flanges*

EN 1092-2, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 2: Cast iron flanges*

EN 1092-3 ^{A1}, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 3: Copper alloy flanges*

EN 1643, *Valve proving systems for automatic shut-off valves for gas burners and gas appliances*

EN 1854, *Pressure sensing devices for gas burners and gas burning appliances*

EN 10204, *Metallic products — Types of inspection documents* ^{A2}

EN 10208-1, *Steel pipes for pipelines for combustible fluids — Technical delivery conditions — Part 1: Pipes of requirement class A*

EN 10208-2, *Steel pipes for pipelines for combustible fluids — Technical delivery conditions — Part 2: Pipes of requirement class B*

EN 10216-1, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 1: Non-alloy steel tubes with specified room temperature properties*

EN 10217-1, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 1: Non-alloy steel tubes with specified room temperature properties*

EN 12067-1, *Gas/air ratio controls for gas burners and gas burning appliances — Part 1: Pneumatic types*

EN 12067-2 ^{A1}, *Gas/air ratio controls for gas burners and gas burning appliances — Part 2: Electronic types*

EN 15036-1:2006, *Heating boilers — Test regulations for airborne noise emissions from heat generators — Part 1: Airborne noise emissions from heat generators* ^{A1}

EN 50156-1:2004, *Electrical equipment for furnaces and ancillary equipment — Part 1: Requirements for application design and installation* ^{A2}

^{A1} *deleted text* ^{A1}

EN 60335-2-102:2007, *Household and similar electrical appliances — Safety — Part 2-102: Particular requirements for gas, oil and solid-fuel burning appliances having electrical connections (IEC 60335-2-102:2004, modified)* ^{A1}

EN 60529, *Degrees of protection provided by enclosures (IP code) (IEC 60529:1989)*

^{A1} *deleted text* ^{A1}

[A1] EN 60730-1, *Automatic electrical controls for household and similar use — Part 1: General requirements* (IEC 60730-1:1999, modified + A1:2003, modified)

EN 61310-1, *Safety of machinery — Indication, marking and actuating — Part 1: Requirements for visual, auditory and tactile signals* (IEC 61310-1:1995 + Corrigendum 1995) **[A1]**

[A1] EN 10220 **[A1]**, *Seamless and welded steel tubes — Dimensions and masses per unit length*

[A1] EN ISO 228-1 **[A1]**, *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, *Codes for the representation of names of countries and their subdivisions — Part 1: Country codes* **[A1]** (ISO 3166-1:2006) **[A1]**

[A1] EN ISO 4871, *Acoustics — Declaration and verification of noise emission values of machinery and equipment* (ISO 4871:1996) **[A1]**

[A2] EN ISO 9606-2, *Qualification test of welders — Fusion welding — Part 2: Aluminium and aluminium alloys* (ISO 9606-2:2004)

EN ISO 9606-3, *Approval testing of welders — Fusion welding — Part 3: Copper and copper alloys* (ISO 9606-3:1999)

EN ISO 9606-4, *Approval testing of welders — Fusion welding — Part 4: Nickel and nickel alloys* (ISO 9606-4:1999)

EN ISO 9606-5, *Approval testing of welders — Fusion welding — Part 5: Titanium and titanium alloys, zirconium and zirconium alloys* (ISO 9606-5:2000) **[A2]**

[A1] EN ISO 12100-1, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology* (ISO 12100-1:2003)

EN ISO 12100-2:2003, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles* (ISO 12100-2:2003)

EN ISO 13849-1, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design* (ISO 13849-1:2006) **[A1]**

[A2] EN ISO 15609-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding* (ISO 15609-1:2004)

EN ISO 15609-2, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 2: Gas welding* (ISO 15609-2:2001)

EN ISO 15609-3, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 3: Electron beam welding* (ISO 15609-3:2004)

EN ISO 15609-4, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 4: Laser beam welding* (ISO 15609-4:2004)

EN ISO 15609-5, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 5: Resistance welding* (ISO 15609-5:2004)

EN ISO 15612, *Specification and qualification of welding procedures for metallic materials — Qualification by adoption of a standard welding procedure* (ISO 15612:2004)

EN ISO 15614-7, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 7: Overlay welding* (ISO 15614-7:2007)

EN ISO 15614-11, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 11: Electron and laser beam welding* (ISO 15614-11:2002) **[A2]**

ISO 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

3 Terms and definitions

^[A1] For the purposes of this document, the terms and definitions given in EN ISO 12100-1 and the following apply. ^[A1]

3.1 General terms and definitions

3.1.1

forced draught burner

burner in which the total air for combustion is supplied by means of a fan

3.1.2

automatic forced draught burner

burner that is fitted with an automatic ignition, flame monitoring and burner control devices. Ignition, flame monitoring and the on/off switching of the burner occur automatically. The heat input of the burner can be adjusted during operation either automatically or manually

3.1.3

dual-fuel burner

burner in which both gaseous and liquid fuels can be burnt either simultaneously or in succession

3.1.4

total pre-mixed burner

burner in which part, or all, of the air for complete combustion of the gas is mixed with the gas upstream of the mixture outlet ports

3.1.5

nozzle mixed burner

burner in which part, or all, of the air required for combustion of the gas is mixed with the gas at, or downstream of, the air and gas ports

3.1.6

integrated ignition burner

burner with direct main ignition burner at reduced rate with by-pass start gas supply

3.1.7

start gas rate

gas rate ignited by the ignition device during the start-up of the burner

3.1.8

industrial applications

industrial applications means:

- the extraction,
- growth,
- refining,
- processing,
- production,
- manufacture or
- preparation

of materials, plants, livestock, animal products, food or artefacts

3.1.9

combustion chamber

part of the appliance in which the combustion takes place

3.2 Specific terms and definitions

3.2.1 Combustible gases

3.2.1.1

reference conditions

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

3.2.1.2

calorific value

quantity of heat produced by the combustion, at a constant pressure equal to 1 013,25 mbar, of 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: in which the water produced by combustion is assumed to be condensed;

Symbol: H_s

and

— the net calorific value: in which the water produced by combustion is assumed to be in the vapour state.

