BRITISH STANDARD

BS EN
676:2003

Automatic forced draught burners for gaseous fuels

The European Standard EN 676:2003 has the status of a British Standard

ICS 27.060.20

National foreword

This British Standard is the official English language version of EN 676:2003. It supersedes BS EN 676:1997 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GSE/27, Automatic gas burners, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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

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EUROPEAN STANDARD

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EN 676

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Supersedes EN 676:1996

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.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This document EN 676:2003 has been prepared by Technical Committee CEN/TC 131 “Gas burners using fans”, the secretariat of which is held by DIN.

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 February 2004, and conflicting national standards shall be withdrawn at the latest by February 2004.

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 Annex ZB, which is an integral part of this document.

NOTE This European Standard had also been proposed for inclusion in the mandate under the EU Directive 98/37/EC (Machinery Directive). As the mandate has been given after the Standard had been accepted by the Technical Committee for submission to Formal Vote and in order not to further delay its publication, it will be reviewed within the context of the Directive 98/37/EC directly after the publication.

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.

Annexes A, B, C, D, E, F, G, H, J and ZA are informative.

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, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the 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

1 Scope

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 type test procedure for these burners.

This standard is applicable to

— automatic gas burners with a combustion air fan (hereinafter called "burners") that are equipped as described in clause 4, intended for use in heat generators of different types, and that are operated with fuel gases;

— total pre-mixed burners and nozzle mixed burners.

The standard is applicable to

— single burners with a single combustion chamber, although such burners are fitted to a single appliance, in which case the requirements of the relevant appliance standard shall additionally apply;

— single-fuel and dual-fuel burners when operating only on gas;

— the gas function of dual-fuel burners designed to operate simultaneously on gaseous and liquid fuels in which case the requirements of EN 267 will also apply in respect of the liquid fuel function.

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).

EN 88, *Pressure governors for gas appliances for inlet pressures up to 200 mbar.*

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

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

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 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.*

prEN 1092-3, 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 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.*

prEN 12067-2, *Gas/air ratio controls for gas burners and gas burning appliances — Part 2: Electronic types.*

prEN 50156-1, *Electrical equipment for furnaces and ancillary equipment — Part 1: Requirements for application design and installation.*

EN 60204-1, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:1997).*

EN 60335-1:1994, *Safety of household and similar electrical appliances — Part 1: General requirements (IEC 60335-1:1991, modified).*

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

EN 60947-5-1, *Low-voltage switchgear and controlgear — Part 5-1: Control circuit devices and switching elements — Electromechanical control circuit devices (IEC 60947-5-1:1997).*

ENV 10220, Seamless and welded steel tubes — Dimensions and masses per unit length.

prEN ISO 228-1, 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 (ISO 3166-1:1997).

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

3 General definitions

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

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

3.1 Specific definitions

3.1.1 Combustible gases

3.2.1.1
reference conditions
these correspond to 15 °C, 1013,25 mbar, unless otherwise specified

3.2.1.2
calorific value
quantity of heat produced by the combustion, at a constant pressure equal to 1013,25 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

3.1.2 Operation of the burner

3.1.2.1 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: $Q_{F\,min}$

3.1.2.2 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

3.1.3 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

3.1.4 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 its 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

3.1.5 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

3.1.6 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 requirement

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

The design and construction of the burner shall for its intended application be such that with the intended input or input range and within the prescribed range of pressure, the fuel gas that is to be used is burned completely and safely. Moving parts shall be shielded if the enclosure provided does not ensure adequate protection.

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.

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.

4.2.2 Accessibility for maintenance and use

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. 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 fail safe in design and, if it is a limit switch, shall comply with EN 60204-1 and EN 60947-5-1.

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 0-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 ENV 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 so arranged or so designed that they are easily detachable. Furthermore, they shall be designed or marked in such a way that if the manufacturer's instructions are followed they cannot be replaced incorrectly.

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 prEN ISO 228-1. Flange connections shall comply with EN 1092-1, EN 1092-2 and prEN 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. Lubrication points, if provided, shall be readily accessible.

4.3.2 Electrical safety

For the electrical equipment and connections of the burner the following requirements of prEN 50156-1 and EN 60335-1 shall apply:

a) rated value;

b) protection against accessibility to live parts;

— leakage current and electric strength;

— internal wiring;

— components;

— supply connection and external flexible cords;

— connection terminals for external conductors;

— provision for earthing;

— creepage distances, clearances and distances through insulation;

c) radiation;

— resistance to heat, fire and tracking.

The leakage current and electrical strength tests on the complete burner need not be performed if the components and sub-assemblies have been separately tested and the interconnection is carried out in accordance with the manufacturer's instructions.

If the measurements of the leakage current as required in EN 60335-1:1994, 13.2, are not possible, because the circuits of protective impedance or radio interference filters cannot be disconnected, then the leakage limit specified for leakage current is to be calculated taking into account the current through those circuits.

NOTE Industrial application: EN 60204-1 should apply.

In addition the documentation of the electrical connections for the individual components shall be provided by means of an electrical wiring and connection diagram.

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.

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. This valve need not be supplied by the manufacturer, but it shall be specified in the manufacturer's installation instructions.

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

The manual gas valve shall be readily accessible and capable of rapid operation. The manual valve shall be capable of operating at a pressure equal to 1,5 times the maximum supply pressure.

Manual valves shall be of the 90 turn type and 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.

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 ± 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 EN 88 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 EN 88 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 x B	2 × A or 2 × B + VP	A [b]	2 × A
> 70 ≤ 1200	2 × A	2 × A	2 x 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 prEN 12067-2.

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 $\left(9^{0}_{-0,5}\right)\text{mm}$ 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	≤0,1 Q_{Fmax}	5	$Q_{F\,max}$	5
> 70 ≤ 120	$Q_{F\,max}$	3	$Q_{F\,max}$	3	$Q_{F\,max}$	3	≤0,1 Q_{Fmax}	5	$Q_{F\,max}$	3
> 120	not permitted		120 kW or $t_S \times Q_S \leq 100$ (max. t_S = 3 s)				≤0,1 Q_{Fmax}	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:

a) 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.

The surface temperatures of knobs and levers intended to be manipulated shall not exceed the ambient temperature by more than

— 35 K for metals;

— 45 K for porcelain or equivalent materials;

— 60 K for plastics or equivalent materials.

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.

4.4.3 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 ± 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.

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)

a) 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;

b) the CO content shall not exceed 2140 mg/kWh (2000 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 2140 mg/kWh (2000 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;

— O_2 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:

Table 3 - NO_x-classes

Class	NO_x-emissions in mg/kWh	
	2nd family groups H,E and L	3rd family)
1	≤ 170	≤ 230
2	≤ 120	≤ 180
3	≤ 80	≤ 140

Note that:

— the maximum NO_x-value shall not exceed 170 mg/kWh for 2nd family gas and 230 mg/kWh for 3rd family gas;

— no measured value shall exceed that of the next NO_x-class up;

— an arithmetic average value for determining the NO_x-class is formed from the measuring points of the working diagram (see annex A) and shall be within the NO_x-class according to Table 3.

4.4.8 Starting characteristics

Under the test conditions specified in 5.6, no excessive pressure fluctuations or flame pulsations shall occur. Any pressure fluctuations after ignition shall be reduced to the operating condition within 20 s. These requirements shall be verified by inspection.

4.4.9 Appliance categories

Forced draught burners using fans are exclusively commissioned on the supply gas and the supply gas pressure available on site. The gas categories are:

— I_{2R} for natural gas;

— I_{3R} for liquefied petroleum gas;

— $II_{2R/3R}$ for natural gas/liquefied petroleum gas.

5 Test methods

5.1 General

5.1.1 Test gases for forced draught burners

Gases are classified into families and groups. Table 4 shows a selection of test gases for forced draught burners taken from Table C.1.

The proof of the performance of a burner is achieved by the use of the test gases given in Table 4. When the heat input is equal to or greater than 300 kW the use of line-conveyed gas of group H/E or L, and of the 3rd family, is permissible.

In this case the gas rate shall be adjusted to give the heat input that would have been obtained if the reference gas had been used.

Table 4 - Selection of test gases

	1st family	2nd family			3rd family
		Group H	Group E	Group L	
Output	G 110	G 20	G 20	G 25	G 30 G 31
Stability range	G 110 G 112	G 20	G 20	G 25	G 30 G 31
Combustion quality	G 110	G 20 G 21	G 20 G 21	G 25 G 26	G 30 G 31
Light back [a]	G 112	G 222	G 222	G 25	G 32
Flame lift [a]	—	G 23	G 231	G 27	G 31
[a] on total pre-mixed burners					

5.1.2 Test pressures

The test pressures given in Table 5 are minimum pressures; other pressures which are higher than the pressures in Table 5 may be declared by the manufacturer provided they derive from the gas distribution network.

In this latter case, the minimum pressure will be equal respectively to 0,8 times and the maximum pressure will be equal respectively to 1,2 times the nominal pressure declared by the manufacturer.

Table 5 - Test pressures

Type of gas	Normal pressure mbar	Minimum pressure mbar	Maximum pressure mbar
1st family	8	6	15
2nd family group H	20	17	25
2nd family group E	20	17	25
2nd family group L	25	20	30
3rd family	29 37 50	25 25 42,5	35 45 57,5

5.1.3 General test conditions

5.1.3.1 Test rig

The test rig shall include test flame tubes (see examples shown in Figure 3). Each flame tube is defined by the internal diameter (0,225 m, 0,300 m, 0,400 m, 0,500 m, 0,600 m, 0,800 m) and its length, as well as its corresponding heat input (see Figure 4). The individual flame tubes can be operated with a difference of ± 10 % in the given inputs.

The manufacturer shall nominate the flame tube to be used at minimum or maximum heat input.

The length of the flame tube shall be calculated using the following equation:

$$l_1 = 0{,}23\sqrt{\frac{Q_F}{10}}$$

Where:

Q_F is the heat input in kilowatts;

l_1 is the length of the flame tube in metres.

The length is adjusted by means of a sliding rear wall which moves longitudinally inside the flame tube.

According to the manufacturer's choice the burners may be tested on a flame tube either with

— direct flame operation, or

— reversed flame operation.

For direct flame operation a steel cylinder, which is uncooled, having the same internal diameter as the flame tube combustion chamber and wall thickness of 3 mm, shall be inserted in the inlet of the combustion chamber so as to seal the flue gas tubes entry.

The flame tube is equipped with a shutter device to enable a variable pressure drop to be created at the combustion chamber outlet or in the flue. By means of this device the pressure within the combustion chamber may be adjusted.

All walls, with the exception of the front wall, are cooled.

The flame tube is fitted with sealed windows enabling visual inspection of the flame to be made. It shall be possible to measure the pressure in the flame tube.

NOTE The pressure measurement should be carried out by means of a device fitted in the combustion chamber door (flame tube door).

It is acceptable for the flames to strike the cooled rear wall.

If the manufacturer develops a burner intended to fire into a combustion chamber with dimensions significantly different from those given in Figure 3, then the tests are carried out on a typical boiler or on another test flame tube pending the development of a new standard test flame tube. In this case special mention shall be made in the burner instruction manual.

For burners with a heat input above the values given in Figure 4 the test is carried out on a test rig specified by the manufacturer.

5.1.3.2 Cooling medium

The temperature of the cooling medium in the test flame tube is maintained as low as possible in the range between 15 °C and 60 °C during:

— start-up (see 5.6);

— the determination of the flame stability and the safe operational limits using the flame lift limit gases (see 5.3.5);

— the flame stability test (see 5.3.4).