Symbol: H_i

Units: either

— megajoules per cubic metre (MJ/m³) of dry gas at the reference conditions, or

— megajoules per kilogram (MJ/kg) of dry gas

3.2.1.3

relative density

ratio of the masses of equal volumes of dry gas and dry air at the same conditions of temperature and pressure

Symbol: d

3.2.1.4

Wobbe index

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

Symbols: gross Wobbe index: W_s

net Wobbe index: W_i

Units: either

— megajoules per cubic metre (MJ/m³) of dry gas at the reference conditions, or

— megajoules per kilogram (MJ/kg) of dry gas

3.2.1.5

gas pressure

static pressure of the moving gas, relative to the atmospheric pressure, measured at right angles to the direction of flow of the gas. It is expressed in millibars (mbar) or in bars (bar)

3.2.1.6

reference gases

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

3.2.1.7

limit gases

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

NOTE The characteristics of the reference and limit gases are given in Table C.1.

3.2.1.8

normal pressure

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

3.2.1.9

limit pressures

pressures representative of the extreme variations in the burner supply conditions

NOTE The test pressures are given in Table 5.

3.2.1.10

supply pressure

pressure measured at the measuring point M1 as specified in Figure 1, at which the nominal conditions are achieved

3.2.1.11

adjustment pressure

pressure measured at the measuring point M2 as specified in Figure 1, at which the nominal conditions are achieved

3.2.1.12

burner head pressure

pressure measured at the measuring point M3 as specified in Figure 1, at which the nominal conditions are achieved

3.2.1.13

pressure in the combustion chamber

pressure or depression, relative to atmospheric pressure, prevailing in the combustion chamber

3.2.2 Operation of the burner

3.2.2.1 gas rate

3.2.2.1.1

volumetric flow rate

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

Units: 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).

Symbol: V

3.2.2.1.2

nominal volumetric flow rate

volumetric flow rate stated by the manufacturer, expressed in cubic metres per hour (m^3/h)

3.2.2.1.3

maximum flow rate

highest flow rate stated by the manufacturer, expressed in cubic metres per hour (m^3/h) at reference conditions

3.2.2.1.4

minimum flow rate

lowest flow rate stated by the manufacturer, expressed in cubic metres per hour (m^3/h) at reference conditions

3.2.2.1.5

mass flow rate

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

Symbol: M

Units: kilograms per hour (kg/h), or grams per hour (g/h)

3.2.2.1.6

nominal mass flow rate

mass flow rate stated by the manufacturer

3.2.2.1.7

heat input

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

Symbol: Q_F

Unit: kilowatt (kW)

Burners with fixed heat input or single stage burners have a single heat input. Range-rated burners have a maximum heat input and a minimum heat input declared by the manufacturer.

3.2.2.1.8

maximum heat input

highest value of the heat input declared by the manufacturer

Symbol: $Q_{F \max}$

3.2.2.1.9

minimum heat input

lowest value of the heat input declared by the manufacturer

Symbol: $Q_{F \min}$

3.2.2.2 running conditions

3.2.2.2.1

burners for permanent operation

burners that are designed to remain in the running condition for more than 24 h without interruption

3.2.2.2.2

burners for intermittent operation

burners that are designed to remain in the running condition for less than 24 h

3.2.3 Gas line components

3.2.3.1

gas line

part of the burner which is made up of the valves and controls and safety devices in which gas is conveyed between the inlet connection and the burner head

3.2.3.2

range-rating device

component on the burner intended to be used for adjusting the heat input, within a range of heat inputs stated by the manufacturer, to suit the actual heat requirements of the installation.

This adjustment can be progressive or in discrete steps

3.2.3.3

automatic shut-off valve

valve which opens when energised and closes automatically when de-energised

3.2.3.4

filter/strainer

device that enables foreign elements, which might otherwise cause failures in the system, to be collected

3.2.3.5

pressurised parts

piping components and devices having pressure bearing housings with a pressure greater than 0,5 bar and a size greater or equal to DN 100 mm

NOTE See EU Directive 97/23/EC.

3.2.3.6

means for draining and venting

devices to allow harmless draining and venting of the pressurised fuel supply lines 

3.2.4 Adjusting, control and safety devices

3.2.4.1

pressure governor

device which maintains the downstream pressure constant to within fixed limits independent of variations, within a given range, of the upstream pressure

3.2.4.2

adjustable pressure governor

pressure governor fitted with a means of adjusting the loading on the diaphragm and thus the downstream pressure

3.2.4.3

gas pressure protection devices

device which compares the actual value of the pressure with the desired value, gives a signal when the actual value exceeds or drops below the desired value and initiates the controlled shut-down

3.2.4.4

flame detector device

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

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, can be assembled in a single housing for use in conjunction with a programming unit

3.2.4.5

automatic burner control system

system which comprises at least a programming unit and all the elements of a flame detector device. The various functions of an automatic burner control system can be in one or more housings

3.2.4.6

programming unit

unit 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 non-volatile lock-out. The programming unit follows a predetermined sequence of actions and always operates in conjunction with a flame detector device

3.2.4.7

safe start check

procedure employing a protection circuit or circuits, to establish whether or not a fault in a safety system or a flame simulating condition exists prior to start-up

3.2.4.8

controlled shut-down

process by which the power to the gas shut-off valve(s) is removed before any other action takes place, e.g. as a result of the action of a controlling function

3.2.4.9

safety shut-down

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

NOTE Safety shut-down can also occur as a result of an interruption/decrease of the power supply.