The cooling medium temperature shall be between 40 °C and 80 °C and thermal equilibrium shall be maintained during:

— the tests for the flame stability and safe operational range using the light-back limit gas (see 5.3.5);

— the determination of the combustion characteristics (see 5.5);

— the determination of the input range (see 5.7).

5.1.3.3 Test room

The burner is installed in a well-ventilated, draught-free room which has an ambient temperature of 20 °C ± 5 °C.

Other ambient temperatures are acceptable provided that the test results are not affected.

5.1.3.4 Evacuation of the combustion products

The test flame tube is connected to a flue as described in Figure 3.

The combustion products are sampled as shown in Figure 7.

5.1.3.5 Electrical supply

The burner is supplied with electricity at the nominal voltage (U_N) except where otherwise stated.

5.1.3.6 Installation

The manufacturer shall supply the test laboratory with the burner fitted with all the accessories necessary for its installation according to the manufacturer's instructions.

The burner to be tested is connected to the test flame tube as described in Figure 3, and the distance l_1 between the flame stabiliser and the adjustable rear wall of the combustion chamber is adjusted according to the table in Figure 3.

The over-pressure in the combustion chamber is created by adjusting the shutter device in the rear wall, or any other system placed downstream, either separately or in combination.

For burners operating in a negative pressure in the combustion chamber, an induced draught fan (downstream of the measuring device) is required or the required values are obtained with the help of a manual adjusting device or by an automatic combustion chamber pressure control system.

Burners to be tested on a particular heat generator or another test flame tube are installed in accordance with the manufacturer's instructions.

5.1.3.7 Accuracy of measurements

5.1.3.7.1 Measurement tolerances of the measuring devices

Except where otherwise stated in the relevant requirements, the measuring instruments used shall enable measurements to be made with the following accuracy:

calorific value	± 0,5 %;
density	± 0,5 %;
gas temperature	± 0,2 K
time	± 0,1 s
gas pressure	± 0,1 mbar
atmospheric pressure	± 0,5 mbar
combustion products (NO_x, CO)	± 5 ppm
mass	± 0,5 %;
gas volume	± 0,5 %;
surface temperature	± 2 K
soundness of the gas parts	± 0,1 mbar

5.1.3.7.2 Measurement uncertainties during test

length of the combustion chamber l_1	± 3 %
temperature of air at burner inlet	± 2 K
combustion chamber pressure during operation	± 5 %;
combustion chamber pressure during start-up	± 10 %;
fuel throughput	± 2,5 %;
CO_2 content	± 0,3 % by volume
O_2 content	± 0,3 % by volume
CO content	± 10 ppm
NO_x-content	± 10 ppm

5.1.4 Types of test

5.1.4.1 General

A burner is tested as a separate unit.

A complete unit consists of the burner and its accessories; Figure 1 shows an example of a burner and its equipment.

5.1.4.2 Structural testing

After the conclusion of the tests, a comparison between the drawings and the construction of the burner is made. The burner is disassembled if necessary for this purpose.

If conversion from one type of gas to another is intended, all the parts required for the conversion are tested together with the burner and the appropriate test gas.

5.2 Functional tests

5.2.1 General

The burner is installed according to the manufacturer's instructions and in accordance with 5.1.3.6 and the electrical supply voltage adjusted to the nominal voltage, except where otherwise stated.

The normal condition is at nominal voltage and exceptions are 85 % or 110 % of the nominal voltage.

Under these conditions the correct operation of the individual components and of the burner is verified.

5.2.2 Start-up

The burner is installed according to the manufacturer's instructions and in accordance with 5.1.3. It is checked that the requirements of 4.4.1.1 are satisfied.

5.2.3 Pre-purge

The burner is operated from the beginning of the burner control programme. It is checked that the requirements of 4.4.1.2 are satisfied.

5.2.4 Start-up heat input

The burner is operated with the electrical supply at its nominal voltage. Under these conditions it is checked that the requirements concerning the maximum start-up heat input specified in 4.4.1.3 are satisfied. The heat input range is measured in accordance with 5.7.

5.2.5 Ignition

The main burner and ignition burner are supplied with each reference gas for the burner category at the normal pressure so as to obtain the maximum heat input.

Under these conditions the requirements of 4.4.1.4 and 4.4.2.4 are verified.

5.2.6 Safety times

5.2.5.1 General

The tests are carried out with the reference gas or gases of the respective gas family or group.

5.2.5.2 First and second safety time

The relevant burner is extinguished and the flame detector device is put out of action.

a) first safety time

— time interval between the pilot gas valve, the start gas valve or main gas valve, as applicable, being energised and the pilot gas valve, start gas valve or main gas valve, as applicable, being de-energised if the flame detector signals the absence of a flame;

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

b) 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 interval between the main gas valve being energised and the main gas valve being de-energised if the flame detector signals the absence of a flame.

5.2.5.3 Extinction safety time

With the burner in operation flame failure is simulated by putting the flame sensor out of action. The time is measured between this operation and the moment at which the safety device de-energises the safety shut-off valves of the gas supply.

5.2.5.4 Failure to ignite

The relevant burner is started and the flame detector device is put out of action.

It is checked that the requirements of 4.4.1.7 are satisfied.

5.2.5.5 Flame failure during the running condition

With the burner in operation flame failure is simulated by putting the flame sensor out of action. It is checked that the requirements of 4.4.1.8 are satisfied.

5.3 Operation

5.3.1 External soundness

The tests are carried at ambient temperature, using air or gas at a pressure of 150 mbar or 1,5 times the manufacturer's declared maximum supply pressure, whichever is the higher, in the direction of gas flow.

An air or a gas supply is connected to the inlet of the burner gas line.

The safety shut-off valves are maintained in the open position except the last downstream means of isolation.

The inlet pressure is adjusted to the specified value and all gas-carrying parts are subjected to this pressure.

The soundness test is carried out, using a suitable foaming agent, at the beginning of the tests. The system is deemed to be sound if no bubbles are formed.

5.3.2 Resistance of the burner to over-heating

The burner is installed in accordance with 5.1.3 and the temperature of the cooling medium is maintained between 20 °C and 60 °C.

5.3.2.1 Nozzle-mixed burners

The burner is supplied with reference gas at 1,09 times its maximum heat input and the pressure in the flame tube adjusted to the maximum value corresponding to the maximum heat input specified by the manufacturer.

The burner is operated for 10 min after which it is checked that the requirements of 4.4.2.2 are satisfied. (point Hp1).

5.3.2.2 Total pre-mixed burners

The burner is adjusted in accordance with 5.3.2.1. Without re-adjustment the burner is then supplied with the appropriate light back gas specified in Table 4 and operated for 10 min. At the end of this time it is checked that the requirements of 4.4.2.2 are satisfied.

5.3.3 Temperature of the control and safety devices

The burner is installed in accordance with 5.1.3 and supplied with the appropriate reference gas at the maximum heat input. The temperatures of the control and safety devices are measured with the burner in the cold condition. After 30 min operation the temperatures are again measured and it is checked that the requirements of 4.4.2.3 are satisfied.

However if an electrical component is itself likely to cause a rise in temperature (e. g. automatic shut-off valves) the temperature of the component is not measured. In this case the temperature measuring probes are placed so as to measure the air temperature around the device.

5.3.4 Ignition — flame stability

At the test points 3 and 4 in Figures 5 and 6 safe ignition and safe operation are checked at an excess air ratio λ equal to or greater than 1,5 or the air dampers are fully opened.

In addition, for pre-mixed burners a stability test is carried out at points 1 and 4, using the light-back limit gas.

5.3.5 Operation — flame stability

The burner is installed in accordance with 5.1.3.

In the test diagram the flame stability shall be observed under the following conditions:

a) Nozzle-mixed burners: when supplied with the reference gas of the gas family or group for which the burner is designed.

b) Total pre-mixed burners:

1) for burners of heat input up to and including 150 kW:
with the burner adjusted to the manufacturer's specified value of λ for the relevant reference gas, then changed to operation on the corresponding lift limit gas without readjustment (points 1 and 4 in Figures 5 and 6);

2) for burners of heat input greater than 150 kW:
when supplied with the reference gas of the gas family or group, for which the burner is designed.

5.4 Tests to be carried out on the working and test diagrams

The tests to be carried out and the adjustments to be made at each point on the working and test diagrams are as follows.

5.4.1 Tests at point 1

All burners:

With the appropriate reference gas at normal supply pressure adjust:

— the heat input to maximum value;

— the electrical supply voltage to the nominal value;

— the excess air ratio λ to the declared value;

— the combustion chamber pressure to the minimum value.

a) Check combustion: CO, NO_x and λ . (See 4.4.7.1a), 4.4.7.2 and Table 7);

b) check temperature of the control and safety devices (see 5.3.3);

c) reduce voltage to 85 % of the nominal value. Check combustion: CO (see 4.4.7.1 b);

d) reduce voltage to 70 % of the nominal value. Check combustion: CO or safety shut-down (see 4.4.7.1 d);

e) check heat input variation with variation in supply pressure (see 4.3.4.4);

f) check ignition and flame stability (single stage burners only; see 5.3.4 and 5.3.5).

Total pre-mixed burners (additional tests):

g) replace reference gas by light back gas. Check ignition (see 5.3.4);

h) if the heat input is equal to or less than 150 kW replace the reference gas by lift limit gas. Check ignition and flame stability (see 5.3.4 and 5.3.5).

5.4.2 Tests at point Hp1

All burners:

Adjust burner and combustion chamber pressure as specified in 5.4.1.

a) Either increase heat input on reference gas by 9 %, or replace reference gas by corresponding incomplete combustion gas;

b) check combustion: CO (see 4.4.7.1 c);

c) check ignition and flame stability (see 5.3.4 and 5.3.5);

d) check for resistance to over-heating (see 5.3.2.1 and 5.3.2.2).

NOTE Extra test point for extended flame tube.

5.4.3 Tests at points 2, 5 (single, multi-stage and modulating burners) and 6 (multi-stage and modulating burners)

All burners:

With the appropriate reference gas at normal supply pressure adjust:

— the heat input to the declared value;

— the electrical supply voltage to the nominal value;

— the excess air ratio λ to the declared value;

— the combustion chamber pressure to the maximum value (positive at points 2 and 6; negative or zero at point 5).

a) Check combustion: CO, NO_x and λ (see 4.4.7.1 a, 4.4.7.2 and Table 7);

b) check ignition and flame stability (single stage burners only; see 5.3.4 and 5.3.5).

5.4.4 Tests at points Hp2 (single, multi-stage and modulating burners) and Hp6 (multi-stage and modulating burners)

All burners:

Adjust burner as specified in 5.4.3 at points 2 and 6.

a) Adjust combustion chamber pressure to 1,1 times the maximum value and readjust the heat input. The excess air ratio λ may require readjustment;

b) either increase heat input by 9 % or replace the reference gas by the corresponding incomplete combustion gas;

c) check combustion: CO (see 4.4.7.1 c);

d) check ignition and flame stability (see 5.3.4 and 5.3.5).

5.4.5 Tests at point 3

All burners:

With the appropriate reference gas at normal supply pressure adjust:

— the heat input to minimum value;

— the electrical supply voltage to the nominal value;

— the excess air ratio λ to the declared value;

— the combustion chamber pressure to the maximum value.

a) Check combustion: CO, NO_x and λ (see 4.4.7.1 a, 4.4.7.2 and Table 7);

b) adjust λ to 1,5 or greater or open air damper fully, as appropriate;

c) check ignition and flame stability (see 5.3.4 and 5.3.5).

5.4.6 Tests at point 4

All burners:

Adjust the burner as specified in 5.4.5 and set the combustion chamber pressure to the minimum value.

This value may be zero or negative.

a) Carry out test as specified in items a), b) and c) of 5.4.5;

Total pre-mixed burners (additional tests):

b) replace the reference gas by the light back gas and operate burner for 10 min;

c) check ignition and flame stability (see 5.3.4 and 5.3.5);

d) if the heat input is ≤ 150 kW replace the reference gas by the lift limit gas;

e) check flame stability (see 5.3.4 and 5.3.5).

5.4.7 Tests at first stage points or minimum heat input

All multi-stage or modulating burners:

Adjust burner and combustion chamber settings as for points 2, 5 and 6 or points 1, 2 and 6 as appropriate.

a) Operate the burner at its first stage or its minimum heat input, as appropriate;

b) check combustion: CO, NO_x and λ (see 4.4.7.1 a), 4.4.7.2 and Table 7);

c) check ignition and flame stability (see 5.3.4 and 5.3.5);

d) repeat b) at the mid-point of the heat input range.

5.4.8 Summary

The measurements to be made and the corresponding requirements and test procedures are given in Table 6.

Table 6 - Summary of tests

Point	1	2	3	4	5	6	Hp1	Hp2	Hp6	Clause
U = 0,85 U_N	x	----	----	----	----	----	----	----	----	4.4.7.1 b)
U = 0,7 U_N	x	----	----	----	----	----	----	----	----	4.4.7.1 d) and 5.5
Heat input variation	x	----	----	----	----	----	----	----	----	4.3.4.4
λ [a]	x	x	x	x	x	x	----	----	----	Table 7 and 5.4.7
CO < 100 mg/kWh [a]	x	x	x	x	x	x	----	----	----	4.4.7.1 a) and 5.4.7
NO_x < 170 mg/kWh [a]	x	x	x	x	x	x	----	----	----	4.4.7.2 and 5.4.7
CO < 2140 mg/kWh	----	----	----	----	----	----	x	x	x	4.4.7.1 c)
Ignition at $\lambda \geq 1,5$ or air damper fully open	----	----	x	x	----	----	----	----	----	4.4.2.4
Ignition and flame stability [a]	x	x	x	x	x	x	x	x	x	4.4.2.4
Start-up single stage burner	x	x	x	x	x	----	x	x	----	5.6
Start-up multi-stage burner	x	x	----	----	x	x	x	x	x	5.6
Pre-mixed burner, light-back limit gas	x	----	----	x	----	----	----	----	----	4.4.2.4
Pre-mixed burner, flame lift limit gas ≤ 150 kW	x	----	----	x	----	----	----	----	----	4.4.2.4
Resistance to over-heating	----	----	----	----	----	----	x	----	----	4.4.2.2
Temperature of the control and safety devices	x	----	----	----	----	----	----	----	----	5.3.3

[a] The tests carried out at the first stage points corresponding to the points indicated (see Figure 6).

5.5 Combustion

The burner is installed in accordance with 5.1.3 and operated with reference gas of the gas family or group and at the nominal voltage for which the burner is designed:

a) at points 1 to 6 the excess air ratio λ is adjusted in accordance with Table 7, and it is checked that the CO and NO_x-values are in accordance with 4.4.7.1 a) and 4.4.7.2 respectively;

b) at point 1 in Figures 5 and 6, with λ adjusted in accordance with Table 7, the supply voltage is adjusted to 85 % of the value declared by the manufacturer. It is checked that the CO values are in accordance with 4.4.7.1 b);

c) at points 1, 2 and 6 in Figures 5 and 6 the combustion chamber pressure is increased in accordance with 5.4 and either

— the heat input is increased by 9 % at the nominal voltage, without adjusting the air flow rate, or

— the corresponding reference gas is replaced by the relevant incomplete combustion limit gas.

Under these conditions (at points Hp 1, Hp 2 or Hp 6) it is checked that the CO content in the dry air-free products of combustion does not exceed the value given in 4.4.7.1 b);

d) in addition, when adjustment is made in accordance with a), the supply voltage is reduced to 0,7 times the nominal voltage. Under these conditions it is checked that the requirements of 4.4.7.1 d) are satisfied.

Table 7 - Excess air ratio

Burner type	Turn-down ratio	Excess air ratio λ					
		Point 1	Point 2	Point 3	Point 4	Point 5	Point 6
Single stage	-------	≤ 1,2	≤ 1,2	≤ 1,3	≤ 1,3	≤ 1,2	-----
Multi-stage or modulating	≤ 1 to 4	≤ 1,2	≤ 1,2	≤ 1,3	≤ 1,3	≤ 1,2	≤ 1,2
	> 1 to 4	≤ 1,2	≤ 1,2	≤ 1,5	≤ 1,5	≤ 1,2	≤ 1,2

For pre-mix burners of NO_x-class 3, the excess air ratio may be ≤ 1,4 at full and part load.

5.6 Start-up

The burner is supplied with the reference gas corresponding with the gas family or group for which it is intended and the value of λ adjusted to an excess air ratio value equal or greater than those in table 7. The electricity supply to the burner is adjusted to 85 % of the minimum of the manufacturer's specified voltage range.

The start-up tests are carried out with the conditions in the test flame tube corresponding to the points of the working and test diagrams as determined in accordance with 5.4.

Three start-up tests are carried out at each point, the first test being carried out with the cooling medium cold.

For the second and third start-up tests the burner is switched off and immediately switched on again. The interval between switching off and on shall be not more than 5 s.

During the start-up tests no excessively high pressure fluctuations or flame pulsations shall occur in the test flame tube. This shall be verified by visual check.

5.7 Obtaining the heat input

The heat input Q_F in kW is given by one of the two formulae:

$$Q_F = 0{,}278 \cdot M_N \times H_i$$

or

$$Q_F = 0{,}278 \cdot V_N \times H_i$$

where:

M_N is the nominal mass flow rate in kg/h obtained under reference conditions (dry gas, 15 °C; 1013,25 mbar);

V_N is the nominal volumetric flow rate in m³/h obtained under reference conditions (dry gas, 15 °C; 1013,25 mbar);

H_i is the net calorific value of the gas in MJ/kg (1st formula) or in MJ/m³ (2nd formula).

These mass and volumetric flow rates correspond to a measurement and flow of gas under reference conditions, i. e. assuming the gas to be dry at 15 °C and under 1013,25 mbar pressure.

In practice the value obtained during the tests do not correspond to these reference conditions. They therefore need to be corrected to the values that would actually have been obtained had the reference conditions existed during the tests.

When the determination is made by weight, (3rd family gas), the corrected mass rate is calculated by the formula:

$$M_0 = M \sqrt{\frac{1013{,}25 + p}{p_{at} + p} \quad \frac{273{,}15 + t_g}{288{,}15} \quad \frac{d_r}{d}}$$

When the determination is made from the volumetric rate the following correction formula is used:

$$V_0 = V \sqrt{\frac{1013{,}25 + p}{1013{,}25} \quad \frac{p_{at} + p}{1013{,}25} \quad \frac{288{,}15}{273{,}15 + t_g} \quad \frac{d}{d_r}}$$

The corrected rate is calculated from the formula:

$$M_O = 1{,}226 \times V_O \times d$$

where:

M_0 is the mass flow rate under reference conditions;

M is the mass flow rate obtained under test conditions;

V_0 is the volumetric flow rate under reference conditions at the burner inlet;

V is the volumetric flow rate obtained under test conditions (measured at pressure $p_{at} + p$ and temperature t_g);

p_{at} is the atmospheric pressure in mbar;

p is the gas pressure measured at the meter in mbar;

t_g is the temperature of the gas measured at the meter in °C;

d is the density of the dry gas relative to dry air;

d_r is the density of the dry reference gas relative to dry air.

5.8 Electrical safety

Examination of the electrical equipment and connections of the burner as specified in 4.3.2 b) shall be carried out visually, by functional test or by measurement.

The burner manufacturer shall provide a detailed declaration of conformity showing that the requirements of 4.3.2 c) have been fulfilled.

The electrical connections for and the correct integration of the individual components shall be examined by means of the electrical wiring diagram provided by the manufacturer.

6 Marking, labelling and packaging

6.1 General

The burner, its packaging and other relevant components shall be marked with the relevant information specified in 6.2, 6.3 and 6.5.

The code to be used for identifying the country of destination of the burner shall be that specified in EN ISO 3166-1.

6.2 Data plate

Each burner shall have, in a visible position after installation, but not possibly after the removal of part of the case, a data plate stating the following information in indelible characters:

— the name of the manufacturer and/or the trade mark, with the address;

— the serial number and year of manufacture (coded);

— identification number of the device/product (PIN);

— the trade name under which the burner is presented for testing;

— the burner category, or categories;

— the gas family or group;

— the heat input expressed in kilowatts (kW) and where necessary the fuel consumption in kg/h;

— for range-rated burners the maximum and minimum heat inputs in kW;

— the direct country or countries of destination of the burner;

— the supply pressure or pressure range which can be used;

— the nature of electrical supply, i.e. direct or alternating, the voltage and power consumption.

6.3 Other marking

The burner shall carry a suitable plate or durable label indelibly marked with the following text:

"This burner must be installed in accordance with the rules in force, and used only in a well-ventilated space. Consult the instructions before installation and use of this burner."

The burner shall also carry all useful information relating to any electrical equipment, particularly the voltage and the current to be used and the appropriate insulation code in accordance with EN 60529.

Permanent warning notices shall be provided in a ready visible position on the burner requiring the burner to be switched off and the gas supply isolated before carrying out any servicing operation.

Provision shall be made on the burner or the data plate for the marking of the appliance category and the gas pressure in accordance with 4.4.9.

Provision shall be made on the burner or the data plate for CE marking.

6.4 Instructions for installation, adjustment, maintenance and operation

Each burner shall be accompanied by instructions giving relevant information on its correct installation, adjustment, maintenance and operation. Further a commissioning report shall be available on site. It shall show the following on site measured data and values:

— gas type;

— Wobbe index (calorific value);

— volumetric gas flow rate;

— minimum and maximum heat output rates;

— supply gas pressure;

— adjustment gas pressure;

— CO and CO_2-percentage content of the flue gases;

— combustion air temperature;

— flue gas temperature.

In each case these documents shall show a date of issue.

In addition the instructions shall include a wiring diagram and details of the control box sequencing used.

A simplified electrical connection diagram shall be made available for display at or near the electrical junction box. The gas types suitable for the burner shall also be stated.

The installation instructions shall contain full details of the intended range of operation as well as the parameters necessary for matching the burner to the heat generator (working diagram, connection dimensions). In addition details shall be included on the gas supply connection for the burner, the burner head, the inlet pressure, pressure monitoring and adjustment pressure.

In addition, where the burner has been designed for operation in a combustion chamber whose dimensions are significantly different from those of the test flame tube then this shall be indicated in the instructions for installation.

The operating instructions shall provide information on the mode of use of monitoring devices fitted to the burner. The operating instructions shall also contain details of the measures to be taken in the event of a fault or an emergency.

Concise instructions for the user concerning the procedure for start-up and shut-down of the burner shall be made available for display at or near the burner.

The manufacturer's instructions shall provide technical information on the procedures to be followed when adjusting the burner from use on one gas in a family to use on a gas of another family, or from gas to gas within a family.

6.5 Marking on the packaging

The packaging shall carry the following information:

— the type of gas in relation to the gas pressure for which the burner has been adjusted; any pressure indication shall be identified in relation to the corresponding burner category index;

— the direct country or countries of destination of the burner;

— the burner category or categories; if more than one burner category is specified, each of these categories shall be identified in relation to the appropriate country or countries of destination.