3.2.4.10

non-volatile lock-out

safety shut-down condition of the system, such that a restart can only be accomplished by a manual reset of the system and by no other means

3.2.4.11

volatile lock-out

safety shut-down condition of the system, such that a restart can only be accomplished by either the manual reset of the system, or an interruption of the main power and its subsequent restoration

3.2.4.12

start signal

signal, e.g. from a thermostat, which releases the system from its start position and commences the predetermined programme

3.2.4.13

recycling

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

3.2.4.14

valve proving system

system to check the effective closure of the start gas or main gas safety shut-off valves, and which is capable of detecting small gas leakage rates

3.2.4.15

ignition device

any means (flame, electrical ignition or other means) used to ignite the gas at the ignition burner or at the main burner

3.2.4.16

running position of the burner system

position of the system in which the burner is in normal operation under the supervision of the programming unit and the flame detector device

3.2.4.17

purge

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

3.2.4.17.1

pre-purge

purge which takes place between the start signal and the energisation of the ignition device

3.2.4.17.2

post-purge

purge which takes place immediately following a controlled shut-down

3.2.4.18

monitoring devices

devices used for monitoring and controlling the burner when firing pressurised equipment

NOTE For the purpose of this standard they serve for safe use and operation of the burner. They are not safety accessories for the purpose of the PED. 

3.2.5 Sequencing times

3.2.5.1

pre-purge time

period during which purge takes place at the proven air rate prior to the energisation of the ignition device

3.2.5.2

post-purge time

period between any shut-down and the moment the fan is switched off

3.2.5.3

ignition time

period between the opening of the gas valves and the first indication of the flame by the flame detector device

3.2.5.4

first safety time

period between the pilot gas valve, the start gas valve or main gas valve(s), as applicable, being energised and the pilot gas valve, start gas valve or main gas valve(s), as applicable, being de-energised if the flame detector device signals the absence of a flame

NOTE Where there is no second safety time, this is called the safety time.

3.2.5.5

second safety time

where there is a first safety time applicable to either a pilot or start gas flame only, the second safety time is the period between the main gas valves being energised and the main gas valves being de-energised if the flame detector device signals the absence of a flame

3.2.5.6

extinction safety time

period that starts with the signal that the flame has been extinguished and ends with the signal to de-energize the safety shut-off valve of the gas supply

3.2.5.7

total closing time

period that starts with the signal that the flame has been extinguished and ends with the shut-off valves being closed

3.2.6 Combustion

3.2.6.1

flame stability

capacity of flame to remain on the burner head or in the flame reception zone intended by the design

3.2.6.2

flame lift

total or partial lifting of the base of the flame away from the burner head or the flame holding zone provided by the design

3.2.6.3

light back

unintended movement of the flame front to a point upstream of its normal stable operating position

4 Constructional and operational requirements – safety requirements and/or protective measures

4.1 Conversion to different gases

The precautions to be taken when converting from a gas of one group or family to a gas of another group or family and/or to adapt for different gas supply pressures shall be given by the manufacturer in the instructions for operation.

4.2 Construction

4.2.1 Design

4.2.1.1 Combustion

The design and construction of the burner shall be such that within the intended input range and within the prescribed pressure range, the used fuel gas is burned completely and safely.

NOTE The burner head can be lengthened as long as the performance of the burner is not effected in an unsafe manner. The geometry and the distance l of the mixing device in the flame tube should remain unchanged.

4.2.1.2 Mechanical safety, stability and control devices

Moving parts shall be shielded if the enclosure provided does not ensure adequate protection. See also 4.3.1.

The construction of the burner shall be in such a way that no instability, distortion or breakage likely to impair its safety can occur.

Levers and similar devices which have to be operated by the installer or user shall be appropriately identified.

Constructional parts accessible during use and maintenance shall be free from sharp edges and corners that might cause damage or personal injury during use or maintenance.

The design of the burner shall be such that it can be handled safely. It shall be designed and packaged so that it can be stored safely and without damage.

Where the weight, size or shape of the burner or its components prevents them from being moved by hand, they shall be fitted with means to lift them easily. 

4.2.2 Accessibility for maintenance and use

 *deleted text*  Burners that can be withdrawn or swivelled out of position without the use of tools shall be interlocked (for example, by means of limit switches) in such a way that they cannot be operated in the withdrawn or swivelled position.

Ⓐ The interlock device shall be equipped with positive mode actuation as defined in 3.7 of EN 1088:1995 and the related part of the control system shall not be less than category 1 in accordance with EN ISO 13849-1. Ⓐ

4.2.3 Soundness

Holes for screws, studs, etc. intended for the assembly of parts shall not open into gasways. The wall thickness between drillings and gasways shall be at least 1 mm. This requirement shall not apply to orifices for measurement purposes or to components within the burner head.

The soundness of parts and assemblies making up the gas circuit and likely to be dismantled during regular maintenance in situ shall be achieved by means of mechanical joints, for example metal-to-metal joints, gaskets, or O-ring joints, but excluding the use of all sealing materials such as tape, paste or liquids. All sealing materials shall remain effective under normal conditions of burner use.

4.2.4 Materials

The quality and thickness of the materials used in the construction of the burner shall be selected in such a way that the constructional and performance characteristics of the system do not deteriorate during operation. In particular, all the components of a burner shall withstand the mechanical, chemical and thermal loads that may be encountered during operation. Under normal conditions of use, maintenance and adjustment, they shall not show any changes that could affect their normal functioning.

If the housing contains any metal parts not made of corrosion-resistant material, these shall be suitably protected with an effective anti-corrosion coating.

Asbestos or asbestos-containing materials shall not be used.

Copper shall not be used for gas carrying parts where its temperature is likely to exceed 100 °C. Solder that has a melting point below 450 °C after application shall not be used for gas carrying parts.

The pipework material shall comply with EN 10208-1 and EN 10208-2, EN 10216-1, EN 10217-1 or Ⓐ EN 10220 Ⓐ, as appropriate.

4.2.5 Mounting

The burner shall be designed in such a way that it can be effectively mounted on the heat generator.

The burner components shall be arranged and secured in such a manner that their correct operating position, and above all, the correct position of the burner orifices, cannot change during operation. The correct operating position shall be maintained when accessories are dismantled and re-fitted.

Parts of the burner that are set or adjusted at the stage of manufacture and which should not be manipulated by the user or installer shall be sealed.

Ⓐ Components requiring regular maintenance shall be arranged or designed so that they are easily detachable. Furthermore, incorrect replacement shall be prevented by design or, when this is not possible, by marking and/or instructions. Ⓐ

4.2.6 Connections

Inlet connections with pressure-tight joints made on the threads, connections within the burner with pressure-tight joints made on the threads that are not loosened for maintenance, and connections for parts that are not frequently dismantled and re-fitted shall be designed in accordance with ISO 7-1.

Connections which have to be loosened for maintenance purposes shall be designed in accordance with Ⓐ EN ISO 228-1 Ⓐ. Flange connections shall comply with EN 1092-1, EN 1092-2 and Ⓐ EN 1092-3 Ⓐ.

NOTE Attention is drawn to annex D which sets out the connection method permitted or prohibited in certain countries.

4.3 Equipment

4.3.1 Motors and fans

Motors and fans shall be so protected by suitable guards, shields or grilles of adequate size, strength and durability that they are not liable to be touched accidentally. The degree of protection shall be at least IP 20, according to EN 60529. Removal of such guards, shields or grilles shall be possible only with the use of commonly available tools.

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 minimise noise and vibration. ^{A1} *deleted text* ^{A1}

4.3.2 Electrical safety

^{A1} The electric safety of

- a) the burner;
- b) the interfaces (e.g. connectors) between control devices

shall comply with EN 60335-2-102.

The electrical safety of control devices shall comply either with EN 60335-2-102, with EN 60730-1 or its relevant part 2 or with the electrical requirements of the standards listed in EN 60335-2-102:2007, Annex ZBB.

The documentation of the electrical connections for the individual components shall be provided by means of an electrical wiring and connection diagram. ^{A1}

^{A2} NOTE For burners firing pressurised bodies see Annex K. ^{A2}

4.3.3 Adjustable air damper

Every burner shall be fitted with an adjustable air damper or a similar device for controlling the air flow. This device shall be adjustable only by means of a tool. The adjusting positions of the air damper shall be visible, possibly after removal of a cap.

If the burner is provided with a manual means of adjusting the combustion air flow, this means shall be so designed that, after adjustment according to the manufacturer's instructions, it is capable of being set and sealed.

4.3.4 Gas line components

4.3.4.1 General

All gas line components shall be designed for the individual inlet pressure of the burner or be protected against any excessive increase in pressure by means of relevant safety devices.

^{A2} For piping with a pressure > 0,5 bar and a pipe diameter DN ≥ 100 mm Annex K applies. ^{A2}

4.3.4.2 Manually operated shut-off valve

A quick-acting manually operated shut-off valve shall be provided upstream of all controls to isolate the burner.

^{A1} If this valve is not supplied by the manufacturer appropriate information shall be given in the installation instructions, see 6.4. ^{A1}

In addition burners shall be provided with such manually operated shut-off valves as are essential for their commissioning and normal operation.

A1 The manual gas valve shall be readily accessible and capable of rapid operation (e.g. 90° turn valve). The manual valve shall be capable of operating at a pressure equal to 1,5 times the maximum supply pressure.

The manual valves shall be so designed 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. **A1**

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

4.3.4.3 Filter/strainer

A filter/strainer shall be fitted at the inlet of the safety shut-off valve system to prevent the ingress of foreign elements.

The maximum strainer hole dimension shall not be greater than 1,5 mm and the mesh shall not permit the passage of a 1 mm pin gauge.

4.3.4.4 Gas pressure governor

The gas supply for operation and start-up shall be controlled by a pressure governor to ensure that the pressure at the burner head of the main burner or any ignition burner greater than 2 kW heat input remains stable. The heat input shall not vary by more than $\pm 5\%$ from the specified value if the supply pressure changes within the limits of Table 5. The main burner and any ignition burner may also be governed separately.

The gas pressure governor shall comply with **A2** EN 88-1 **A2** or EN 334, whichever is applicable. Where the operating pressure falls outside of the scope of these standards, the gas pressure governor shall be suitable for its purpose.

The accessibility of the pressure governor shall be such that it can be easily adjusted or put out of operation for use with another gas, but precautions shall be taken to make unauthorised adjustment difficult.

If the outlet side of the gas pressure governor and/or the gas valve of the following gas line section with its equipment up to the burner is/are not designed for the maximum supply pressure under fault conditions:

- a high gas pressure shut-off valve shall be applied upstream of the gas pressure governor, shutting off the gas supply before an excessively high pressure occurs;

and

- a safety relief valve shall be installed down-stream of the gas pressure governor. The safety valve shall be vented to a safe area.

The high gas pressure shut-off valve and the safety relief valve may be integrated in one apparatus with the gas pressure governor.

The high gas shut-off valve shall close before the permitted operation overpressure of the downstream gas line components is exceeded.

NOTE The safety relief valve can operate before the high pressure shut-off valve closes. Excessive operation of the safety relief valve should be avoided preventing the release of unburned gases to the atmosphere.

4.3.4.5 High gas pressure over load protection device

High gas pressure over load protection device shall be fitted where no gas pressure governor is used in compliance with **A2** EN 88-1 or EN 88-2 **A2** except when:

- a) the pressure drop across the gas pressure governor(s) is less than 30 % of the normal operating minimum governor pressure, and
- b) any governor failure shall not result in an unsafe start-gas rate being obtained.

Where a high gas pressure over load protection device is fitted, it shall cause a non-volatile lock-out:

- 1) if the heat input to the burner exceeds 1,15 times the nominal input, or
- 2) if the pressure at the burner head exceeds 1,3 times the burner head pressure at the nominal inlet pressure

The high gas pressure over load protection device shall comply with EN 1854.