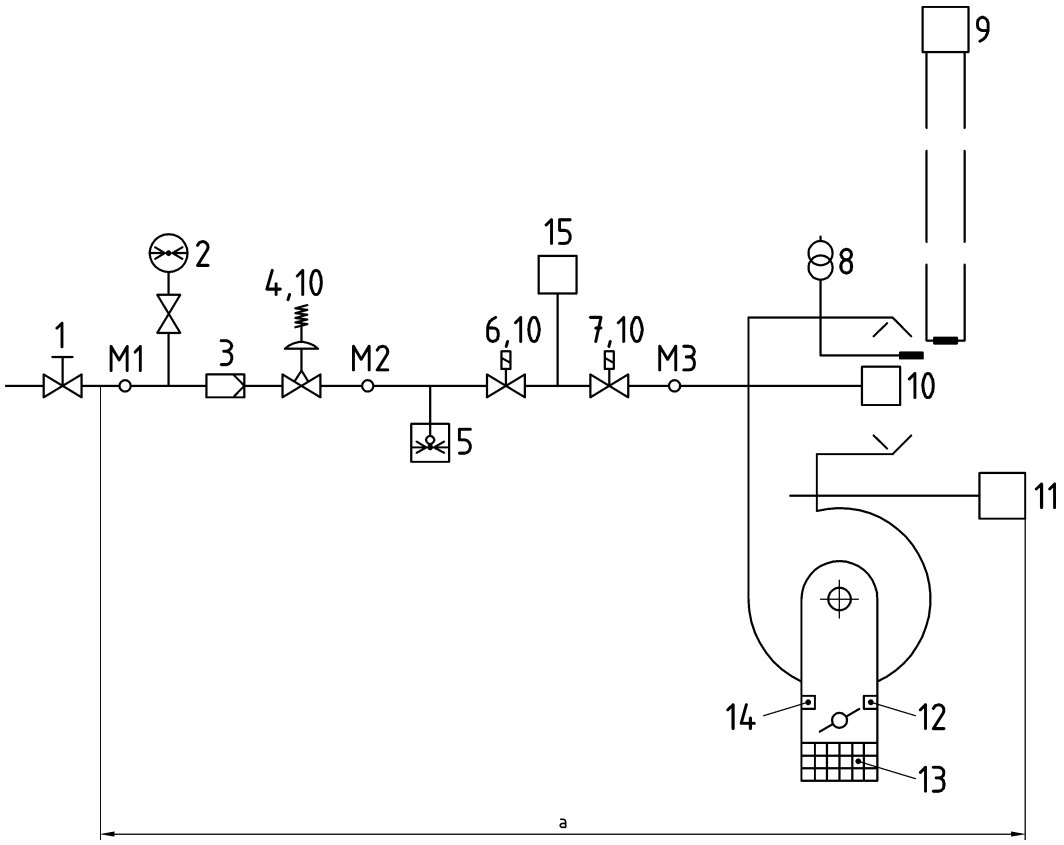
No other information shall be included on the package if this could lead to confusion with regard to the current state of adjustment of the burner and the corresponding burner category or categories and the direct country or countries of destination.

In addition the burner packaging shall carry a label indelibly marked with the following text:

"This burner must be installed in accordance with the rules in force, and used only in a well-ventilated space. Consult the instructions before installation and use of this burner."

6.6 Official languages to be used

All information specified in 6.2; 6.3; 6.4 and 6.5 shall be given in the official language(s) of the direct country or countries of destination.



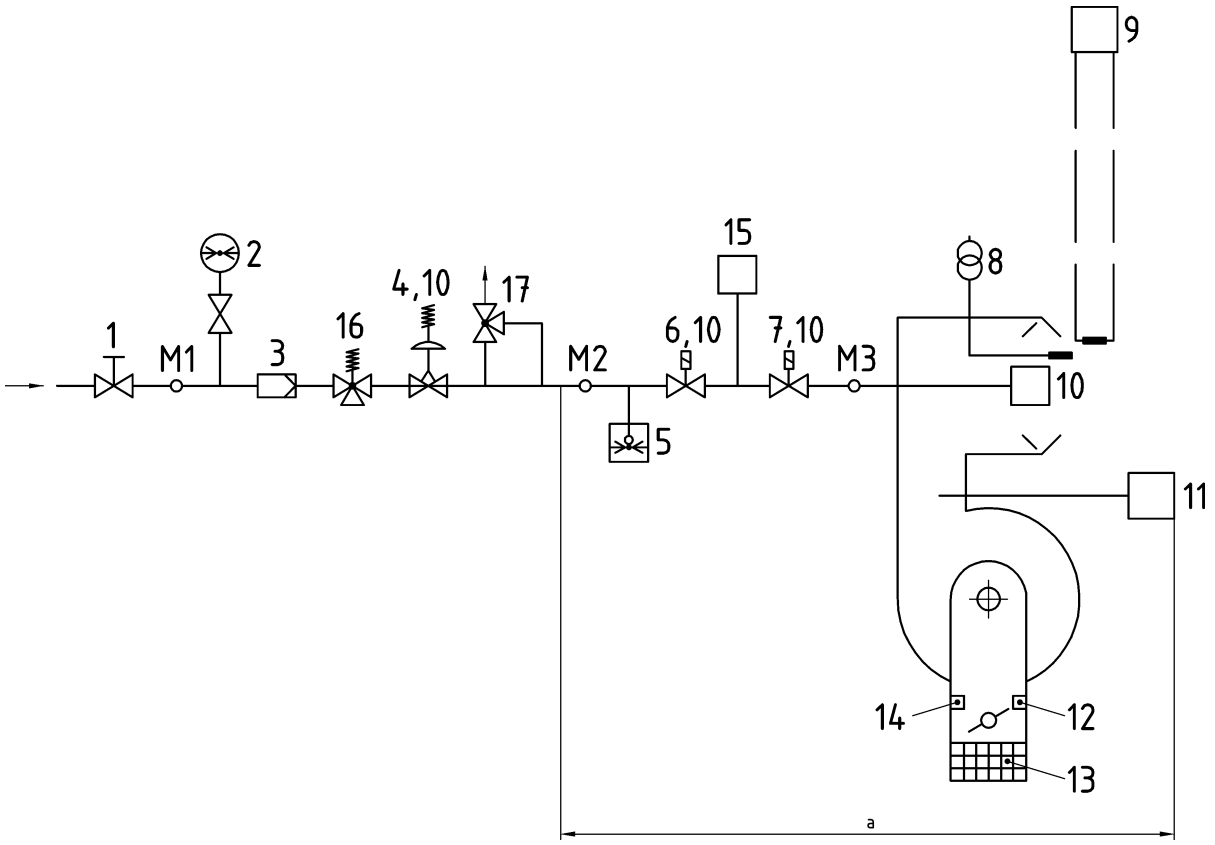
Key

1 Manually operated shut-off device
2 Gas pressure gauge
3 Filter
4 Gas pressure governor according to EN 88 or EN 334
5 Low gas pressure protection device
6 Safety shut-off device
7 Control device
8 Ignition device
9 Flame detector
10 Preliminary adjusting device
11 Fan proving device
12 Low air flow position switch
13 Safety device for moving parts e. g. grille
14 High air flow position switch
15 Valve proving system (> 1,2 MW)
M1 Measuring point for supply pressure
M2 Measuring point for adjustment pressure
M3 Measuring point for burner head pressure

NOTE a = Minimum equipment for type testing

a) ≤ 360 mbar gas pressure

Figure 1 - Example of equipment for a forced draught gas burner

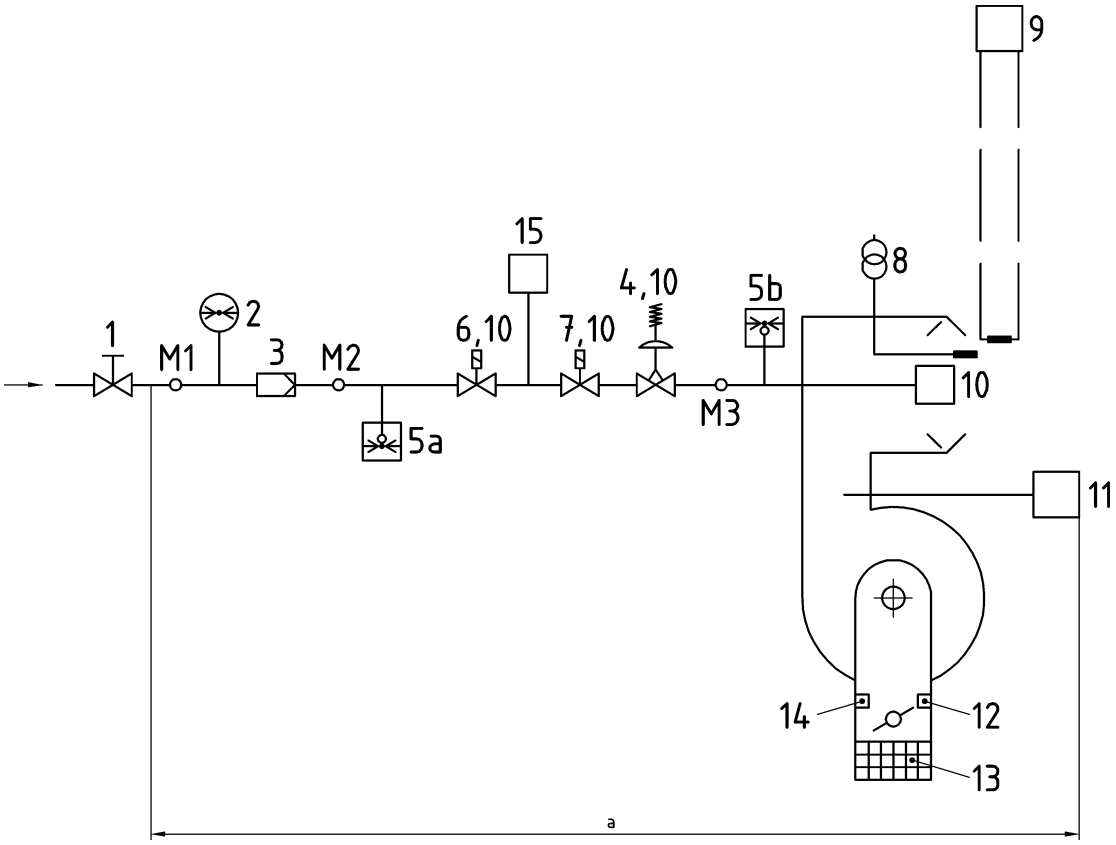


Key

1 Manually operated shut-off device
2 Gas pressure measuring device
3 Filter
4 Gas pressure governor according to EN 88 or EN 334
5 Low gas pressure protection device
6 1st Safety shut-off device
7 2nd Safety shut-off device
8 Ignition device
9 Flame detector
10 Preliminary adjusting device
11 Fan proving device
12 Low air flow position switch
13 Safety device for moving parts e. g. grille
14 High air flow position switch
15 Valve proving system (> 1,2 MW)
16 High gas-pressure shut-off valve
17 Safety relief valve
M1 Measuring point for supply pressure
M2 Measuring point for adjustment pressure
M3 Measuring point for burner head pressure
NOTE a = Minimum equipment for type testing

b) gas pressure > 360 mbar

Figure 1 (continued) - Example of equipment for a forced draught gas burner

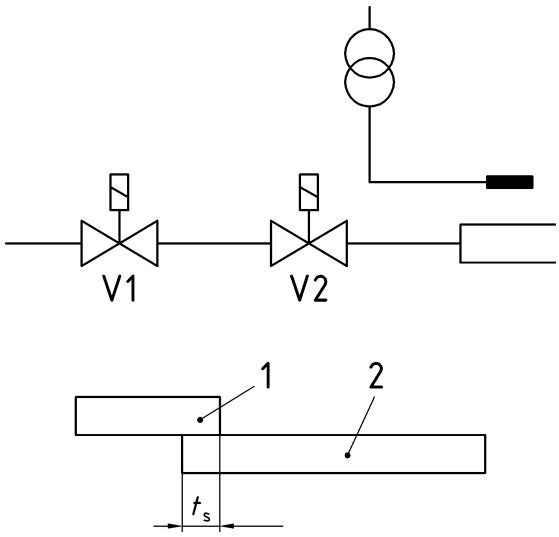


Key

1 Manually operated shut-off device
2 Gas pressure measuring device
3 Filter
4 Gas pressure governor according to EN 88 or EN 334
5a Low gas pressure protection device
5b High gas pressure over load protection device
6 1st Safety shut-off device
7 2nd Safety shut-off device
8 Ignition device
9 Flame detector
10 Preliminary adjusting device
11 Air proving device
12 Low air flow position switch
13 Safety device for moving parts e. g. grille
14 High air flow position switch
15 Valve proving system (> 1,2 MW)
M1 Measuring point for supply pressure
M2 Measuring point for adjustment pressure
M3 Measuring point for burner head pressure
NOTE a = Minimum equipment for type testing

c) governed supply pressure

Figure 1 (concluded) - **Example of equipment for a forced draught gas burner**



Key

V1, V2 Main gas safety shut-off valve

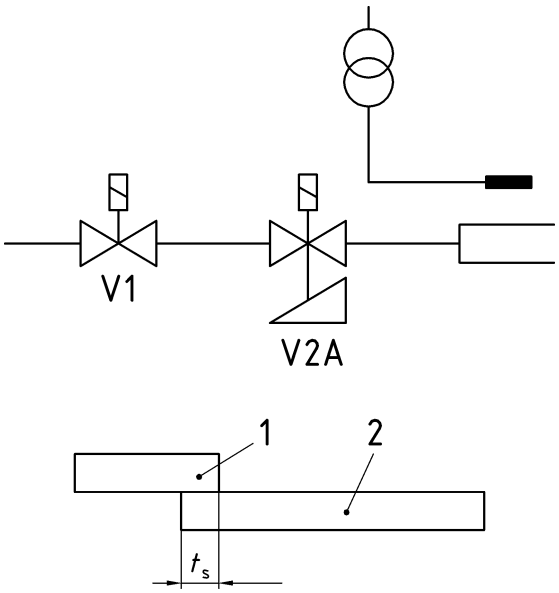
t_s Safety time

1 Ignition

2 Main gas valves

a) Direct main burner ignition at full rate

Figure 2 - Direct main burner ignition



Key

V1 Main gas safety shut-off valve

V2A Main gas slow opening or two step safety shut-off valve

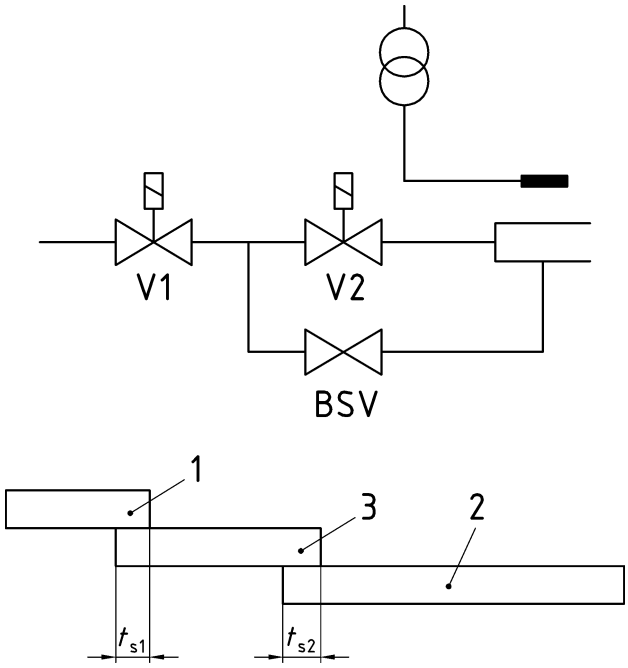
t_S Safety time

1 Ignition

2 Main gas valves (V1, V2A)

b) Direct main burner ignition at reduced rate

Figure 2 (continued) - Direct main burner ignition

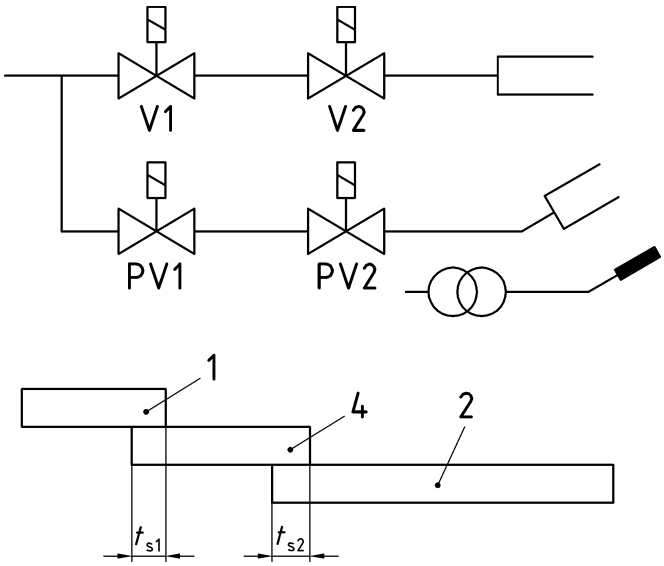


Key

V1, V2	Main gas safety shut-off valve
BSV	By-pass start gas valve
t_{s1}	First safety time
t_{s2}	Second safety time
1	Ignition
2	Main gas valve V2
3	By-pass start gas valve (BSV + V1)

c) Direct main burner ignition at reduced rate with by-pass start gas supply

Figure 2 (continued) - Direct main burner ignition

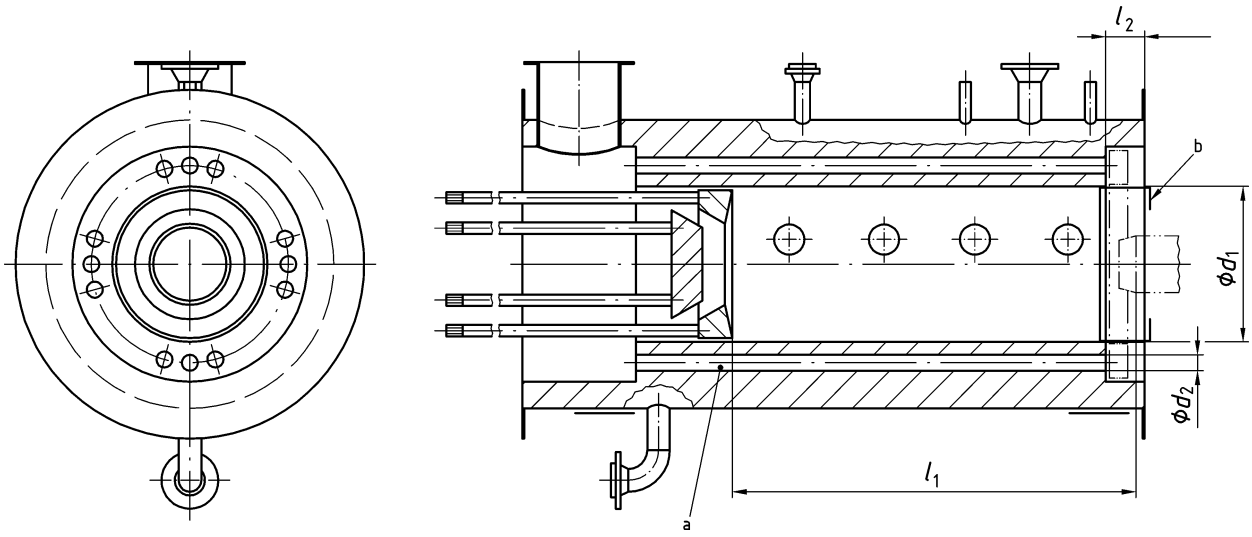


Key

V1, V2	Main gas safety shut-off valve
PV1, PV 2	Ignition burner safety shut-off valve
t_{s1}	First safety time
t_{s2}	Second safety time
1	Ignition
2	Main gas valves (V1 + V2)
3	Start gas valves (PV1 + PV2)

d) Main burner ignition with independent ignition burner

Figure 2 (concluded) - Direct main burner ignition



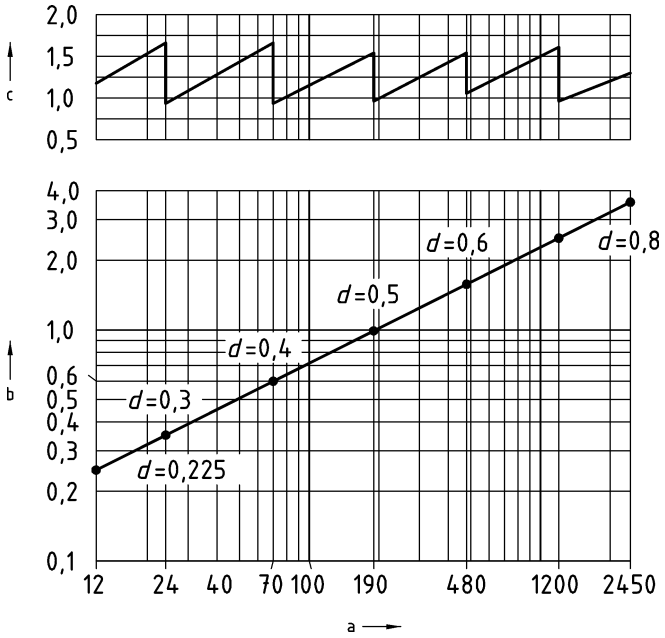
Key

a At the manufacturer's choice the test may also be carried out with flame reversal

b Direct flame operation (steel cylinder)

Test flame tube	**Flue gas tube**			
d_1 m	d_2 mm		Numbers	l_2 mm
	internal	external		
0,225	16	20	8	60
0,3	21	25	14	80
0,4	36,5	41,5	12	100
0,5	39,5	44,5	26	130
0,6	51,5	57	30	160
0,8	80,9	88,9	28	200