4.3.4.6 Low gas pressure protection device

The burner shall be fitted with a low gas pressure protection device to cause controlled safety shut-down when the supply pressure falls below a pre-determined value.

The low gas pressure protection device may be omitted, if the following conditions are fulfilled:

If the inlet pressure falls to 25 % of the nominal value the burner shall

- a) continue to operate safely and the CO-content shall not exceed 1 % by volume of the dry, air-free combustion products;

or

- b) proceed to non-volatile lock-out.

Low gas pressure sensing devices shall comply with EN 1854.

4.3.4.7 Adjustment devices

An adjustment device shall be provided to allow the gas rate to be achieved with the fuel gases intended by the manufacturer and over the relevant range of pressures. This adjustment device may be that of the gas pressure governor. Adjusters shall require a tool for adjustment.

4.3.4.8 Automatic safety shut-off valves

All burners shall be fitted with two automatic safety shut-off valves in series as defined in Table 1 and complying with EN 161.

Where the main flame establishment is by means of a start-gas flame, the start gas supply shall be either:

- a) under the control of the downstream main gas safety shut-off valve incorporating a start gas limit position, or
- b) under the control of safety shut-off valves as indicated in Table 1.

Table 1 - Safety shut-off valve requirements

Heat input kW	With pre-purge			Without pre-purge		
	Main gas	Start gas		Main gas	Start gas	
		≤ 10 %	> 10 %		≤ 10 %	> 10 %
≤ 70	2 × B	B ^a	2 × B	2 × A or 2 × B + VP	A ^b	2 × A
> 70 ≤ 1200	2 × A	2 × A	2 × A	2 × A + VP	2 × A	2 × A
> 1200	2 × A + VP	2 × A	2 × A	2 × A + VP	2 × A	2 × A
^a For third family gases: two class B valves are required ^b For third family gases: two class A valves are required VP = valve proving system						

4.3.4.9 Ignition device

The ignition device shall ensure safe ignition of the ignition and/or main burner under the specified conditions of operation.

4.3.4.10 Flame detector device

The main flame and the flame of any ignition burner shall be monitored by a flame detector device.

The mounting of the flame sensors on the burner shall be such that the flame sensors do not receive any extraneous light.

Where the ignition burner and the main burner are each provided with their own flame monitor the ignition burner flame shall not influence the detection of the main flame. The main gas supply shall be opened only after the ignition means is switched off and the ignition burner flame has been established and detected.

For systems where the ignition burner remains in use during main burner operation, separate flame sensors to monitor the ignition and main flames shall be fitted. The main flame sensor shall be so positioned that it cannot in any circumstance detect the ignition burner flame.

For systems where the ignition burner is extinguished during main burner operation a single sensor will suffice. The ignition burner flame shall not influence the detection of the main flame.

The flame detector device shall be such that upon flame failure there is no noticeable delay between the flame extinction and the failure of the flame signal.

The flame detector device shall be suitable for the particular thermal rating and mode of operation of the burner (intermittent or permanent operation). When installed on the burner it shall comply at least with protective category IP 40, and with protective category IP 54 for installations in the open air, in accordance with EN 60529.

The flame detector device shall be subjected to a safe start check which shall lead to safety shut-down or non-volatile lock-out, if the flame detector signals flame presence at any time during the pre-purge. The safe-start check may cease during the 5 s preceding an attempt at ignition. If a flame simulating condition exists, non-volatile lock-out shall occur.

The time for the safety shut-off valves to be de-energised upon flame failure shall be not more than 1 s during normal operation, and not more than 2 s where a self-checking test is made at the same time as the flame failure.

4.3.4.11 Air proving device

The burner shall be fitted with a device for proving adequate air flow during the pre-purge, ignition and operation of the burner. Air flow failure at any time during the ignition or operation of the burner shall cause non-volatile lock-out.

Air flow failure during pre-purge shall at least proceed to safety shut-down (see 4.4.1.2).

For burners of heat input up to and including 120 kW safety shut-down followed by a single attempt at re-start is permitted. If this re-start attempt fails then non-volatile lock-out shall occur.

Proof of adequate air flow may be achieved by one of the following methods:

- a) by pressure sensing;
- b) by flow sensing;
- c) by any other system which does not rely only on fan rotation. An air damper interlock or an air damper actuator interlock alone is not sufficient.

The air proving device shall be proved in the no flow state prior to start-up. Failure to prove the device in the no flow state shall prevent start-up or cause non-volatile lock-out.

This check is not necessary if failure of the air proving device leads to a safe condition.

The air proving device shall be adjusted in such a way that if there is insufficient air supply at the highest or lowest burner operating stage, the device operates before the CO content at the controlled stage of the combustion products exceeds 1 % by volume, air-free/dry.

Where the burner is fitted with automatic air/gas ratio control in which an air flow device provides the lead signal, continuous monitoring of the air flow by the air proving device during the operation of the burner is not necessary. In the event of the failure of the air lead signal the gas valves shall be closed.

NOTE For multi-stage and modulating burners only one air proving device is necessary to control the air flow. In such cases adequate air flow will be ensured as required by 4.3.4.11.

An air proving device may be omitted if the burners are fitted with:

- a device for checking the actual fan speed if no safety shut-down or blocking occurs, and
- a device for checking the state of the adjustable air damper during pre-purge, if no gas opening occurs, and
- a device for a positive coupling between motor/fan, and
- a device for fuel release via gas /air ratio control, and
- a device which shall close the gas valve in the event of the failure of the air reference signal.

If separate combustion air fan to the burner is used, proof of adequate air flow is in principle the same as for a burner according to this standard, only the positioning of the safety devices can be dependent on the situation on site. The air proving device shall be located in such a position, that sufficient air combustion supply is detected.

The test method for the air proving device shall be effective and comply with the special design of the burner (annex H).

4.3.4.12 Air/gas ratio control devices

Each burner shall be provided with an adjustment device for the air flow.