Figure 3 - Test flame tube — Schematic representation



Key

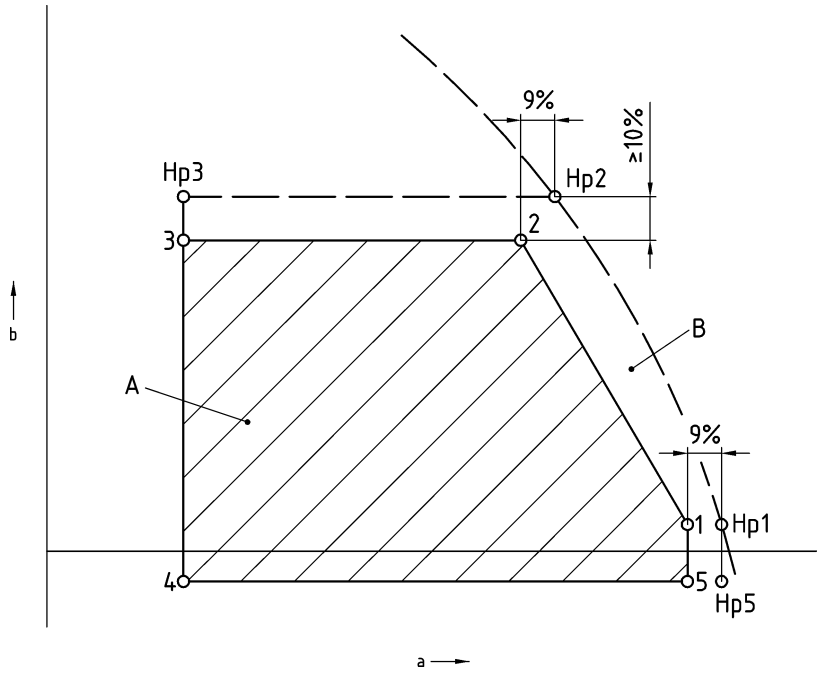
a Heat input Q_F in kW

b Length of the flame tube in m

c Flame tube firing intensity in MW/m³

d Diameter of flame tube in m

Figure 4 - Firing intensity, diameter and length of the test flame tube as a function of the heat input Q, flame tube / dimensions of combustion chamber



Key

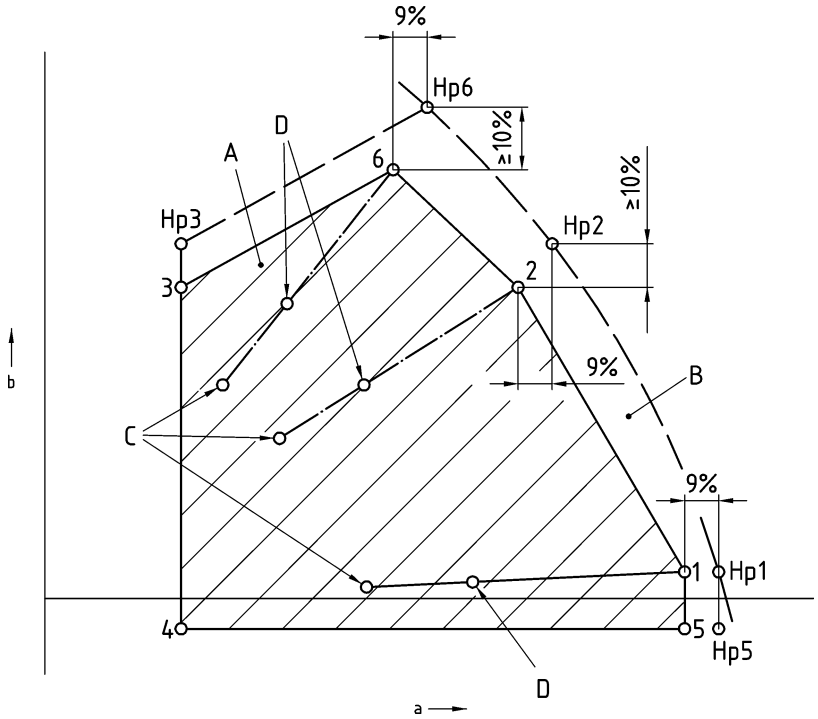
a Heat input Q_F in kW

b Pressure in the combustion chamber in mbar

A Working diagram

B Test diagram

Figure 5 - Working diagram and test diagram for single stage burner
(The points Hp3 and Hp5 are not determined.)



Key

a Heat input Q_F in kW

b Pressure in the combustion chamber in mbar

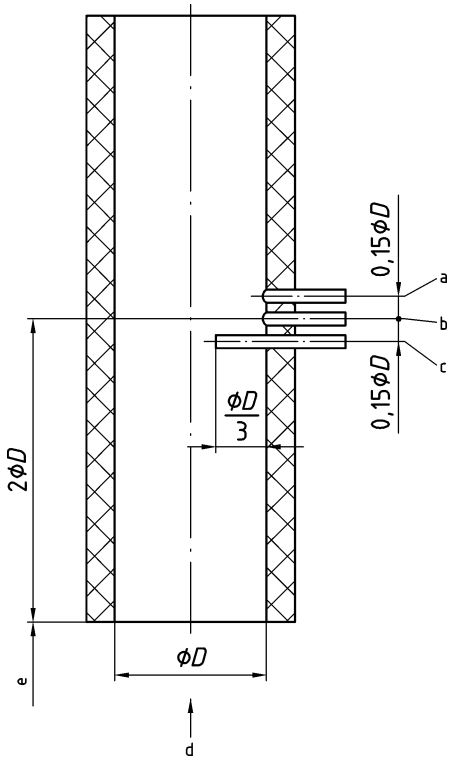
A Working diagram

B Test diagram

C Points of minimum heat input

D Points of intermediate heat input

Figure 6 - Working diagram and test diagram for two-stage, multi-stage and modulating burners
(The points Hp3 and Hp5 are not determined.)



Key

a Temperature

b Draught/Pressure

c Flue gas analysis

d Test flame tube rear wall

e Direction of flow of flue gas

Figure 7 - Flue gas measurement section — Schematic representation
(the measuring tubes may be staggered)

Annex A
(informative)

Determination of the combustion characteristics - carbon monoxide and nitrogen oxides

For range-rated burners the tests are carried out at the maximum and the minimum heat input stated by the manufacturer.

Modulating burners are tested at the maximum and the minimum heat input given by the controls.

A representative dry sample of the combustion products is taken when the burner has reached thermal equilibrium.

The CO content of the dry, air-free combustion products is given by the formula:

$$(CO)_N = (CO_2)_N \frac{(CO)_M}{(CO_2)_M} \quad \text{(A.1)}$$

where:

$(CO)_N$ is the carbon monoxide content in ppm by volume of the dry, air-free combustion products;

$(CO_2)_N$ is the maximum possible carbon dioxide content in % by volume of the dry, air-free combustion products;

$(CO)_M$ is the measured concentration, expressed in ppm by volume of carbon monoxide in the sample taken during the combustion test;

$(CO_2)_M$ is the measured concentration, expressed in % by volume of carbon dioxide in the sample taken during the combustion test.

The CO content in % by volume of the dry, air-free combustion products can also be calculated by the formula:

$$(CO)_N = \frac{21}{21-(O_2)_M} (CO)_M \quad \text{(A.2)}$$

where:

$(O_2)_M$ is the measured concentration, expressed in % by volume, of oxygen in the sample taken during the combustion test.

$(CO)_M$ is the measured concentration, expressed in % by volume, of carbon monoxide in the sample taken during the combustion test.

The use of this formula is recommended where it gives greater accuracy than the formula based on the CO_2 content.

The NO_x-content of the dry, air-free combustion products is given by the formula:

$$NO_x = (NO_x)_M \left(\frac{21}{21-(O_2)_M} \right) 2{,}05 \left(\frac{V_{at,tr}}{H_i} \right) \quad \text{(A.3)}$$

where:

NO_x is the NO_x-emission in mg/kWh, referring to the energy input

$(NO_x)_M$ measured NO_x- emission in ppm, volumetric

$(O_2)_M$ Oxygen concentration in the gaseous combustion products in % - volume

2,05 NO_2-density in kg/m³

$V_{at,tr}$ theoretical reference flue gas volume, dry, in m³/m³

H_i net calorific value in kWh/m³ (referring to 15 °C and 1013,25 mbar)

Determination of the arithmetical NO_x mean value of the working diagram:

$$(\overline{NO_x})_M = \sum_{i=1}^{n}\left(\frac{(NO_x)_{mi}}{n}\right) \qquad \text{(A.4)}$$

where

$(\overline{NO_x})_M$ is the arithmetical mean value of the measured nitrogen emission limits in the working diagram

$(NO_x)_{mi}$ is the measured NO_x-concentration at the points in the working diagram

n is the number of points in the working diagram.

The values, in % by volume, of $(CO_2)_N$ for the test gases are given in Table A.1.

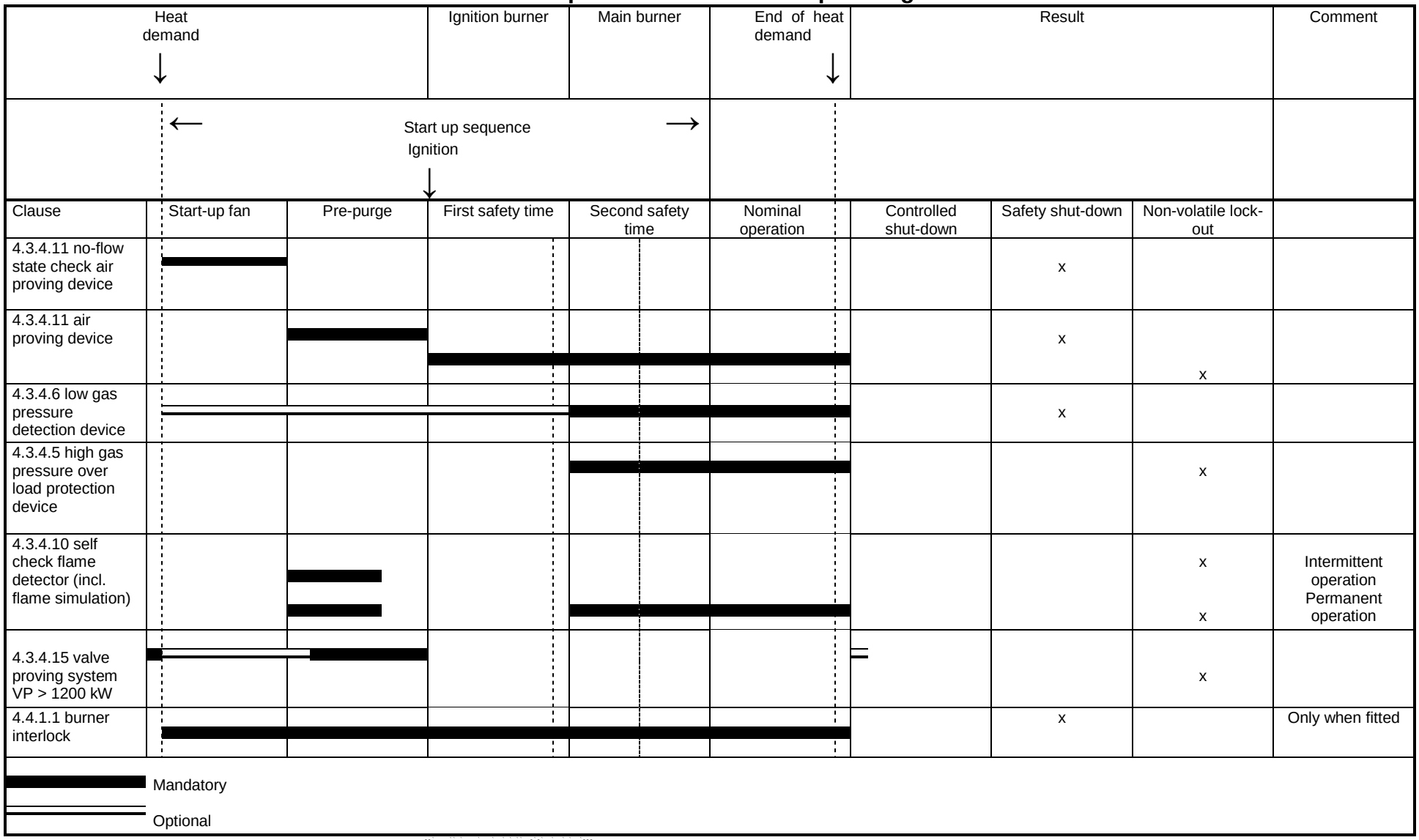
Table A.1 - Values of $(CO_2)_N$

Designation of gas	G 110	G 20	G 21	G 25	G 26	G 30	G 31
$(CO_2)_N$ % volume	7,6	11,7	12,2	11,5	11,9	14,0	13,7

If an alternative limit gas is used with difference in Wobbe index of ± 2 % (see 5.1.1), then re-calculation of these values is necessary.

Annex B
(informative)

Examples of control box sequencing



Clause	Start-up fan	Pre-purge	First safety time	Second safety time	Nominal operation	Controlled shut-down	Safety shut-down	Non-volatile lock-out	
4.3.4.11 no-flow state check air proving device							x		
4.3.4.11 air proving device							x	x	
4.3.4.6 low gas pressure detection device							x		
4.3.4.5 high gas pressure over load protection device								x	
4.3.4.10 self check flame detector (incl. flame simulation)								x x	Intermittent operation Permanent operation
4.3.4.15 valve proving system VP > 1200 kW								x	
4.4.1.1 burner interlock							x		Only when fitted

Mandatory

Optional

Annex C
(informative)

Test gases

C.1 General

Gases are classified into families, sub-divided into groups, according to the value of the Wobbe index. The classification scheme for the gas families is given in EN 437.

One of the aims of this standard is to check that the performance of a burner is satisfactory for each family or group of gases and for the supply pressures for which it is designed, if necessary using adjusting devices. This is achieved by the use of test gases.

In each family or group:

a) the test gas which in general corresponds to the gas most frequently distributed and for which the burner is designed is called the "reference gas";

b) the test gases which correspond to the extremes of a particular gas family or gas group are called "limit gases".

The compositions and principal characteristics of the test gases for the various families or groups are given in Table C.1. The characteristics given in Table C.1 correspond to standard reference conditions of 15 °C, 1013,25 mbar, dry gas.

The data for the calorific values are taken from ISO 6976.

C.2 Conditions for preparation of the test gases

The composition of gases used for the tests is as close as possible to that given in Tables C.1 and C.2. For the preparation of these gases the following rules are observed:

a) the Wobbe index of the gas used is within ± 2 % of the value indicated in Table C.1 for the corresponding test gas (this tolerance includes the error due to measuring instruments);

b) the constituents used for the preparation of the mixtures have at least the following purity:

- nitrogen N_2 ..... 99 %
- hydrogen H_2 ..... 99 %
- methane CH_4..... 95 %[2])
- propene C_3H_6..... 95 %[2])
- propane C_3H_8 ..... 95 %[2])
- butane[1]) C_4H_{10} ..... 95 %[2])

However, these conditions are not mandatory 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 preceding conditions. One can therefore, in order to make up a mixture, start with a gas already containing, in suitable proportions, several components of the final mixture.

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[1]) Any mixture of iso/n-butane can be used.

[2]) With a total content of hydrogen, carbon monoxide and oxygen below 1 % and a total nitrogen and carbon dioxide below 2 %.

However, for gases of the 2nd family:

— 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, can 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 the table for the corresponding reference gas;

— for preparation of the limit gases another gas can be used as the base gas instead of methane;

— for limit gases G 21, G 222 and G 23 a natural gas of group H can be used;

— for limit gases G 27 and G 231 a natural gas of group H or group L or of group E can be used;

— for the limit gas G 26 a natural gas of group L can be used.

In all cases the final mixture obtained by adding propane or nitrogen can have a Wobbe index within ± 2 % of the value given in Table C.1 for the corresponding limit gas. The hydrogen content of the final mixture is given in Table C.1 as appropriate.

C.3 Practical application of the test gases

C.3.1 Choice of test gases

When a burner can be operated with gases belonging to different groups or families, a choice is made from the test gases shown in Tables C.1 or C.2 as appropriate (see 5.1.1, Table 4).

Table C.1 - Test gases characteristics

Gas Family and Group	Test gases	De-signation	Composition by volume %	W_i MJ/m³	H_i MJ/m³	W_s MJ/m³	H_s MJ/m³	d
Gases of the first family								
Group a	Reference gas Incomplete combustion flame lift and sooting limit gases	G 110	CH_4 = 26 H_2 = 50 N_2 = 24	21,76	13,95	24,75	15,87	0,411
	Light back limit gas	G 112	H_2 = 59 CH_4 = 17 N_2 = 24	19,48	11,81	22,36	13,56	0,367
Gases of the second family								
Group H	Reference gas	G 20	CH_4 = 100	45,67	34,02	50,72	37,78	0,555
	Incomplete combustion Sooting limit gas	G 21	CH_4 = 87 C_3H_8 = 13	49,60	41,01	54,76	45,28	0,684
	Light back limit gas	G 222	CH_4 = 77 H_2 = 23	42,87	28,53	47,87	31,86	0,443
	Flame lift limit gas	G 23	CH_4 = 92,5 N_2 = 7,5	41,11	31,46	45,66	34,95	0,586
Group L	Reference gas and light- back limit gas	G 25	CH_4 = 86 N_2 = 14	37,38	29,25	41,52	32,49	0,612
	Incomplete combustion and sooting limit gas	G 26	CH_4 = 80 C_3H_8 = 7 N_2 = 13	40,52	33,36	44,83	36,91	0,678
	Flame lift limit gas	G 27	CH_4 = 82 N_2 = 18	35,17	27,89	39,06	30,98	0,629
Group E	Reference gas	G 20	CH_4 = 100	45,67	34,02	50,72	37,78	0,555
	Incomplete combustion and sooting limit gas	G 21	CH_4 = 87 C_3H_8 = 13	49,60	41,01	54,76	45,28	0,684
	Light back limit gas	G 222	CH_4 = 77 H_2 = 13	42,87	28,53	47,87	31,86	0,443
	Flame lift limit gas	G 231	CH_4 = 85 N_2 = 15	36,82	28,91	40,90	32,11	0,617

(continued)

Table C.1 (concluded)

Gas Family and Group	Test gases	De-signation	Composition by volume %	W_i MJ/m³	H_i MJ/m³	W_s MJ/m³	H_s J/m	d
Gases of the third family								
Third Family and Groups 3B/P and 3B	Reference gas and incomplete combustion and sooting limit gas	G 30	n C_4H_{10} = 50 i C_4H_{10} = 50	80,58	116,09	87,33	125,81	2,075
	Flame lift limit gas	G 31	C_3H_8 = 100	70,69	88,00	76,84	95,65	1,550
	Light-back limit gas	G 32	C_3H_6 = 100	68,14	82,78	72,86	88,52	1,476
Group 3P	Reference gas, incomplete combustion, sooting and flame limit gas	G 31	C_3H_8 = 100	70,69	88,00	76,84	95,65	1,550
	Light-back and sooting limit gas	G 32	C_3H_6 = 100	68,14	82,78	72,86	88,52	1,476

NOTE The calorific values of 3rd family gases, expressed in Table C.1 in MJ/m³, can also be expressed in MJ/kg, as shown in Table C.2.

Table C.2 - Calorific values of 3rd family test gases

Test gas designation	H_i MJ/kg	H_s MJ/kg
G 30	45,65	49,47
G 31	46,34	50,37
G 32	45,77	48,94

C.3.2 Conditions of supply and adjustment of the burner

The tests are carried out under the supply conditions (pressures) as declared by the manufacturer and with the appropriate reference and limit test gases.

Except where otherwise specified and depending upon the supply conditions, the temperature of the test room, the atmospheric pressure and the measuring conditions (dry meter or wet meter), the pressure upstream of the burner head is adjusted to give the heat input to within ± 2 % (by altering the gas rate adjusters or the burner governor, if adjustable, or the burner supply pressure) before the tests at the heat input with the reference gas at the normal supply pressure are carried out.

Annex D
(informative)

Gas connections conditions in common use in the various countries

Table D.1

Country Code	Category I_3						Other categories				
	Threaded connections		Plain connections	Compression joints	Other connections	Flanges	Threaded connections		Plain connections	Com-pression joints	Flanges
	ISO 7-1[a]	prENISO 228-1				EN 1092	ISO 7-1[a]	prENISO 228-1			EN 1092
AT	yes	yes		yes	yes	yes	yes	yes			yes
BE	yes			yes	yes		yes				
CH					yes		yes				
DE					yes		yes				
DK					yes		yes				
ES		yes	yes		yes			yes	yes		
FI	yes	yes[b]	yes	yes[a]		yes	yes	yes[a]	yes	yes[a]	yes
FR	yes	yes					yes	yes			
GB	yes		yes	yes			yes		yes	yes	
GR	yes						yes				
IE											
IS											
IT	yes	yes			yes		yes	yes			
LU											
NL	yes					yes	yes				
NO											
PT	yes	yes	yes	yes	yes		yes	yes	yes	yes	
SE											

[a] Tapered male threads and parallel female threads.

[b] with pipe DN limitation

Annex E
(informative)

Tests

E.1 Supplementary testing

Supplementary testing is carried out in order to assess the effect of any subsequently attached or modified components of the burner on its conformity to standards.

With the consent of the notified body, a supplementary test can be dispensed with if the modifications involved concern the adjustment of type tested burners to a particular appliance to allow for the effects of the fuel, the combustion chamber and the operation of the appliance as a whole. This assumes that modifications to the air supply, air compression, the jet systems, the mixing device and the air/gas ratio control device will be necessary. Such measures are only permissible if:

a) they are carried out by properly qualified personnel;

b) flame stability is maintained;

c) no increase in burner rating results;

d) criteria of relevance to safety are not affected;

e) combustion characteristics such as CO and CO_2 content remain within the permitted limits;

f) the notified body is provided with documentation of the successful completion of the work by way of records of the measurements made. Additional measurements can be required by the notified body.

E.2 Drawing review

The manufacturer can request a drawing review if

a) changes or supplements have been made to the burner design compared to the previous design

or if

b) gas burners of different input stages of the same construction have been manufactured by a manufacturer but proof of conformity with the standard has only been supplied for individual input stages.

The extent of the drawing review depends on whether the changes resulting from a) or b) have an effect or not on the requirements of this standard being met.

Gas burners having been successfully tested on the basis of a drawing review are regarded as being conform to the standard.

E.3 Individual test and inspection

If, in order to check conformity to standards, the burner manufacturer or a public authority requests testing of an individual, or individually manufactured, gas burner as a substitute for type testing, this individual test or individual inspection is carried out with the appropriate heat generator or within the framework of the inspection of the complete installation. For testing purposes, the heat generator equipped with the burner to be tested is regarded as a test rig.

The requirements for testing the burner are as follows:

a) Proving of the equipment required by this standard;

b) functional testing of all safety equipment;

c) testing of the burner control system according to EN 298.

d) proving of the maximum and minimum heat input;

e) proving of flame stability on burner start-up, at maximum and minimum heat input, and on alteration of the heat input with respect to the appropriate combustion chamber pressure. During testing, excessive pressure variations should not occur.

f) proof that the required pre-purge and the safety times are observed;

g) proof of the combustion performance, i. e. CO_2 (or O_2), CO and NO_x-content at minimum and maximum heat input.

E.4 Test report

A test report should be compiled after testing has been satisfactorily completed. The test report should show the nature of the test concerned (e. g. type testing). It should contain a description of the burner together with the details required and should set out the results of the tests. At the end of the test report the essential data relating to the use of the burner should be given.

Annex F
(informative)

Use of alternative gas lines and test documentation

F.1 Use of alternative gas lines

Where the manufacturer specifies alternative gas lines for use with a particular burner model the following requirements can apply:

a) Each burner type can be treated as a unit and be tested in accordance with this standard. Structurally, the unit can be of defined extent (e. g. up to the connecting flange upstream of the gas isolating valve);

b) as with any other burner, this burner unit is subject, on being modified, to re-testing as specified in the test procedure;

c) the manufacturer is responsible for measuring the inherent losses due to the gas lines which he intends to use in conjunction with the burner and for developing a reproducible method of calculating these values;

d) the selection of gas lines is undertaken by the manufacturer on the basis of tests he has carried out himself and are subject of a test report;

e) the object of such tests is to establish by calculation whether the performance of the burner when operated in conjunction with a given gas train still lies within the working diagram as determined by the test house.

F.2 Test documentation

The manufacturer or the applicant provides the notified body with two copies of the following documents at the time of the test:

a) Dated and duly signed workshop drawings. The drawings are executed with the relevant sectional views in such a way that a clear picture is obtained of the construction of the burner and its principal components. An overall drawing of the unit is also provided;

b) a description of the burner together with, where applicable, details of the components used, the design and construction, including information with regard to installation, maintenance, heat input ranges, connection methods and burner pressure ranges;

c) a declaration by the manufacturer that the electrical components and their assembly satisfy the electrical regulations in force in the country or countries of destination;

d) a statement of the type number or designation of the burner;

e) information on the materials used (if applicable, from a parts list);

f) a statement of the type of gas and burner inlet pressure for which the burner is intended;

g) information on the electrical connection data of the burner;

h) instructions for the installation, adjustment and operation of the burner, together with diagrams illustrating the switching, wiring and functional operation.

For individual testing or an individual inspection, the notified body can also be supplied, in addition to the listed test documentation, with a wiring diagram and description of the whole installation.

Annex G
(informative)

Correction of the influence of combustion air temperature and humidity on NO_x- emissions

Formula to correct the influence of combustion air temperature and humidity on NO_x-emissions from burners to reference conditions 10 g/kg for humidity and 20 °C for temperature:

$$NO_{xR} = (NO_x)_M + \left[\frac{0{,}02\ (NO_x)_M - 0{,}34}{1 - 0{,}02\ (h_M - 10)}\right] \quad (h_M - 10) + [0{,}85\ \ (20 - T_M)]$$

where:

$(NO_x)_M$ is the NO_x measured at h_M and T_M in mg/kWh in the range 50 mg/kWh to 300 mg/kWh;

h_M is humidity during the measurement of $(NO_x)_M$ in g/kg in the range 5 g/kg to 15 g/kg;

T_M is the temperature during the measurement of $(NO_x)_M$ in °C in the range 15 °C to 25 °C;

NO_{xR} is the value of NO_x corrected to the reference conditions chosen at 10 g/kg for humidity and 20 °C for temperature. NO_{xR} is expressed in mg/kWh.

Annex H
(informative)

Check of the air proving device

The check of the air proving device is carried out alternatively by the lowest or highest input. The air pressure can be changed by:

a) change of motor speed;

b) closure of the air damper;

c) closure of the air inlet openings or

d) other possibilities.

A non volatile lock-out occurs before a CO-content of 1 % air-free/dry is reached in the burner operating stage.

During the test on the flame tube the mode of operation of the air proving device should be checked in reference to the burner design. Installation influences — such as the flue installation, the boiler, the installation room or the air supply — on the air proving device and its adjustment will be taken into account during operation.

Annex I
(informative)

Specific additional requirements and limitations for use of EN 676 burners for industrial applications

I.1 Pre-heating of the combustion air

If an EN 676 burner is operated with pre-heated combustion air, then the temperature of the combustion air should not exceed 50 Kelvin above the ambient temperature.

If an EN 676 burner is used within the limits given above, then:

— the surface temperatures of knobs and levers intended to be manipulated should not exceed the ambient temperature by more than the values given in 4.4.2.3;

— the components should not exceed the maximum temperatures declared by the component manufacturer or supplier;

— the flame stability should not be effected during initial start-up of the burner at any rate.

Preheating of combustion air can limit the working diagram.

I.2 Continuous working of the air ventilator

Modifications are necessary for the air proving device to make it possible to check the 'no flow state' prior to start-up (see 4.3.4.11).

I.3 Electronic air/fuel ratio and O_2-controllers

The electronic air/fuel ratio controller should comply with the applicable European electronic standards. Electronic components should comply with these European electronic standards also (e.g. pressure transmitters).

The burner should not exceed its maximum output at any load.

In general, O_2-controllers are used to correct variations in climatic conditions of the combustion air and variations of the gas quality in order to obtain an optimal combustion efficiency. These corrections should be adjusted in such a way that the working diagram of the burner is not exceeded.

In order to operate a burner under all normal circumstances within the working diagram, a reserved O_2-output band at maximum rate of the burner should be considered for the air supply.

I.4 Variable excess of combustion air

Table 7 of 5.5 is not mandatory for EN 676 gas burners at high ratings for industrial processes. The flame should be stable under all conditions and the combustion should be hygienic.

I.5 Burner with start gas flame

For burners with start gas flame it should be guaranteed that under all operation conditions of the main burner, the burner with start gas flame can ignite the main burner.

Otherwise, separate flame sensors to supervise the start gas flame and main flame should be fitted. The main flame sensor should be so positioned that it cannot in any circumstances detect the start gas flame.

I.6 Air filtering

In a dusty environment it can be necessary to filter the inlet combustion air,

Thus the function of the air proving device can be impacted (see 4.3.4.11)

Annex ZA
(informative)
A-deviations

A-deviation: National deviation due to regulations, the alteration of which is for the time being outside the competence of the CEN/CENELEC member.

This European Standard falls under Directive 90/396/EEC.

NOTE (from CEN/CENELEC IR Part 2, 3.1.9): Where standards fall under EC Directives, it is the view of the Commission of the European Communities (OJ No G 59, 9.3.1982) that the effect of the decision of the Court of Justice in case 815/79 Cremonini/Vrankovich (European Court Reports 1980, p. 3583) is that compliance with A-deviations is no longer mandatory and that the free movement of products complying with such a standard should not be restricted except under the safeguard procedure provided for in the relevant Directive.

A-deviations in an EFTA-country are valid instead of the relevant provisions of the European Standard in that country until they have been removed.

Switzerland:

Deviation to the requirements of 4.4.7.1, 4.4.7.2 and 5.4

In deviation to the requirements of 4.4.7.1, 4.4.7.2 and 5.4, the requirements of the Swiss law (Luftreinhalte-Verordnung) of 1985-12-16 (state on 1996-01-01), the test requirements for heating installations, e.g. limiting values for carbon monoxide and nitrogen oxide as well as energetic requirements, are additionally applicable for automatic forced draught burners.

Netherlands:

Deviation to the requirements of 4.4.7.2

In deviation to the requirements of 4.4.7.2, the limiting values for combustion emissions of the Dutch law are applicable, i.e. "Besluit emissie-eisen stookinstallaties milieubeheer A" and "Besluit emissie-eisen stookinstallaties milieubeheer B" for burners of maximum heat input exceeding 900 kW and "Besluit typekeuring verwarmingstoestellen luchtverontreiniging stikstofoxyden" for burners of maximum heat input not exceeding 900 kW.'

Annex ZB
(informative)

Clauses of this European Standard addressing essential requirements or other provisions of EU Directives

This European Standard 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 90/396/EEC.

WARNING: Other requirements and other EU Directives may be applicable to the product falling within the scope of this standard.

The following clauses of this standard are likely to support requirements of Directive 90/396/EEC.

Compliance with the clauses of this standard provides one means of conforming with the specific essential requirements of the Directive concerned and associated EFTA regulations.

Table ZB.1

Essential requirements		
	Subject	Relevant clause prEN 676
1.1	Safe design and construction	1, 4, 5
1.2	Instructions installer Instructions user Warning notices on appliance Warning notices on packaging Official language	6.4 6.4 6.3 6.5 6.6
1.2.1	Instructions installer containing type of gas gas supply pressure flow of fresh air - for combustion supply - danger unburned gas dispersal combustion products forced draught burners	 6.4 6.4 6.3; 6.4 not applicable not applicable 6.4
1.2.2	instructions user containing - all instructions - restrictions on use	 6.4 6.4
1.2.3	Warning notices with - type of gas - gas supply pressure - restrictions	 6.3; 6.5 6.3; 6.5 6.3; 6.5
1.3	Fittings Instructions	 not applicable
2.1	Appropriate for their purpose	4.2.4,
2.2	Properties of the materials	see under Annex II

Table ZB.1 (continued)

Essential requirements		
	Subject	Relevant clause prEN 676
3.1.1	Safety of construction	4.2.1, 4.2.2; 4.2.5
3.1.2	Condensation	not applicable
3.1.3	Risk of explosions at event of external fire	4.2.3, 4.2.4
3.1.4	Water/Air penetration in gas circuit	not applicable
3.1.5	Normal fluctuation of auxiliary energy	4.4.7;5.5, 5.6
3.1.6	Abnormal fluctuation or failure of auxiliary energy	4.4.7; 5.4.1, 5.5
3.1.7	Hazards of electrical origin	4.3.1; 4.3.2
3.1.8	Pressurised parts	not applicable
3.1.9	Failure of devices gas circuit automatic shut-off devices flame supervision device atmospheric sensing device gas/air ratio control combustion products discharge safety device air proving device automatic burner control system thermostat/overheat protection governors multifunctional controls	 4.3.4. 4.3.4.8 4.3.4.10 not applicable 4.3.4.12 not applicable 4.3.4.11 4.3.4.14 not applicable 4.3.4.4 not applicable
3.1.10	Overruling safety devices	4.4.1
3.1.11	Adjustment protection	4.3.3, 4.3.4.4, 4.3.4.7
3.1.12	Clear markings of devices	4.2.1
3.2.1	Risk of gas leakage	4.4.2.1
3.2.2	Risk of gas accumulation during ignition during re-ignition after extinction	 4.4.1.6.1, Table 2; 4.4.1.7; 4.4.1.8 4.4.1.6.2 4.4.1.6.3
3.2.3	Safety device fitted Rooms with sufficient ventilation	4.3.4.9; 4.4.1.1 not applicable
3.3.	Ignition; re-ignition Cross-lighting	4.4.1.3; 4.4.1.6.1, Table 2; 4.4.1.7; 4.4.1.8; 4.4.2.4; 5.3.4; 5.3.5; 5.4; not applicable
3.4	Combustion	4.4.5 up to 4.4.7, 5.4
3.4.1	Flame stability Unacceptable concentration Harmful to health	4.4.2.4; 4.3.4.11; 5.3.4, 5.3.5 4.3.4.11; 4.4.7; 5.5
3.4.2	No accidental release of combustion products	not applicable
3.4.3	No release in dangerous quantity	not applicable
3.4.4	CO concentration	not applicable
3.5	Rational use of energy	not applicable

Table ZB.1 (concluded)

Essential requirements		
	Subject	Relevant clause prEN 676
3.6.1	Floor and adjacent walls	not applicable
3.6.2	Knobs and levers	4.4.2.3
3.6.3	External parts	not applicable
3.7	Sanitary water	not applicable
Annex III	Data plate	6.2

Bibliography

[1] EN 437, *Test gases - Test pressures - Appliance categories.*

[2] EN 746 (all parts), *Industrial thermoprocessing equipment.*

[3] ISO 6976, *Natural gas — Calculation of calorific values, density, relative density and Wobbe index from composition.*

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