For two-stage or multi-stage burners the flow rate of combustion air and gas shall be controlled in tandem by a sequential switching system. The air and gas adjustment devices shall be interconnected (e. g. by mechanical, pneumatic, electric or electronic means) such that the relationship between combustion air and gas is fixed in a repeatable way at any operating point of the burner.

For burners with intermittent operation, the function of the air/gas ratio control system, except for pneumatically operated devices, shall be checked during the start sequence, e. g. by means of pressure or position switches.

On multi-stage or modulating burners where the air and gas flows are not altered simultaneously, there shall be either:

- a) air lead on increasing firing rate and gas lead on reducing firing rate, or
- b) sufficient excess air to prevent gas-rich firing.

The combined control or the sequential switching shall be effected in such a manner that, even in the case of fault, the system will tend towards higher excess air or proceed to safety shut-down.

- 1) Where a pneumatically operated air/gas ratio device is fitted it shall comply with the requirements of EN 12067-1.
- 2) Where an electronic operated air/gas ratio device is fitted it shall comply with the requirements of A1 EN 12067-2 A1 .

A1 Where a combustion quality control system influencing the ratio between the gas and air supply is used it shall conform to the requirements of EN 12067-2.

NOTE For burners used for intermittent operation, the electronic fuel/air ratio control system should conform to the requirements of EN 12067-2. A1

4.3.4.13 Pressure test points

To enable the gas inlet pressure, the gas adjustment pressure, the pressure in the burner head and the air pressure to be checked, test points or pressure measuring devices shall be provided.

NOTE A single pressure test point can be provided for the measurement of both the adjustment pressure and the pressure in the burner head.

Pressure test points, with a maximum internal diameter of 1 mm, an external diameter of $\left(9_{-0,5}^0\right)$ mm and a length of 10 mm, shall be such that they can be tightly closed, or shall be self-sealing.

4.3.4.14 Automatic burner control unit

The automatic burner control unit shall comply with the requirements of EN 298 and shall be suitable for the individual output stages of the burner. The automatic burner control unit shall be suitable for the mode of burner operation (intermittent or permanent).

NOTE Industrial application: The burner control unit should be tolerable for EMC severity level 3, assessment criteria a) and b) of EN 298 table 4.

4.3.4.15 Valve proving system

Where a valve proving system is fitted it shall comply with the requirements of EN 1643.

The downstream valve of two gas valves in series shall not be permitted to open for a period of more than 3 s before or during the pre-purge or during the post-purge as part of a valve proving system that vents into the combustion chamber.

After a lock-out or power failure of the gas burner the valve proving shall be carried out prior to, or during the pre-purge of the next burner start.

4.4 Functional and operational requirements

4.4.1 General function requirements

The components specified in 4.3 shall be mechanically or electrically designed such that the requirements laid down in the following clauses are satisfied.

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

4.4.1.1 Burner start-up

Burner start-up shall be possible only if the following conditions have been complied with:

- a) any burner mounting interlock (see 4.2.2) is indicating correct location for the safe operation of the burner;
- b) any installation interlock (e. g. flue damper) is indicating its correct position;
- c) the flame detector has been checked for flame simulation. This check may also be carried out during the pre-purge or after a controlled shut-down;
- d) any valve proving system has completed its check successfully. This check may also be carried out during the pre-purge or after a controlled shut-down;
- e) the air flow proving device has been proved to be functioning correctly.

4.4.1.2 Pre-purge

Before energising the ignition device the combustion chamber shall be pre-purged.

The duration of the pre-purge shall be either:

- a) at least 20 s at the full combustion air rate corresponding to the maximum heat input, or
- b) where the air rate is reduced, a time period increased by an amount inversely proportional to the reduced air rate.

e.g.	100 % air rate	– at least 20 s pre-purge time;
	50 % air rate	– at least 40 s pre-purge time;
	33 % air rate	– at least 60 s pre-purge time.

This reduced air flow rate shall not be less than 33 % of the full combustion air rate.

The pre-purge air flow rate shall at least correspond to the adjusted heat input.

If the pre-purge air flow falls below the required rate at any time during the pre-purge either

- c) the burner shall proceed to at least safety shut-down, and restart, or
- d) the pre-purge shall be continued until the required air rate is restored, provided that the total controlled pre-purge time is not reduced.

Two stage or multi-stage burners with air dampers driven by servo drivers of any kind shall have low and high air flow positions. Depending on the selected air flow rate, one of these positions indicates the correct location during the pre-purge sequence. If this position is incorrect during the pre-purge it shall cause a stop in the pre-purge sequence and prevent the burner to start-up until it is re-established.

The duration of the pre-purge may be different or the pre-purge may be omitted if this is permitted in the appropriate heat generator standard.

After a controlled shut-down a restart without a pre-purge may be achieved as follows:

- e) with burners of heat input up to and including 70 kW fitted with either two class A safety shut-off valves in series, or with two class B safety shut-off valves in series plus a valve proving system;
- f) with burners of heat input greater than 70 kW fitted with two class A safety shut-off valves in series plus a valve proving system.

A pre-purge shall be carried out after:

- g) non volatile lock-out;
- h) standstill of more than 24 h;
- i) after electrical power failure;
- j) shut-down by lack of gas.

NOTE Industrial application: The content of the combustion chamber should be purged at least 5-times by the burners prepurge.

4.4.1.3 Start gas heat input

Burners shall start-up at an excess air ratio value equal or greater than those in table 7. Burners with a maximum heat input up to and including 120 kW may be ignited directly.

For burners with a maximum heat input exceeding 120 kW, the start gas heat input shall not exceed 120 kW or the value given by the equation

$$t_s \times Q_s \leq 100$$

If burners are ignited by an independent ignition burner, the start gas heat input of the ignition burner shall not exceed the value given by the equation

$$t_s \times Q_s \leq 150$$

where:

t_s is the safety time in seconds (s);

Q_s is the maximum start gas heat input expressed as a percentage of the main gas rate.

(Maximum start gas heat input and safety times see Table 2.)

NOTE Industrial application: Burners should have no limitation in start-up heat input when the applied ignition system is reliable. They should have enough energy to ensure rapid, low noise and smooth ignition of the main burner without excessive pressure increase.

4.4.1.4 Start gas ignition

The start gas valves shall not be energised before the ignition spark (or other means of ignition) is energised except for purposes of valve proving.

Where a hot surface ignition system is used, the ignition system shall be so energised that the ignition source is capable of igniting incoming gas before the start gas valve(s) are opened.

The start gas flame proving period shall establish that the flame is stable on its own. If the flame fails during this period a non-volatile lock-out shall result.

For burners with a heat input of 120 kW and above, and on which the start gas supply is taken from between the main gas safety shut-off valves, the downstream main gas safety shut-off valve shall be de-energised prior to start-up.

Where the start gas rate is controlled by a start gas rate position contained within the downstream main safety shut-off valve any means of adjustment of the start gas rate shall comply with 4.3.4.7.

4.4.1.5 Main burner ignition

4.4.1.5.1 Establishment by means of a start gas flame

If the start gas flame has been ignited at a separate ignition burner and proved, the second safety time shall be not more than 5 s at the end of which time sensing of the main flame shall begin. If the main flame is not detected at the end of this period, non-volatile lock-out shall result.

4.4.1.5.2 Direct establishment of the main gas flame

The ignition source shall not be energized before completion of the pre-purge period and shall be de-energised at, or before, the end of the safety time.

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

4.4.1.5.3 Energising of the main gas safety shut-off valves

The main gas safety shut-off valve immediately up-stream of the burner shall not be energised:

- before the ignition spark or other means of ignition is energised (in the case of direct main flame ignition) (see Figure 2a);
- after ignition other than to permit flow of start gas (in the case of staged opening valves) (see Figure 2 b);
- until the start gas flame has been established (see Figures 2c and 2d).

Exception: During the valve proving sequence according to 4.3.4.15.

4.4.1.6 Safety times

4.4.1.6.1 Ignition safety time

The ignition safety time shall be determined from the equation given in 4.4.1.3 as a function of the start gas rate, but in no case shall the safety time exceed 5 s.

The ignition of the main and ignition burners, the maximum start gas rate and the corresponding safety time shall be as specified in Table 2 according to the maximum heat input of the burner.

Figure 2 illustrates the ignition systems referred to in this clause.

Burner start-up may be achieved in accordance with one of the following methods:

- direct ignition of the main burner at full rate (see Table 2, column 2, Figure 2 a);
- direct ignition of the main burner at reduced rate; (see Table 2, column 3, Figure 2 b);

- direct ignition of the main burner at reduced rate with by-pass start gas supply; (see Table 2, column 4, Figure 2 c);
- ignition of the main burner by means of an independent ignition burner; (see Table 2, column 5, Figure 2 d).

Higher start gas rates than those specified in Table 2 may be achieved at the end of the safety time provided that it is proved that the total amount of energy released in the combustion chamber during the safety time is not greater than the energy release calculated by multiplying the values of maximum start gas heat input and safety time given by Table 2.

When the electrical supply voltage U_N varies between 85 % and 110 % of the mean value specified by the manufacturer, the safety times declared by the manufacturer shall not be exceeded.

The safety times given in Table 2 are absolute maxima.

Table 2 - Maximum start gas heat inputs (Q_s) and safety times (t_s)

1	2		3		4		5			
Main burner	Direct main burner ignition at full rate		Direct main burner ignition at reduced rate		Direct main burner ignition at reduced rate with by-pass start gas supply		Main burner ignition with independent ignition burner			
							Ignition burner ignition		Main burner ignition	
Rate $Q_{F \max}$	Rate Q_s	Safety time t_s	Rate Q_s	Safety time t_s	Rate Q_s	Safety time t_s	Rate Q_s	First safety time	Rate Q_s	Second safety time
kW	kW	s	kW	s	kW	s	kW	s	kW	s
≤ 70	$Q_{F \max}$	5	$Q_{F \max}$	5	$Q_{F \max}$	5	$\leq 0,1 Q_{F \max}$	5	$Q_{F \max}$	5
> 70 ≤ 120	$Q_{F \max}$	3	$Q_{F \max}$	3	$Q_{F \max}$	3	$\leq 0,1 Q_{F \max}$	5	$Q_{F \max}$	3
> 120	not permitted		120 kW or $t_s \times Q_s \leq 100$ (max. $t_s = 3$ s)				$\leq 0,1 Q_{F \max}$	3	120 kW or $t_s \times Q_s \leq 150$ (max. $t_s = 5$ s)	

$Q_{F \max}$ = maximum heat input in kilowatts
 Q_s = maximum start gas heat input expressed as a percentage of $Q_{F \max}$
 t_s = safety time in seconds

4.4.1.6.2 Extinction safety time

The extinction safety time shall not exceed 1 s.

4.4.1.6.3 Total closing time

The total closing time shall not exceed 2 s. The two valves shall close simultaneously, but where a valve proving system is used there may be a delay for the second valve of up to 2 s.

4.4.1.7 Failure to ignite

Failure to ignite shall lead to either:

- max three attempts of recycling, where each recycling has to perform the full start-up sequence. Following this action, the flame signal shall be present by the end of the first safety time of the last permitted recycle attempt; if not, the system shall immediately react with safety shut down followed by a non-volatile lock-out.

or

b) immediately safety shut-down followed by non-volatile lock-out.

4.4.1.8 Flame failure during the running condition

Upon flame failure during the running condition, the flame sensing system shall lead either to:

a) recycling, with a full start-up sequence. Following this action, the flame signal shall be present by reaching the running position of the burner after the permitted recycle attempt; if not, the system shall immediately react with safety shut down followed by a non-volatile lock-out.

or

b) immediate safety shut-down followed by non-volatile lock-out.

4.4.1.9 Burner shut-down

The operation of a safety device other than a low gas pressure sensing device shall cause non-volatile lock-out without delay.

In the case of permanent loss of the actuating energy the burner shall proceed to a safe condition.

4.4.2 Operational requirements

4.4.2.1 External soundness

When tested as specified in 5.3.1 the gas carrying parts of the burner, up to the last downstream shut-off device, shall be sound.

4.4.2.2 Resistance of the burner to over-heating

Under the conditions specified in 5.3.2 the various parts of the burner shall not suffer any deterioration other than the superficial alterations inherent in combustion.

4.4.2.3 Temperatures of the control and safety devices

Under the conditions specified in 5.3.3, the temperature of the adjusting, control and safety devices shall not exceed the value stated by the manufacturer of the device and their operation shall remain satisfactory.

A1 *deleted text* **A1**

4.4.2.4 Ignition, operation and flame stability

Under the conditions specified in 5.3.4 and 5.3.5, as appropriate, ignition shall be effected correctly, rapidly and without any pulsation. The flames shall be stable and shall not create any disturbing noise. A slight tendency to lift at the moment of ignition is permissible, but the flames shall be stable thereafter.

For burners fitted with a range-rating device, these requirements shall be satisfied at the maximum and minimum heat inputs declared by the manufacturer.

4.4.2.5 **A1** Surface temperatures

The temperature limits according to EN 60335-2-102 apply with the following additions:

If the burner is installed according to the manufacturers instruction, the surface temperatures of accessible burner parts not intended to be touched shall not exceed 60 K above the ambient temperature.

If these temperature limits cannot be respected for technical reasons adequate warnings according to EN 61310-1 shall be provided to the burner.

NOTE Taking into account the nature of the equipment the direct application of EN ISO 13732-1 has not been considered appropriate. ^{A1}

4.4.3 Heat input range of the burner

The maximum and minimum heat inputs shall be measured under the conditions specified in 5.7 and shall be in accordance with the values stated by the manufacturer within $\pm 5\%$.

4.4.4 Dual-fuel burner

Safe operation of the burner shall not be affected by the operational state of the control and safety devices intended for the alternative fuel.

4.4.5 Working diagram and test diagram

4.4.5.1 Working diagram

The working diagram represents the permitted range of application of the burner in terms of the combustion chamber pressure expressed as a function of the burner heat input.

Its boundaries are defined by a series of points 1 to 5 inclusive, as shown in Figure 5 for single stage burners, or 1 to 6 inclusive, as shown in Figure 6 for multi-stage burners.

These points are determined in accordance with 5.4, 5.5, 5.6 and Table 6.

^{A1} In any case the burner operation points shall not exceed the boundaries given by the working diagram. ^{A1}

4.4.5.2 Test diagram

The test diagram represents the ranges of combustion chamber pressure and burner heat input over which the burner is tested to establish conformity to this standard.

It comprises the working diagram and a test zone defined by a series of points Hp1, Hp2, Hp3 and Hp5 for single stage burners and Hp1, Hp2, Hp3, Hp5 and Hp6 for multi-stage burners, as shown in Figures 5 and 6 respectively.

These points are determined in accordance with 5.4, 5.5, 5.6 and Table 6.

4.4.6 Determination of the flame stability and safe range of operation

Under the test conditions specified in 5.3.5, the burner shall operate correctly and safely. The flames shall be stable without pulsation.

4.4.7 Limiting values for combustion emissions

Under the test conditions specified in 5.5, the CO and NO_x-content of the dry air-free combustion products shall not exceed the values specified in 4.4.7.1 and 4.4.7.2.

4.4.7.1 Carbon monoxide (CO)

- The CO content shall not exceed 100 mg/kWh (93 ppm) when the burner is tested at the supply voltage declared by the manufacturer with the reference gas of the gas family or group(s) for which the burner is designed;
- the CO content shall not exceed 2 140 mg/kWh (2 000 ppm) when the burner is tested at 0,85 times the supply voltage declared by the manufacturer with the reference gas of the gas family or group(s) for which the burner is designed;

- c) the CO content shall not exceed 2 140 mg/kWh (2 000 ppm) when the burner, under the same conditions as in (a), is tested at the supply voltage declared by the manufacturer with the incomplete combustion gas of the gas family or group(s) for which the burner is designed;
- d) the burner shall be provided with means to ensure that in the event of the supply voltage falling below 0,85 times the manufacturer's declared value, it either continues to operate safely and the CO content of the products of combustion does not exceed 1 % by volume, or proceeds to safety shut-down.

NOTE This requirement can be satisfied by the incorporation of one of the following:

- motor speed checking device;
- voltage checking device in the automatic burner control unit;
- O₂ checking device;
- air flow checking device;
- air/gas ratio control device.
- CO-monitoring.

This list is not exhaustive and other methods can achieve the same result.

4.4.7.2 Nitrogen oxide (NO_x)

4.4.7.2.1 General NO_x-emission

The NO_x-content of the combustion products is expressed under the following reference conditions (see annex G):

- ambient temperature: 20 °C;
- relative humidity: 70 %.

Where the burner is designed to operate on more than one gas family, after adjustment, the maximum NO_x-levels shall be as given in a), b) and c), as appropriate:

- a) 170 mg/kWh when the burner is tested at the supply voltage declared by the manufacturer with reference gas G 20 for 2nd family gases of group H and E;
- b) 170 mg/kWh when the burner is tested at the supply voltage declared by the manufacturer with reference gas G 25 for 2nd family gases of group L;
- c) 230 mg/kWh when the burner is tested at the supply voltage declared by the manufacturer with reference gas G 31 for 3rd family gases.

4.4.7.2.2 NO_x-classes for burners

Where the burner is designed to operate on 2nd family gases and/or 3rd family gases, the maximum NO_x-levels shall be in classes according to Table 3: