BS EN 12309-2:2015

BSI Standards Publication

Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW

Part 2: Safety

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National foreword

This British Standard is the UK implementation of EN 12309-2:2015. Together with BS EN 12309-1:2014 it supersedes BS EN 12309-1:2000, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GSE/37, Gas fired sorption and laundering appliances.

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

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

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English Version

Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 2: Safety

Appareils à sorption fonctionnant au gaz pour le chauffage et/ou le refroidissement de débit calorifique sur PCI inférieur à 70 kW - Partie 2 : Sécurité

Gasbefeuerte Sorptions-Geräte für Heizung und/oder Kühlung mit einer Nennwärmebelastung nicht über 70 kW - Teil 2: Sicherheit

This European Standard was approved by CEN on 14 February 2015.

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 CEN-CENELEC 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 CEN-CENELEC Management Centre has the same status as the official versions.

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COMITÉ EUROPÉEN DE NORMALISATION
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Foreword

This document (EN 12309-2:2015) has been prepared by Technical Committee CEN/TC 299 “Gas-fired sorption appliances, indirect fired sorption appliances, gas-fired endothermic engine heat pumps and domestic gas-fired washing and drying appliances”, the secretariat of which is held by UNI.

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 November 2015, and conflicting national standards shall be withdrawn at the latest by November 2015.

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

This document supersedes EN 12309-1:1999.

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 ZA, Annex ZB and Annex ZC, which are integral parts of this document.

EN 12309 comprises the following parts under the general title, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW*:

— Part 1: Terms and definitions;

— Part 2: Safety;

— Part 3: Test conditions;

— Part 4: Test methods;

— Part 5: Requirements;

— Part 6: Calculation of seasonal performances;

— Part 7: Specific provisions for hybrid heating appliances;

— Part 8: Environmental aspects.

EN 12309-1 and EN 12309-2 supersede EN 12309-1:1999, whereas EN 12309-1 and EN 12309-3, EN 12309-4, EN 12309-5, EN 12309-6 and EN 12309-7 supersede EN 12309-2:2000. EN 12309-1, EN 12309-2, EN 12309-3, EN 12309-4, EN 12309-5, EN 12309-6 and EN 12309-7 have been prepared to address the essential requirements of the European Directive 2009/142/EC relating to appliances burning gaseous fuels (see EN 12309-2:2015, Annex ZA, for safety aspects and EN 12309-5:2014, Annex ZA, for rational use of energy aspects).

These documents are linked to the following European Directives:

— Energy Related Products Directive (2009/125/EC) in terms of tests conditions, tests methods and seasonal performances calculation methods under Mandate M/495 (see EN 12309-5:2014, Annex ZB);

For the relationship with EU Directive(s), see EN 12309-2:2015, Annex ZA, and EN 12309-5:2014, Annex ZA, Annex ZB and Annex ZC. These documents will be reviewed whenever new mandates could apply.

EN 12309-8, Environmental aspects, deals with the incorporation of the Resolution BT 27/2008 regarding CEN approach on addressing environmental issues in product and service standards.

This document deals particularly with the operational safety of the appliance.

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

1 Scope

1.1 Scope of EN 12309 series

Appliances covered by this European Standard include one or a combination of the following:

— gas fired sorption chiller;

— gas fired sorption chiller/heater;

— gas fired sorption heat pump.

This European Standard applies to appliances only when used for space heating and cooling with or without heat recovery.

This European Standard applies to appliances having flue gas systems of type B and C (according to CEN/TR 1749) and to appliances designed for outdoor installations. EN 12309 does not apply to air conditioners, it only applies to appliances having:

— integral burners under the control of fully automatic burner control systems;

— closed system refrigerant circuits in which the refrigerant does not come into direct contact with the water or air to be cooled or heated;

— mechanical means to assist transportation of the combustion air and/or the flue gas.

The above appliances can have one or more primary or secondary functions (i.e. heat recovery - see definitions in EN 12309-1:2014). In the case of packaged units (consisting of several parts), the standard applies only to those designed and supplied as a complete package.

The appliances having their condenser cooled by air and by the evaporation of external additional water are not covered by this European Standard.

Installations used for heating and/or cooling of industrial processes are not within the scope of these standards.

NOTE All the symbols given in this text are used regardless of the language used.

1.2 Scope of this Part 2 to EN 12309

This part of EN 12309 deals with the safety of gas-driven sorption heat pumps as defined in EN 12309-1. Only types B12 for outdoor installations, B13 for outdoor installations, B22 for outdoor installations, B23 for outdoor installations, C12 and C13, C32 and C33 are covered in this European Standard.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 88-1:2011, *Pressure regulators and associated safety devices for gas appliances - Part 1: Pressure regulators for inlet pressures up to and including 50 kPa*

EN 88-2:2007, *Pressure regulators and associated safety devices for gas appliances - Part 2: Pressure regulators for inlet pressures above 500 mbar up to and including 5 bar*

EN 126:2012, *Multifunctional controls for gas burning appliances*

EN 161:2011+A3:2013, *Automatic shut-off valves for gas burners and gas appliances*

EN 257:2010, *Mechanical thermostats for gas-burning appliances*

EN 298:2012, *Automatic burner control systems for burners and appliances burning gaseous or liquid fuels*

EN 378-2:2008+A2:2012, *Refrigerating systems and heat pumps - Safety and environmental requirements - Part 2: Design, construction, testing, marking and documentation*

EN 378-3:2008+A1:2012, *Refrigerating systems and heat pumps - Safety and environmental requirements - Part 3: Installation site and personal protection*

EN 437:2003+A1:2009, *Test gases - Test pressures - Appliance categories*

EN 1057:2006+A1:2010, *Copper and copper alloys - Seamless, round copper tubes for water and gas in sanitary and heating applications*

EN 1092-1:2007+A1:2013, *Flanges and their joints - Circular flanges for pipes, valves, fittings and accessories, PN designated - Part 1: Steel flanges*

EN 1092-2:1997, *Flanges and their joints - Circular flanges for pipes, valves, fittings and accessories, PN designated - Part 2: Cast iron flanges*

EN 1092-3:2003, *Flanges and their joints - Circular flanges for pipes, valves, fittings and accessories, PN designated - Part 3: Copper alloy flanges*

EN 1254-2:1998, *Copper and copper alloys - Plumbing fittings - Part 2: Fittings with compression ends for use with copper tubes*

CR 1404, *Determination of emissions from appliances burning gaseous fuels during type-testing*

CEN/TR 1749, *European scheme for the classification of gas appliances according to the method of evacuation of the combustion products (types)*

EN 12067-2:2004, *Gas/air ratio controls for gas burners and gas burning appliances - Part 2: Electronic types*

EN 12309-1:2014, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 1: Terms and definitions*

EN 12309-3:2014, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 3: Test conditions*

EN 12309-4:2014, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 4: Test methods*

EN 12309-5:2014, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 5: Requirements*

EN 14459:2007, *Control functions in electronic systems for gas burners and gas burning appliances - Methods for classification and assessment*

EN 60335-1:2012, *Household and similar electrical appliances - Safety - Part 1: General requirements (IEC 60335-1:2010, modified)*

EN 60335-2-102:2006, *Household and similar electrical appliances - Safety - Part 2-102: Particular requirements for gas, oil and solid-fuel burning appliances having electrical connections (IEC 60335-2-102:2004, modified)*

EN 60529:1991, *Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989)*

EN 60730-2-9:2010, *Automatic electrical controls for household and similar use - Part 2-9: Particular requirements for temperature sensing controls (IEC 60730-2-9:2008, modified)*

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

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

ISO 7-1:1994, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 1182:2010, *Reaction to fire tests for products — Non-combustibility test*

ISO 3864-2:2004, *Graphical symbols — Safety colours and safety signs — Part 2: Design principles for product safety labels*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12309-1:2014 and the following apply.

3.1
automatic recycling
automatic process by which, after loss of flame during operation, the gas supply is interrupted and the full start procedure is re-initiated automatically

4 Classification

Appliances can be classified according to:

— the gases they use;

— the mode of air supply and evacuation of combustion products;

— the temperatures of their heat transfer media;

— their denomination.

4.1 Classification of appliances

4.1.1 Classification of gases

Gases are classified into three families, divided into groups according to the value of the Wobbe index. Families and groups of gas used in this standard are in accordance with those of the EN 437:2003+A1:2009.

4.1.2 Classification according to the mode of air supply and evacuation of the combustion products

The types of appliances as defined in CEN/TR 1749 are applicable.

4.1.3 Classification according to the temperatures of the heat transfer media

4.1.3.1 General

The classification according to the temperatures of the heat transfer media is formed in such a way that the heat transfer media are indicated together with their temperatures (in °C). A short classification is formed in such a way that a characteristic letter is used for the heat transfer medium: A for air, W for water and B for brine.

For the purposes of this standard, all references to the term “absorber” shall be taken to mean “adsorber” where the function of the appliance is based on adsorption.

4.1.3.2 Cooling mode

When the appliance is operating in the cooling mode, the temperatures indicated in the first place refer to the indoor heat exchanger and the temperatures in the second place to the outdoor heat exchanger.

Air and water/brine temperatures for the indoor heat exchangerindoor heat exchanger are inlet temperatures. Water/brine temperatures for the outdoor heat exchanger are outlet temperatures.

EXAMPLE A27/W7 means an inlet temperature of air for the indoor heat exchangerindoor heat exchanger of 27 °C and an outlet temperature of water for the outdoor heat exchanger of 7 °C.

4.1.3.3 Heating mode

When the appliance is operating in the heating mode, the values indicated in the first place refer to the outdoor heat exchanger and the values in the second place to the indoor heat exchanger.

Air and water/brine temperatures for the outdoor heat exchanger are inlet temperatures. Water/brine temperatures for the indoor heat exchanger are outlet temperatures.

EXAMPLE B0/W50 means an inlet temperature of brine for the outdoor heat exchanger of 0 °C and an outlet temperature of water for the condenser/absorber of 50 °C.

4.1.4 Classification according to denomination

4.1.4.1 Cooling mode

Appliances designed to operate in the cooling mode are denominated in such a way that the heat transfer medium for the indoor heat exchanger is indicated first, followed by the heat transfer medium for the outdoor heat exchanger. Examples of such appliances are given in Table 1.

Table 1 — Examples of appliances designed to provide cooling

Heat transfer medium		Denomination
Indoor heat exchanger	Outdoor heat exchanger	
Air	Water [a]	Air Cooled Liquid Chiller Air Cooled Liquid Chiller Heater
Water [a]	Water [a]	Water Cooled Liquid Chiller Water Cooled Liquid Chiller Heater
Brine	Water [a]	Brine Cooled Liquid Chiller Brine Cooled Liquid Chiller Heater
[a] This description also applies where the water contains additives to prevent corrosion as specified in the appliance's instructions.		

4.1.4.2 Heating mode

For the purposes of this standard, appliances designed to operate in the heating mode are denominated in such a way that the heat transfer medium for the outdoor heat exchanger is indicated first, followed by the heat transfer medium for the indoor heat exchanger. Examples of such appliances are given in Table 2.

Table 2 — Examples of appliances designed to provide heating

Heat transfer medium		Denomination
Outdoor heat exchanger	Indoor heat exchanger	
Air	Water [a]	Air/water Heat pump
Water [a]	Water [a]	Water/water Heat Pump
Brine	Water [a]	Brine/Water Heat Pump
[a] This description also applies where the water contains additives to prevent corrosion as specified in the appliance's instructions.		

5 Construction and design requirements

5.1 General

5.1.1 Conversion to different gases

The following operations are allowed in order to convert from a gas of one family or group to a gas of another family or group:

a) adjustment of the gas rate of the main burner and ignition burner;

b) change of injectors or restrictor;

c) change of the ignition burner or its components;

d) change of the gas rate modulation system;

e) putting out of service and sealing a gas rate adjuster and/or a regulator;

f) changes of configuration parameters by data exchange (for requirement see EN 14459).

For each of the operations mentioned above the appliance shall be tested with each of the gases. These operations shall be possible without having to interfere with the connections of the appliance to its pipe-work (gas, water, duct system).

5.1.2 Materials and method of construction

When the appliance is installed in accordance with the appliance's instructions, all components, including the heat exchangers and the refrigerant circuit, shall withstand the mechanical, chemical and thermal conditions to which they may be subjected in the course of normal use.

In addition, the appliance shall be designed in such a way that if condensation takes place, this shall not:

— affect the operational safety;

— drop outside the appliance.

This requirement does not apply to the flow of condensate which is produced at the outlet of the combustion products evacuation duct or from a purpose made condensate discharge system.

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

Asbestos or materials containing asbestos shall not be used.

Solder with a melting point below 450 °C after application shall not be used for gas carrying parts. Hard solder containing cadmium in its formulation shall not be used in the construction of the appliance.

Where appropriate, materials used on the appliance shall be non-combustible in accordance with the requirements of ISO 1182.

5.1.3 Accessibility for maintenance and use

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

It shall be possible to clean the combustion vessel and the parts in contact with combustion products in accordance with the appliance’s instructions without using special tools unless these are supplied as necessary accessories with the appliance.

Access shall be possible to all handles, buttons etc. required during normal use of the appliance, without having to remove any part of the case. For this purpose, the opening of a door or access panel is permitted.

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.

5.1.4 Thermal insulation

Any thermal insulation shall retain its insulating properties under the influences of temperature and ageing. The insulation shall withstand the normally expected thermal and mechanical stresses. The insulation of parts associated with the combustion products circuit shall be non combustible. All insulation shall be securely located and protected against mechanical damage, condensate and vermin.

5.1.5 Gas connection

The appliance gas inlet connection shall be accessible.

The clearance around the inlet connection, after removing the case if necessary, shall be adequate to allow the use of tools required to make the connection. It shall be possible to make all the connections without special tools.

It shall be possible to connect the appliance by rigid or flexible metallic means to the gas supply.

A compression fitting suitable for copper tube shall comply with EN 1254-2 and EN 1057.

If the appliance has a threaded connection, this thread shall comply with EN ISO 228-1 or ISO 7-1. In the first case (EN ISO 228-1), the end of the appliance inlet connection shall be sufficiently flat to allow the use of a sealing washer.

If flanges are used, they shall comply with EN 1092-1, EN 1092-2 or EN 1092-3 as appropriate and the counterflanges and sealing gaskets shall be provided.

5.1.6 Soundness

5.1.6.1 Soundness of the gas circuit

The gas circuit shall consist of metallic parts.

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 does not apply to orifices for measurement purposes.

The soundness of parts and assemblies making up the gas circuit and likely to be dismantled for routine maintenance *in situ* shall be achieved by means of mechanical joints, e.g. metal-to-metal joints, packing, or O-ring joints, i.e. excluding the use of all sealing materials such as tape, paste or liquid. However, the sealing materials mentioned above may be used for permanent assemblies. These sealing materials shall remain effective under all conditions of appliance use. It shall not be possible for water to penetrate into the gas circuit.

5.1.6.2 Soundness of the combustion circuit

The combustion circuit shall be constructed so as to prevent any leakage of combustion products.

Any means used to achieve soundness of the combustion circuit shall be such that it remains effective under normal conditions of use and servicing.

Parts, which have to be removed during routine service and affect the soundness of the appliance and/or its ducts, shall be sealed by mechanical means, excluding pastes, liquids and tapes. The need for replacement of the seal(s), following a cleaning or servicing operation as stated in the technical instructions, is permitted.

Where the appliance case forms part of the combustion circuit and it can be removed without the use of tools, either the appliance shall not operate, or there shall be no leakage of combustion products into the room where the appliance is installed when the case is replaced incorrectly.

However, parts of the assembly that are not intended to be dismantled for maintenance may be joined in such a way, that permanent soundness is ensured during continuous service under normal conditions of use.

The ducts, bends, if any, and the terminal or fitting piece shall fit together correctly and form a stable assembly.

Parts intended to be dismantled for periodic servicing shall be designed and arranged so that soundness is ensured after reassembly.

Any fitting piece shall allow a sound connection to be made to the system intended for the evacuation of combustion products and supply of air.

5.1.7 Air proving

Appliances with fans shall be fitted with a system for air proving.

Except for appliances with gas/air ratio controls, before each fan starts it shall be checked that there is no simulation of air flow in the absence of air flow.

The system for supervision of the combustion air rate or combustion products rate shall be activated directly by the flow of combustion air or combustion products. This is also valid for appliances with more than one fan speed in which the flows associated with each fan speed are monitored.

The supply of combustion air shall be checked by one of the following methods:

a) gas /air ratio controls;

b) continuous supervision of the combustion air rate or combustion products rate;

c) start up supervision of the combustion air rate or combustion products rate provided that for indoor installations:

   — the combustion products circuit is completely surrounded by the air supply circuit;

   — there is a shutdown at least every 24 h[1)];

   — there is an indirect system for air proving (e.g. fan speed supervision) during operation.

5.1.8 Air proving device

5.1.8.1 General

Depending on the principle of air proving, the applicable requirements are described in the clauses below.

The appliance is installed as stated in 7.1.6.4. The appliance is supplied with one of the reference gases for the category to which it belongs.

The appliance is fitted with the longest combustion air supply and combustion products evacuation ducts stated in the installation instructions. The tests may be carried out without the terminal or fitting piece.

The CO concentration is determined as stated in 7.3.5.

5.1.8.2 Supervision of the combustion air rate or the combustion products rate

Under the test conditions 7.3.14.1 the following requirement shall be met.

At a reduced flow rate the CO concentration (dry, air-free) may not exceed a specific value.

The following methods of flow reduction are to be examined:

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1) Some appliances can be used in a way that it is very likely they can shutdown at least once per 24 h without having a specific function to ensure this.

a) progressive blockage of the air inlet;

b) progressive blockage of the combustion products evacuation ducts;

c) progressive reduction of the fan speed, for example by reduction of the fan voltage.

There are two alternative supervision strategies for the air proving; a start up supervision or a continuous supervision. Based on the supervision strategy the appliance shall at a reduced flow rate meet one of the following two requirements:

d) continuous supervision: Shutdown before the CO concentration exceeds 0,2 %, or

e) start up supervision: Not start if the CO concentration exceeds 0,1 %.

5.1.9 Gas/air ratio controls

5.1.9.1 Fixed or adjustable gas/air ratio settings

If the installation instructions state (see 8.2.1) that the gas/air ratio control settings are not intended to be adjusted during installation, appliance service or when the gas valve is replaced then the appliance shall incorporate additional provisions to discourage unauthorized interference with the gas/air ratio control settings.

The following examples are considered to be suitable additional provisions:

a) physical removal of the adjustment screws (or other method of rendering these inoperative);

b) physically preventing access to the adjustment screws (e.g. filling access holes);

c) addition of a suitably worded warning label affixed to the gas valve and/or in close proximity to the adjuster screws. This label shall be clearly visible to whilst gaining access to the adjuster screws.

NOTE 1 Gas/air ratio controls typically have two adjustments (“throttle” and “offset”) and the requirements of this clause apply to both.

If the appliance installation instructions indicate that the valve can be adjusted using appropriate instruments a provision shall be provided to indicate that the valve setting has been changed.

NOTE 2 An example of a suitable provision is to use a paint spot on the adjusting device.

If at the time of installation or service there is an indication that the gas/air ratio control settings have been altered then the appliance instructions shall include how the settings should be checked. The appliance installation instructions shall indicate the action to be taken if the settings are found to be incorrect.

If the appliance installation instructions allow the gas/air ratio controls to be adjusted then the method for adjustment shall be described.

5.1.9.2 Leakage of control tubes

Under the test conditions in 7.3.15, the following requirement shall be met.

When control tubes are not made of metal or of other materials with at least equivalent properties, their disconnection, breakage or leakage shall not lead to an unsafe situation. This implies either locking out or safe operation with no leakage of gas outside the appliance.

5.1.9.3 Supervision of the combustion air rate or the combustion products rate

Under the test conditions in 7.3.14.2 the following requirement shall be met.

At a reduced flow rate the CO concentration may not exceed a specific value. The following methods of flow reduction are to be examined:

a) progressive blockage of the air inlet;

b) progressive blockage of the combustion products evacuation ducts;

c) if internal recirculation can occur then an additional test shall be carried out by progressive reduction of the fan speed, for example by reduction of the fan voltage.

There are two alternative supervision strategies for the air proving; a start up supervision or a continuous supervision. Based on the supervision strategy the appliance shall at a reduced flow rate meet one of the following two requirements:

a) start up supervision:

   not start if the CO concentration (dry, air free) exceeds 0,1 %.

b) continuous supervision:

   shutdown before the CO concentration (dry, air free) exceeds:

   1) 0,20 % over the range of modulation specified in the installation instructions), or

   2) $CO_{mes} \times Q / Q_{KB} \leq 0{,}20$ % below the minimum rate of the modulation range.

where

Q is the instantaneous heat input, in kW;

Q_{KB} is the heat input at the minimum rate, in kW;

CO_{mes} is the measured CO concentration (dry, air free)

5.1.9.4 Adjustment of the gas/air ratio

Under the test conditions in 7.3.16, the following requirement shall be met.

The installation instructions (see 8.2) shall declare maximum and minimum CO_2 levels between which no adjustment action is required.

If the gas/air ratio is adjustable for CO_2 the test of 5.1.9.3 shall be repeated at the test conditions from 7.3.16.

5.1.10 Supply of combustion air and evacuation of combustion products

5.1.10.1 General

All appliances shall be designed so that there is an adequate supply of combustion air during ignition and operation over the whole range of possible heat inputs.

Openings for the access of primary air shall have dimensions greater than 4 mm.

5.1.10.2 Appliance combustion air inlet

The cross-section of the combustion air passageways to the appliance shall not be adjustable.

5.1.10.3 Appliance flue gas outlet

5.1.10.3.1 General

The cross section of the appliance flue gas outlet shall not be adjustable after installation i.e. flue dampers are not permitted.

5.1.10.3.2 Type B_{12} and B_{13} appliances

Connection to the flue shall be made by means of a flue outlet preceded by a draught diverter. This device is part of the appliance.

The flue outlet shall be female and allow, if necessary by means of an adapter supplied with the appliance, connection to a flue pipe whose diameter complies with the standards in force where the appliance is to be installed.

The internal diameter of the flue outlet shall be such as to ensure compliance with requirements concerning operation.

It shall be possible to insert a flue pipe of nominal external diameter (D-2) mm to a depth of at least D/4 but not so far that the evacuation of the combustion products is impaired. However, for a vertical connection, the depth of insertion can be reduced to 15 mm.

NOTE D is the outside diameter of the duct.

5.1.10.3.3 Type B_{22} and B_{23} appliances

The flue outlet shall be female and allow, if necessary by means of an adapter supplied with the appliance, connection to a flue pipe whose diameter complies with the standards in force where the appliance is to be installed.

The internal diameter of the flue outlet shall be such as to ensure compliance with requirements concerning operation.

It shall be possible to insert a flue pipe of nominal external diameter (D-2) mm to a depth of at least D/4 but not so far that the evacuation of the combustion products is impaired. However, for a vertical connection, the depth of insertion can be reduced to 15 mm.

NOTE D is the outside diameter of the duct.

Minimum and maximum equivalent resistance shall be stated. The appliance's instructions shall give details for calculating the equivalent resistance, for example the allowance to be made for bends etc.

Where the appliance is intended to be fitted to a flue having a wall termination, a flue terminal shall be supplied or the type of termination shall be specified. The design of this shall be such that it is not allow entry of a ball of 16 mm diameter applied with a force of 5 N. The design of the flue system shall be such that any condensate formed when operating the appliance from cold shall either be retained and subsequently re-evaporated or discharged clear of the wall. In addition, a terminal guard shall be fitted in accordance with the National Regulations applicable in the various member countries.

5.1.10.3.4 Type C appliances

The terminal and any necessary flue/air ducts shall be supplied or specified.

Minimum and maximum length of ducts that can be used shall be stated.

The terminal shall be designed to prevent the penetration of rain or snow to the appliance or to the fabric of the building. All openings in the external surfaces of the terminal shall not permit the entry of a ball of 16 mm diameter when applied with a force of 5 N. If the terminal performance is dependent on a vessel within the wall, a vessel lining shall be provided with the appliance.

Any condensate formed in the combustion circuit when operating the appliance from cold shall either be retained and subsequently re-evaporated or discharged clear of the wall. For specific requirements related to condensing appliances see 5.15.

5.1.10.3.5 Appliances designed for outdoor installation

The flue outlet shall be so designed and positioned that it cannot be obstructed (e.g. by products of corrosion, air borne dirt, leaves, snow, etc.) and that staining of adjacent surfaces is minimized.

The flue outlet, if integral or provided with the appliance, shall be protected against the ingress of rain or snow. Any opening in the protective guard shall not permit the entry of a ball 16 mm in diameter applied with a force of 5 N.

5.1.10.4 Terminal guard

A terminal guard shall be fitted in accordance with the National Regulations applicable in the various Member States.

5.1.11 Checking the state of operation

It shall be possible during installation to observe visually the ignition and correct operation of the burner(s) and also the length of the flame(s) of the ignition burner, if any. A door may be opened or a case removed provided that the operation of the burner is not disturbed.

If the means of observation is a viewing port, it shall, when located in an area of high temperature, be covered with a suitable material, for example, heat resistant, toughened glass and, if necessary, sealed with a suitable heat resistant sealant.

However, when the main burner is fitted with its own flame detector, an indirect means of indication (e.g. an indicator light) is allowed. The means of indicating presence of flame shall not be used to indicate any other fault, except for a fault in the operation of the means of checking the flame itself, which shall result in an indication that there is no flame.

It shall be possible for the user, perhaps after opening a door or removing an access panel, to check at any time that the appliance is operating, either by visual observation of the flame or by some other indirect means.

5.1.12 Electrical equipment

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

This includes the requirements for the electromagnetic compatibility (EMC).

If the nature of the electrical protection of the appliance is specified on the data plate, this specification shall comply with EN 60529.

— to give the degree of personal protection against contact with dangerous electrical components inside the appliance case;

— to give the degree of electrical protection, inside the appliance case, against harmful actions due to water penetration.

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

Interruption and subsequent restoration of the electricity supply at any time during start up or operation of the appliance shall result in safety shut down or continued safe operation.

Interruption and subsequent restoration of the electricity supply shall not override any non-volatile lock out condition.

5.1.14 Rotating parts (e.g. motors and fans)

The direction of rotation of fans shall be clearly marked.

Rotating parts, including any belt drives, shall be so protected by suitable guards, shields or screens of adequate size, strength and durability that they are not liable to be touched (see also EN 60529:1991, IP 20). Removal of such guards, shields or screens shall be possible only with the use of commonly available tools.

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

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

Lubrication points, if provided, shall be readily accessible.

5.1.15 Pressurized parts of the appliance

All pressurized parts of the appliance shall meet the requirements of EN 378-2.

The maximum working pressure of any vessel of the appliance containing refrigerant which has a part of its external surface at atmospheric pressure and which is capable of being subjected to internal pressures in excess of 0,5 bar above atmospheric pressure shall be specified. This requirement applies to vessels that are subjected to these internal pressures:

— during the normal operation of the appliance, or

— when a safety device has been activated, e.g. where a high pressure vessel is designed to relieve excess pressure to a lower pressure vessel.

NOTE These maximum working pressures are verified by the requirements given in 6.8.

In addition, the minimum yield strength of any vessel capable of being subjected to such internal pressures shall be stated. The yield strength values shall be expressed as internal pressures (in bar) relative to the atmospheric pressure, and shall be valid for the normal operating temperature range of the materials concerned.

Factory-sealed sorption appliances can be installed in occupied spaces according to EN 378-1.

The specified yield strength of each vessel shall be at least 1,5 times its maximum working pressure.

5.2 Requirements for adjusting, control and safety devices

5.2.1 General

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

All controls and safety devices shall be appropriate for use over the range of ambient temperatures declared in the appliance's instruction.

All the following devices or the multifunctional control in which they might be fitted shall be removable or exchangeable if this is necessary for cleaning or replacement of the device. Adjusters for the devices shall not be interchangeable if this could result in confusion.

When there are several control knobs (taps, thermostats, etc.), they shall not be interchangeable if this could lead to confusion or they shall be clearly marked to identify their function.

5.2.2 Gas rate adjusters and range-rating device

5.2.2.1 Common requirements

Gas rate adjusters and range-rating devices shall be designed so that they are protected against accidental maladjustment by the user once the appliance has been installed and put into service. It shall be possible to seal them (e.g. with paint) after adjustment; this sealing shall resist the heat to which it is subjected during normal operation of the appliance. The adjusting screws of the gas rate adjusters and range-rating devices shall be located so that they cannot fall into the gasways.

The soundness of the gas circuit shall not be put at risk by the presence of gas rate adjusters and range-rating devices.

5.2.2.2 Gas rate adjusters

Appliances in categories I_{2H}, I_{2L}, I_{2E}, I_{2E+}, $I_{3B/P}$, I_{3P}, I_{3+}, $II_{2H3B/P}$, II_{2H3+}, II_{2H3P}, II_{2L3P}, $II_{2L3B/P}$, $II_{2E3B/P}$, II_{2E+3+} and II_{2E+3P} shall not be fitted with gas rate adjusters. However, governed appliances in all of these categories, except category II_{2E+3+}, may have a gas rate adjuster consisting of an adjusting screw on the gas pressure regulator.

Appliances in category II_{1a2H} shall have a gas rate adjuster for the 1st family gases.

For appliances in categories II_{2H3+} and II_{2E+3+} having a gas rate adjuster, it shall be possible to put these devices out of service when these appliances are supplied with a 3rd family gas, and the same applies for appliances in category II_{1a2H} when they are supplied with a 2nd family gas. For appliances in category II_{2E+3P} having a gas rate adjuster, it shall be possible to put these devices out of service fully or partially (see 5.2.5) when these appliances are supplied with a 2nd family gas.

The adjusters shall be adjustable only with a tool.

5.2.2.3 Range-rating devices

A range-rating device on an appliance is optional.

For appliances in category II_{1a2H}, the gas rate adjuster and the range-rating device may be one and the same. However, if the gas rate adjuster has to be sealed, either completely or partially, when the appliance is supplied with a 2nd family gas, the gas rate adjuster or its sealed part shall no longer be used as a range-rating device.

5.2.3 Aeration adjusters

Aeration adjusters are not allowed for the appliances in the scope of this standard.

5.2.4 Automatic gas/air ratio controls

Gas/air ratio controls shall be designed and constructed so that reasonably foreseeable damage does not give rise to a change capable of affecting safety.

Pneumatic gas/air ratio controls shall comply with the relevant requirements of EN 88-1.

Electronic gas/air ratio controls shall comply with the relevant requirements of EN 12067-2.

5.2.5 Gas pressure regulators

Gas pressure regulators shall comply with the requirements of EN 88-1 and EN 88-2.

All appliances shall be fitted with a gas pressure regulator, except appliances in categories I_{2L}, II_{2L3P} and $II_{2L3B/P}$ where this is optional.

For appliances in categories I_{2E+}, II_{2E+3P} and II_{2E+3+} the gas pressure regulator shall not be operational in the range of the two normal pressures of the second family pressure couple, i.e. 20 mbar -25 mbar.

Where a gas pressure regulator is fitted, it shall control the gas supply to the main burner and any ignition burner having a heat input of more than 2 kW.

NOTE Separate gas pressure regulators for the main burner and the ignition burner are acceptable.

For appliances in categories I_{3+}, II_{2H3+} and II_{2E+3+}, it shall be possible to put the gas pressure regulator partially out of service when they are supplied with third family gases such that the gas pressure regulator is not operational in the range of the two normal pressures e.g. 28 mbar -30 mbar /37 mbar.

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

5.2.6 Multifunctional controls

Any multifunctional control shall comply with the requirements of EN 126.

5.2.7 Automatic shut-off valves

5.2.7.1 General requirements

Automatic shut-off valves shall comply with the requirements of EN 161.

5.2.7.2 gives the minimum valve requirements.

5.2.7.2 Application

Each main gas supply shall be under the control of at least two automatic shut-off valves in series. Minimum gas valve requirements are for appliances:

— with pre-purge: C + J;

— without pre-purge but with a valve proving system or permanent or alternating ignition flame: C + J;

— without pre-purge: B + J or C + C.

Instead of J-class valves also C-class valves are possible, instead of C-class valves also B-class valves.

For individual gas lines > 0,250 kW, safety devices which require non-volatile lockout to occur shall give rise to simultaneous signal to close the two valves.

In response to a control device, if the delay between the signals to close the two valves is not greater than 5 s, the signals are considered to be simultaneous.

5.2.7.3 Action of the flame supervision system and overheat cut-off device

The flame supervision system and the overheat cut off device shall effect closure of all shut off valves in the systems specified.

5.2.8 Automatic burner control systems

5.2.8.1 General

Automatic burner control systems shall comply with the requirements of EN 298.

In addition, the control system shall be in accordance with the requirements of this standard which determine that it is suitable for its application.

5.2.8.2 Manually operated devices

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

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

5.2.9 Gas strainers

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

In systems comprising multiple automatic shut-off valves of classes A, B or C, only one strainer need be fitted, provided it gives adequate protection to all valves.

Where a gas pressure regulator is fitted upstream of the automatic shut-off valve system, the strainer may be fitted upstream of the gas pressure regulator.

5.3 Ignition devices

5.3.1 General

It shall be possible to light the appliance from a readily accessible position.

Ignition burners and ignition devices shall be protected by design and position against external influences.

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

5.3.2 Ignition device for the main burner

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

5.3.3 Ignition burners

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

5.4 Transportation of combustion air and/or flue gases

5.4.1 Combustion air

Appliances shall be fitted with a suitable device for proving adequate combustion air flow during the pre-purge, ignition and operation of the burner (see 6.5). Combustion air flow failure at any time during the pre-purge, ignition or operation of the main burner shall cause safety shut-down. The air proving device shall be proved in the 'no air flow' position prior to start-up. Failure to prove 'no air flow' shall prevent start-up or cause lock-out.

5.4.2 Pre-purge and post-purge

For fan-assisted appliances, pre-purge is mandatory before each ignition of the main burner (a single ignition attempt or several consecutive automatic ignition attempts) unless one of the following conditions is fulfilled:

a) appliances with a permanent or alternating ignition burner;

b) appliances in which the main burner gas line is fitted with a leakage control device;

c) appliances fitted with two Class C valves or a Class B and a Class J valve, which close simultaneously.

Pre-purge is always necessary after a safety shutdown or a lock out situation unless, when tested in accordance with the test sequence as described below, no hazard or damage occurs.

The volume or the duration of the pre-purge shall be:

1) for appliance where the pre-purge air is induced over the whole cross section of the combustion vessel inlet: at least the volume of the combustion vessel or at least 5 s at the air rate corresponding to nominal heat input,

2) for other appliances: at least three times the volume of the combustion vessel or at least 15 s at the air rate at the nominal heat input (Q_n).

Post-purge is optional.

5.5 Flame supervision system

The burner shall be fitted with a flame supervision device.

The flame supervision device shall incorporate a suitable means to provide safety shut down or lock out if the flame detector signals flame presence at any time during the pre-purge. This is the safe start check.

NOTE Care is to be taken to prevent electrical interference from giving rise to flame detector signals that falsely indicate the presence of a flame.

Upon flame failure the flame supervision device shall either:

— cause non-volatile lock-out or volatile lock-out; or

— permit an immediate reignition attempt by spark restoration, or permit automatic recycling.

Where reignition by spark restoration is used, the immediate reignition attempt shall commence within 1 s and finish by the end of the first safety time. If this reignition attempt is not successful, at least volatile lock-out shall result.

If, in the case of automatic recycling, ignition is not achieved by the end of the first safety time, at least volatile lock-out shall result.

The time for the flame supervision device to de-energize the automatic shut-off valves upon flame failure shall not be more than 3 s. This shall be verified under the conditions of 7.2.2.

5.6 Flame ignition and safety time T_{SA}

Under the test conditions of 7.3.17 the following requirement shall be met.

Any ignition flame shall be established either at the main burner or at a separate ignition burner.

Where the ignition gas supply is taken from between the two main gas valves, either:

a) a means shall be provided to prove closure of the downstream main shut-off valve prior to ignition;

NOTE A valve proving system or a proof of closure switch is deemed to satisfy this requirement.

or,

b) the requirement of 6.4.1.2 shall be met.

The safety time T_{SA} shall be declared.

The safety time shall be verified under the test conditions of 7.2.3 and 7.3.4.1.3. There shall be no deterioration of the appliance, no hazard to the user. The test is repeated with the delay starting at one second and increased by one second each time up to a maximum of T_{SA}.

If the heat input of the ignition burner does not exceed 0,250 kW, there is no requirement in respect of the T_{SA}.

Where the heat input of the ignition burner is between 0,250 kW and 1 kW, there is no requirement in respect of T_{SA} if suitable evidence is given that no dangerous situation for the user or damage to the appliance occurs.

In all other cases, the T_{SA} is chosen in accordance with the test in the section. There shall be no deterioration of the appliance, no hazard to the user. The test as stated below is repeated with the delay starting at one second and increased by one second each time up to a maximum of $T_{SA.}$

However, a delayed ignition test is not necessary if the T_{SA}, determined under the test conditions below, complies with the following requirement:

$$T_{SA} \leq 5 \cdot \frac{Q_n}{Q_{ign}} \text{ seconds but without exceeding 10 s;}$$

where

Q_n is the nominal input in kW;

Q_{ign} is the ignition rate in kW.

Where several automatic ignition attempts are made without being followed by a purge, the sum of the duration of the ignition attempts shall comply with the above requirement for T_{SA}.

Where several automatic ignition attempts are made followed by a purge, the ignition safety time shall be less than T_{SA} for each attempt.

5.7 Main flame establishment

5.7.1 Establishment by means of an ignition flame

The main gas safety shut-off valves shall not be energized to admit the main gas flow to the burner until after the ignition flame has been established.

The main flame shall ignite reliably and smoothly from the ignition flame.

If the ignition flame is at a separate ignition burner, the flame detector shall, under the conditions of operation, detect the ignition flame only at gas flow rates at which it lights the main flame reliably and smoothly. The need to protect against flame diminution, detector drift or maladjustment, gas pressure reduction and dimensional instability shall be taken into account.

5.7.2 Direct establishment of the main flame

Direct ignition of the main flame is permitted e.g. spark ignition, hot surface igniter.

The ignition source shall not be energized before completion of the pre-purge period and shall be de-energized at, or before, the end of the safety time. Where a hot surface ignition system is used, the ignition system shall be so energized that the ignition source is capable of igniting incoming gas before the gas valves are opened.

If the flame has not been detected before the end of the safety time, this shall result in:

a) non-volatile lock-out; or

b) safety shut-down followed by an automatic recycle, with a maximum number of 4 automatic recycling attempts. If these ignition attempts are not successful, non-volatile lock-out shall result.

The safety time shall not exceed the maximum declared safety time.

This safety time shall be verified under the test conditions of 7.2.3 and 7.3.4.1.1.

5.8 Main burner

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

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

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

5.9 Facility for remote control

Where the appliance is capable of being controlled remotely by means of thermostats or a time control, electrical connections of these controls shall be possible without disturbing any internal connections in the appliance other than a purpose designed link.

5.10 Thermostats and control of air temperature

5.10.1 General requirements

Integral mechanical thermostats shall comply with the requirements of EN 257.

Electrical thermostats shall comply with the requirements of EN 60730-2-9.

Overheat cut-off devices shall comply with Type 2K requirements of EN 60730-2-9.

5.10.2 Overheat cut-off device

An overheat cut-off device(s) shall be fitted to the appliance to prevent overheating of parts of the appliance heated by the burner e.g. the generator. Such device(s) shall be so designed and arranged that they cause shut-down and non-volatile lock-out in the event of an overheating condition occurring.

The operating temperature of the device(s) shall be set and sealed. In addition, the maximum operating temperature of the device(s) shall be specified.

The device(s) shall not be wired in series with either the flame sensor or the line supply from a programming unit to any automatic shut-off valve.

The device(s) shall not operate during the normal operation of the appliance.

5.10.3 Sensors

With an electronic system, thermostats and overheat cut off devices may not have the same sensor unless it is fail safe.

5.11 Gas pressure test points

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

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

5.12 Pressure relief devices

The means for pressure relief in case of over-pressurization shall meet the requirements of EN 378-2.

The appliance shall be fitted with one or more pressure relief devices to prevent the over-pressurization of refrigerant containing parts of the appliance in the event, for example, of a fire of external origin.

In the case of refrigerant containing parts that are pressurized, the means of relieving pressure shall be pressure activated.

In the case of refrigerant containing parts that are not pressurized, the means of relieving pressure shall be:

— either pressure activated; or

— temperature activated, providing that the means of pressure relief reacts consistently to over-pressurization in all circumstances.

If temperature activated devices are used the maximum relief temperature shall be declared.

NOTE Operational requirements are given in 6.9.

These devices shall not be adjustable.

5.13 Additional requirements for appliances designed for outdoor installation

5.13.1 General

Appliances designed for outdoor installation shall be so constructed that they are fully protected against the rigours of the environmental conditions under which they are expected to operate.

5.13.2 Combustion air inlets

Air inlets shall be designed such that proper air supply is provided (e.g. in the event of heavy snow or rain). The entrainment of soil shall be prevented. One recommendation to achieve this is to place the combustion air inlet as high as possible above the base of the appliance.

5.13.3 Access panels and doors

Access panels, doors and such insulation that needs to be removed during normal servicing shall be so designed that repeated removal and replacement does not damage the insulation or impair the waterproofing of the appliance.

5.13.4 Dimensions of openings

No dimensions of any opening, e.g. electrical wiring points, from the inside of the appliance to the outside air shall permit the entry of a ball of diameter 16 mm applied with a force of 5 N.

5.13.5 Fixing screws

The fixing of external panels intended to be removed for maintenance and servicing shall be so designed and arranged as to be suitable for outdoor conditions.

5.13.6 Frost protection

If the minimum ambient temperature declared is less than 0 °C, a sorption heat appliance shall be protected from freezing by a frost protection system.

In the installation instruction it shall be described how accumulation of ice is avoided for the condensate drainage and the outdoor heat exchanger defrosting disposal, if any.

NOTE This requirement is to be applied for indoor installations if the ambient temperature declared in the instruction manual is below 0 °C.

5.14 Materials in contact with condensate

All parts of the heat exchanger(s) and other parts of the appliances likely to come into contact with condensate shall be constructed of sufficiently corrosion resistant materials or materials protected by a suitable coating in order to ensure a reasonable life for an appliance that is installed, used and maintained in accordance with the appliance’s instructions.

5.15 Condensate

5.15.1 Discharge of condensate

Under the test conditions 7.3.18 the following requirement shall be met.

Condensing appliances shall be fitted with a condensate discharge system of corrosion-resistant material or covered by a durable protection against corrosion.

Where disposal of condensate from the appliance is by gravity the internal diameter of the condensate discharge connection shall be at least 13 mm. If the appliance incorporates some form of pump assisted condensate disposal the size of the discharge from the appliance and connection to any point of gravity discharge shall be specified by the appliance instructions. The disposal system, forming part of the appliance or supplied with the appliance, shall be such that it can be easily inspected and cleaned in accordance with the appliance's instructions;

Surfaces in contact with condensates (except purpose provided drains, water traps and siphons) shall be designed to prevent condensate retention.

It shall be possible to service and clean the system easily. There may be a common condensate drain for flue gas exhaust and the condensing appliance.

5.15.2 Control of the combustion products temperature

If the combustion products circuit contains materials that are likely to be affected by heat or is intended to be connected to a flue (including seals) that is likely to be affected by heat from the combustion products, the appliance shall incorporate a device to prevent the combustion products temperature exceeding the maximum allowable working temperature declared for the material.

This and the requirements of 6.14 shall be verified under the test conditions of 7.3.13.

The device for limiting the combustion products temperature shall be non-adjustable and shall not be accessible without tools.

5.15.3 Chemical composition of the condensate

If the chemical composition of the condensate is stated, the composition shall be verified at the end of the test.

5.15.4 Additional requirements for indoor installations

The disposal system, forming part of the appliance or supplied with the appliance, shall be such that it cannot transmit combustion products or let enter air into the room where the appliance is installed; this requirement is met if the disposal system incorporates a water trap.

The water trap shall meet 2 requirements:

1) the water trap shall have a seal of at least 25 mm water column;

2) the functional operating of the water trap shall be tested under the blockage tests from b) of 6.5.5 and 7.3.5.5. In that condition there shall be no leakage of combustion products into the room where the appliance is installed.

5.16 Electrical safety

The appliance shall comply with the relevant requirements of EN 60335-2-102.

If the appliance is fitted with electronic components or electronic systems providing a safety function, these shall comply with the relevant requirements in Clause 7.

If the nature of the electrical protection of the appliance is stated, on the data plate, this statement shall comply with EN 60529:1991.

For appliance intended to be installed in a partially protected place:

— the enclosure protection degree shall be at least IPX4D;

— the electrical and/or electronic equipment temperature range shall be suitable for the specified temperature range of the appliance.

6 Operational requirements

6.1 Soundness

6.1.1 Soundness of the gas circuit

The gas circuit shall be sound.

External soundness is ensured if, under the conditions specified in 7.3.1.1 the air leakage rate does not exceed 100 cm^3/h however many valves are fitted in series or in parallel on the appliance.

6.1.2 Soundness of the combustion circuit and correct evacuation of combustion products

6.1.2.1 Type B_{12} and B_{13}, appliances

When the appliance is tested under the conditions of 7.3.1.2.1 combustion products shall not escape except from the flue outlet.

6.1.2.2 Type B_{22} and B_{23} appliances

When the appliance is tested under the conditions of 7.3.1.2.2 combustion products shall not escape except from the flue outlet.

6.1.2.3 Type C_{12}, C_{13}, C_{32} and C_{33} appliances (indoor installations)

Soundness with respect to the room where the appliance is installed is ensured if, under the specified test conditions of 7.3.1.2.3, the leakage rates do not exceed the values in Table 3.

Table 3 — Maximum admissible leakage rates

Test object	Surrounding of the combustion products circuit by the combustion air circuit	Maximum leakage rate m^3/h
Appliance with its air supply and combustion products evacuation ducts and all their joints	Completely not completely	5 1
Appliance and the joints to the air supply and combustion products evacuation ducts	Completely not completely	3 0,6
Combustion products evacuation ducts, not completely surrounded by combustion air, with all its joints excluding the joints tested above		0,4
Air supply duct with all its joints excluding the joints tested above		2

6.1.2.4 Requirements for separate combustion products evacuation duct

The soundness of a separate combustion products evacuation duct with respect to areas other than the room where the appliance is installed is ensured if under the test conditions in 7.3.1.2.5 the leakage rate per surface area of the duct does not exceed 0,006 $dm^3/(s*m^2)$.

6.1.2.5 Requirements for the air supply circuit

The soundness of the air supply circuit with respect to all areas other than the room where the appliance is installed, is ensured if under the test conditions in 7.3.1.2.6 of the leakage rate per surface area of the duct does not exceed 0,5 $dm^3/(s*m^2)$.

6.2 Heat inputs

6.2.1 Nominal heat input

When measured under the conditions of 7.3.2.1, the heat input obtained at the normal pressure, shall be within ± 5 % of the nominal heat input.

6.2.2 Ignition heat input

When measured under the conditions of 7.3.2.2, the start gas heat input obtained at normal pressure shall be within ± 5 % of the start gas heat input declared. If this 5 % is less than 500 W, a tolerance of 500 W is acceptable.

6.2.3 Effectiveness of gas rate adjusters

For an appliance without a gas pressure regulator but with a gas rate adjuster, the rate obtained after adjustment of the device:

— shall not be less than the nominal heat input, under the conditions of test no. 1 of 7.3.2.3;

— shall not exceed the nominal heat input, under the conditions of test no. 2 of 7.3.2.3.

6.2.4 Effectiveness of the gas pressure regulator

For appliances with an adjustable gas pressure regulator, the rate shall not differ by more than + 7,5 % and – 10 % for 1st, 2nd and 3rd family gases, from the rate obtained at the adjustment pressure specified in 7.3.2.4, when the upstream pressure is varied between the minimum and maximum values stated in 7.1.4 for the reference gases of the category concerned.

6.2.5 Effectiveness of the range-rating device

For appliances fitted with a range rating device distinct from a gas rate adjuster, under the conditions stated in 7.3.2.5:

— with the range-rating device in the position giving the maximum rate, the nominal heat input shall be obtained to within ± 5 %; if this 5 % is less than 500 W, a tolerance of 500 W is acceptable;

— with the range-rating device in the position giving the minimum rate, the heat input shall be obtained to within ± 5 % of the minimum heat input stated; if this 5 % is less than 500 W, a tolerance of 500 W is acceptable.

For appliances of category I_{2L} and I_{2H} fitted with a range-rating device not distinct from a gas rate adjuster, the minimum and maximum of the declared range of heat inputs shall be obtained to within ± 5 %.

The appliance is adjusted in accordance with the installation instructions.

6.3 Limiting temperatures

6.3.1 Temperature of parts of the appliance which have to be touched during normal use

The surface temperatures of the control knobs and of all the parts to be touched during normal use of the appliance measured only in the zones intended to be gripped, and under the conditions stated in 7.3.3.2 shall not exceed the ambient temperature by more than:

— 35 K for metals;

— 45 K for porcelain or similar materials;

— 60 K for plastics.

6.3.2 Temperatures of the outer case of the appliance

The temperature of the outer case of the appliance, except for the surfaces of the draught diverter and of any flue pipe between the case and the draught diverter shall not exceed the ambient temperature by more than 80 K when measured under the conditions of 7.3.3.3. This requirement does not apply to those parts of the case within 150 mm of the flue pipe.

6.3.3 Temperature of the floor, walls and worktop/ceiling

When the appliance is tested under the conditions of 7.3.3.4, the temperature of any point of any floor or wall on which an appliance is to be installed and that of the walls at the side and rear of the appliance and the worktop/ceiling, shall not exceed the ambient temperature by more than 60 K.

6.3.4 Component temperatures

When the appliance is tested under the conditions of 7.3.3.5, the maximum temperature of the appliance components shall not exceed the maximum permissible temperatures specified for the individual components.

6.3.5 Motor temperatures (motor windings)

When tested under the conditions of 7.3.3.6, the maximum temperature rise of the motor windings shall not exceed the maximum permissible temperature rise stated for the motor.

6.4 Ignition, cross lighting, flame stability

6.4.1 Ignition and cross-lighting

6.4.1.1 All appliances (still air conditions)

Under the test conditions described in 7.3.4.1.1.2, correct ignition and cross lighting shall be ensured and smooth.

When the gas rate of any ignition burner is reduced under the test conditions described in 7.3.4.1.2 to the minimum required to hold open the gas supply to the main burner, correct ignition of the main burner shall be ensured and smooth. The system shall ignite safely. In addition, the appliance shall not sustain any damage likely to affect its safe operation.

6.4.1.2 Appliances where the ignition gas is taken from between the two main burner gas valves

Where the gas line is designed such that the gas supply to the ignition burner is taken from between the two main gas valves, and means is not provided to prove closure of the downstream main shut off valve prior to ignition, then under the conditions of test described in 7.3.4.1.4, it shall be verified that ignition gas does not give rise to a hazardous situation.

6.4.1.3 Special conditions

6.4.1.3.1 Type B_{12} and B_{13}, appliances

Under the conditions of 7.3.4.1.5.1, ignition of any ignition burner, ignition of the main burner and complete cross lighting of the main burner shall be correct.

6.4.1.3.2 Type C_{12} and C_{13} appliances

Under the conditions of 7.3.4.1.5.2, ignition of any ignition burner, ignition of the main burner and complete cross lighting of the main burner shall be correct.

6.4.1.3.3 Type C_{32} and C_{33} appliances

Under the conditions of 7.3.4.1.5.3, ignition of any ignition burner, ignition of the main burner and complete cross lighting of the main burner shall be correct.

6.4.1.3.4 Flue less appliances

Under the conditions of 7.3.4.1.5.3, ignition of any ignition burner, ignition of the main burner and complete cross lighting of the main burner shall be correct.

6.4.2 Flame stability

6.4.2.1 All appliances (still air conditions)

Under the test conditions described in 7.3.4.2.1, the flames shall be stable. A slight tendency to lift at the moment of ignition is acceptable but the flames shall be stable in normal operation.

6.4.2.2 Special conditions

6.4.2.2.1 Type B_{12} and B_{13}, appliances

Under the conditions of 7.3.4.1.5.1 and 7.3.4.2.2, the main burner and any ignition burner flames shall remain stable and any flame supervision device shall continue to function normally.

6.4.2.2.2 Type C_{12} and C_{13} appliances

Under the conditions of 7.3.4.2.1, the main burner and any ignition burner flames shall remain stable and any flame supervision device shall continue to function normally.

6.4.2.2.3 Type C_{32} and C_{33} appliances

Under the conditions of 7.3.4.2.1, the main burner and any ignition burner flames shall remain stable and any flame supervision device shall continue to function normally.

6.4.2.2.4 Appliances designed for outdoor installation

Under the conditions of 7.3.4.2.3.1, the main burner and any ignition burner flames shall remain stable and any flame supervision device shall continue to function normally.

For appliances which may be installed other than with a vertical flue, under the conditions of 7.3.4.2.3.2, flame lift or light back shall not occur at the main burner and any ignition burner.

6.5 Combustion

6.5.1 General

Under the test conditions of 7.3.5.1, the CO concentration in the dry, air-free, products of combustion shall not exceed the values stated in 6.5.2 and 6.5.3.

6.5.2 Limit conditions

Under the test conditions of 7.3.5.2, the CO concentration shall not exceed 0,10 %.

6.5.3 Special conditions

Under the test conditions of 7.3.5.3, the CO concentration, if not otherwise stated, shall not exceed 0,20 %.

6.5.4 Sooting

Under the test conditions of 7.3.5.4, no soot deposition shall be observed although yellow tipping is acceptable.

6.5.5 Supplementary requirement for condensing appliances

Under the test conditions of 7.3.5.5, the formation of condensate shall not impair the correct operation of the appliance. If the appliance is equipped with a condensate discharge then by choice, the appliance shall meet one of the following requirements:

a) when the condensate discharge is blocked, the gas supply of the appliance shall be shut off before the CO concentration exceeds 0,20 %, or

b) when the condensate discharge is blocked, causing a restriction in the flow of combustion products or air for combustion, resulting in a CO concentration equal to or greater than 0,10 % at equilibrium, restart shall not be possible from cold.

In either case, there shall be no spillage of condensate from the appliance.

6.5.6 Supplementary requirements for B_{12} and B_{13} appliances

Under the test conditions of 7.3.5.6, the CO content of the dry air-free combustion products shall not exceed:

— 0,10 % when the appliance is supplied with the reference gas;

— 0,20 % when the appliance is supplied with the incomplete combustion limit gas.

6.6 Safety of operation in various temperature environments

6.6.1 Temperature operating range

6.6.1.1 Cooling mode

When, for appliances capable of operating in the cooling mode, the appliance is tested at the extremes of the specified temperature operating range under the conditions given in 7.3.6.1.2:

— there shall be no damage to the appliance likely to impair its safety;

— no safety devices shall operate;

— under the maximum temperature conditions, the appliance shall restart automatically following the interruption in operation.

6.6.1.2 Heating mode

When, for appliances capable of operating in the heating mode, the appliance is tested at the extremes of the specified temperature operating range under the conditions given in 7.3.6.1.3, the appliance shall be capable of starting up and operating continuously without the intervention of any safety devices.

6.6.2 Safety in the event of operation outside the temperature operating range

When the appliance is tested outside the specified temperature operating range(s) in the cooling and/or heating modes under the conditions of 7.3.6.2:

— there shall be no damage to the appliance likely to impair its safety; and

— it shall be capable of being put back into operation once temperatures within the temperature operating range have been restored and, if necessary, after safety devices have been reset.

6.7 Overheat cut off device

Under the conditions described in 7.3.7, the following requirements shall be satisfied:

a) the overheat controls shall not operate during normal operation of the appliance in its cooling and/or heating modes, e.g. as a consequence of the operation of a room thermostat or other control;

b) the gas supply to the burner shall be cut off to prevent:

   1) a hazardous condition;

   2) any damage to the appliance.

c) the maximum operating temperature of the device shall not exceed the maximum permissible operating temperature stated for the device.

6.8 Maximum working pressure of pressurized vessels

Where, in accordance with 5.1.15, the maximum working pressure of any vessel of the appliance is specified, the following requirements shall be satisfied:

a) in the case of heated vessels protected by an overheat device, the maximum internal static pressure obtained under the test conditions given in 7.3.8.1 shall not exceed the stated maximum working pressure;

b) in the case of any vessel that is subjected to increased pressures as a result of pressure relief from a higher pressure vessel, the maximum internal static pressure obtained under the conditions given in 7.3.8.2 shall not exceed the stated maximum working pressure (see 5.1.15) for that vessel.

6.9 Pressure relief devices

6.9.1 Pressure activated pressure relief devices

Under the conditions given in 7.3.9.1.1 or 7.3.9.1.2, as appropriate, pressure shall be relieved from the appliance before the internal static pressure within pressurized vessels (see 5.1.15) exceeds the maximum relief pressure, p_r, as given by the following formula:

$$p_r = \frac{p_{mw} + p_y}{2}$$

where

p_{mw} is the maximum working pressure of the vessel specified (in bar) relative to the atmospheric pressure;

p_y is the minimum yield strength of the vessel specified (in bar) relative to the atmospheric pressure).

6.9.2 Temperature activated pressure relief devices

Under the conditions of 7.3.9.2, the internal pressures within the refrigerant circuit shall be relieved safely by means of the device(s) and the temperature at which the pressures are relieved shall not exceed the maximum relief temperature declared.

If, under the conditions given in 7.3.9.2, the internal pressures within the refrigerant circuit can exceed the atmospheric pressure by more than 0,5 bar, the internal pressures within the refrigerant circuit shall not exceed the maximum relief pressure, p_r, as given by the formula:

$$p_r = \frac{p_{mw} + p_y}{2}$$

where

p_{mw} is the maximum working pressure within the refrigerant circuit determined under the conditions of 7.3.9.2 (in bar relative to the atmospheric pressure);

p_y is the minimum yield strength of the refrigerant circuit declared (in bar relative to the atmospheric pressure.

6.10 Effectiveness of the pre-purge

When tested under still air conditions as specified in 7.3.10, the pre-purge shall be such that the pre-purge period is at least 10 s and that the volume of air available for combustion is at least five times greater than the volume of the combustion circuit where this is required in 7.3.10.

6.11 Weather resistance

When tested under the conditions of 7.3.11, an appliance designed for outdoor installation shall continue to function normally, with the main burner and ignition burner(s) operating normally.

In addition, with access doors or panels in place, no water shall accumulate in any part of the appliance such that normal functioning is affected.

6.12 Formation of condensate

When the appliance is installed in accordance with the test conditions for efficiency measurement and at the maximum flue length specified, under the conditions specified the condensate shall only form at the points intended for this purpose and shall be readily drained.

Condensate shall not find its way to parts of the appliance which are not intended for formation, collection and discharge of condensate, nor may the condensate cause any nuisance to the operation, the appliance and the surroundings.

6.13 NOx

The NOx class of the appliance shall be selected from Table 4. Under the test and calculation conditions in 7.3.12.1, the permissible NOx concentration assigned to this class in the dry, air free products of combustion shall not be exceeded.

Table 4 — NOx classes

Class	Concentration in mg/kWh -(NCV)	Concentration in mg/kWh (GCV)
1	260	
2	200	
3	150	
4	100	
5	70	
6		56

NOTE From 2018-09-26, the $NO_{x,m}$ does not exceed 70 mg/kWh heat input, based on GCV.

6.14 Combustion products temperature

The temperature of the combustion products shall not exceed the maximum allowable working temperature for the materials of the combustion circuit and/or the flue materials specified.

If the appliance incorporates a device to limit the maximum temperature of combustion products the operation of the device shall cause non-volatile lock-out of the appliance.

7 Test methods

7.1 General

7.1.1 Characteristics of test gases: reference and limit gases

Appliances are intended for use with gases of various qualities. One of the aims of this standard is to check that the performance of an appliance is satisfactory for each family or group of gases and for the pressures for which it is designed, if necessary using the adjusting devices.

The characteristics of the reference and limit gases are given in EN 437.

7.1.2 Conditions for preparation of the test gases

The composition of gases used for the tests shall be as near as possible to those given in EN 437:2003+A1:2009, Table 2.

7.1.3 Practical application of test gases

7.1.3.1 Choice of test gases

Gases required for the tests described in clauses:

- 7.3.2 Heat input
- 7.3.3 Limiting temperatures
- 7.3.4 Ignition, Cross lighting, Flame stability
- 7.3.5 Combustion

shall be as specified in 7.1.1 and made up in accordance with 7.1.2 and shall be carried out with each of the reference gases appropriate to the country in which the appliance is to be installed, according to the information given in EN 437:2003+A1:2009, Table 7.

The other tests are carried out with only one of the reference gases of the appliance category (see 7.1.1) at one of the normal test pressures required in 7.1.4 for the selected reference gas, hereafter referred to as "the reference gas".

However, the test pressure shall be one of those declared and the appliance shall be fitted with the appropriate injectors.

For the tests described in other clauses, it is permissible, in order to facilitate testing, to replace the reference gas by a gas actually distributed, provided that its Wobbe Index is within ± 5 % of that of the reference gas.

7.1.3.2 Conditions of supply and adjustment of the burners

7.1.3.2.1 Initial adjustment of appliance

Before all tests that are required to be carried out the appliance shall be fitted with the appropriate equipment (injector(s), etc.) corresponding to the gas family or gas group to which the specified test gas belongs (see EN 437:2003+A1:2009, Table 7). Any gas rate adjusters are set in accordance with the appliance's instructions using the appropriate reference gas(es) (see 7.1.3.1) and the corresponding normal pressure(s) given in 7.1.4.

This initial adjustment of the appliance is subject to the limitations given in 5.1.1.

7.1.3.2.2 Supply pressures

Except where an adjustment of the supply pressure is necessary (as described in 7.1.3.2.3 and 7.1.3.2.4) the normal, minimum and maximum supply pressures to be used for testing purposes shall be in accordance with the requirements given in 7.1.4.

Unless otherwise specified, the initial adjustment of the appliance is not altered.

7.1.3.2.3 Adjustment of heat inputs

For tests requiring adjustment of the burner to the nominal or another specified heat input, it shall be ensured that the pressure upstream of the injectors is such that the heat input obtained is within ± 2 % of that specified (by altering the preset adjusters or the appliance gas pressure regulator, if adjustable, or the appliance supply pressure).

The specified heat input shall be calculated in accordance with 7.3.2 and with the appliance supplied with the appropriate reference gas(es).

7.1.3.2.4 Corrected pressures

Where, in order to obtain the nominal heat input within ± 2 %, it is necessary to use a supply pressure, p, different from the normal pressure p_n, then those tests normally carried out at the minimum or maximum pressures p_{min} and p_{max} shall be carried out at the corrected pressures p' and p'' where:

$$\frac{p'}{p_{min}} = \frac{p''}{p_{max}} = \frac{p}{p_n}$$

7.1.4 Test pressures

The test pressures, i.e. the pressures required at the gas inlet connection of the appliance, are given in EN 437:2003+A1:2009, Table 5 and Table 6.

These pressures and the corresponding injectors are used in accordance with the special national conditions given in EN 437, for the country in which the appliance is to be installed.

7.1.5 Test procedures - Tests requiring the use of limit gases

These tests shall be carried out with the limit gases appropriate to the appliance category (see EN 437:2003+A1:2009, Table 7) and with the injector and the adjustments corresponding to the reference gas of the group, or family, to which each limit gas belongs.

7.1.6 General test conditions

7.1.6.1 General

The following clauses are generally applicable except where otherwise specified in particular clauses.

7.1.6.2 Test room

The appliance is installed in a well-ventilated, draught-free room which has an ambient temperature of (20 ± 5) °C, a wider temperature range is permissible provided that the test results are not affected.

7.1.6.3 Evacuation of the products of combustion

Type B_{12} and B_{13} appliances. Appliances with a vertical flue outlet shall be tested with the minimum specified height of vertical flue downstream of the draught diverter, or of 1 m height where no minimum is specified. The flue shall have the same nominal diameter as the flue outlet. Appliances with a horizontal flue outlet shall be fitted in accordance with the appliance's instructions; these shall include the maximum length of horizontal run and the method of adaption to a vertical flue; thereafter the vertical flue shall be fitted as above.

The vertical flue shall be made from sheet metal having a metal thickness less than 1 mm. Unless otherwise stated, the flue shall not be insulated.

Appliances shall be tested with the minimum diameter flue as specified in the installation instructions. If the flue has been adapted for another country, the modification required shall only involve an increase in the flue diameter.

Type B_{22} and B_{23} appliances. Appliances intended to be fitted to a flue having a wall termination shall be tested with a flue having the same diameter as the flue outlet and the declared maximum equivalent resistance.

Appliances intended to be fitted to a vertical flue shall be tested as follows:

a) appliances with a vertical flue outlet shall be fitted with 1 m of vertical flue, or the minimum length specified, having the same diameter as the flue outlet;

b) appliances with a horizontal flue outlet shall be fitted in accordance with the appliance's instructions; these shall include the maximum length of horizontal run and the method of adaption to a vertical flue; thereafter the vertical flue shall be fitted as above.

The flue shall be made from sheet metal having a metal thickness less than 1 mm. Unless otherwise stated, the flue shall be uninsulated.

Type C_{12} and C_{13} appliances. Except where otherwise stated, the tests are carried out with the appliance connected to the air supply and combustion products ducts of the maximum equivalent resistance specified in the appliance's instructions. These shall be supplied. Any terminal guard is not fitted. If necessary, an external telescopic duct may be sealed in accordance with the appliance's instructions.

Type C_{32} and C_{33} appliances. Except where otherwise stated, the tests are carried out using flue/air ducts of the minimum and maximum equivalent resistance specified in the appliance's instructions. These ducts shall be supplied.

7.1.6.4 Test installation

The appliance shall be installed in accordance with the appliance's instructions, with particular reference to minimum declared clearances around the appliance.

The appliance is connected to a test apparatus that enables the temperature of the heat transfer media to be controlled over the full range of the temperature operating range declared and outside this range where this is necessary for testing purposes.

Where the heat transfer medium is water or brine, this control may be achieved by incorporating supplementary heat exchangers in the circuit to increase or lower the temperature of the heat transfer medium as appropriate. These circuits shall also include means of controlling, or shutting off, the flow of heat transfer medium.

Where the heat transfer medium is air, the test apparatus shall include a means of adjusting and controlling the air temperatures. For some tests, a special test room having its own separate air conditioning system may be required.

All tests are carried out with the heat transfer media specified in the appliance's installation instructions. Unless otherwise required in a particular test, the flow rates of the heat transfer media shall be in accordance with the appliance's instructions.

Unless otherwise stated in particular tests, the tests are carried out using the heat transfer media temperatures given in Table 5, Table 6 and Table 7. If, however, the appliance's instructions for installation require other temperatures to be used, these are used instead.

Table 5 — Normal heat transfer media temperatures: Chillers

Operating Mode	Type of appliance	Test condition designation	Temperature at the indoor heat exchanger (°C)		Temperature at the outdoor heat exchanger (°C)	
			Inlet	Outlet	Inlet	Outlet
Cooling	Water cooled water chiller	W30/W7	30	35	12	7
	Water cooled brine chiller	W30/B –5	30	35	0	- 5
	Air cooled water chiller	A35/W7	35	-	12	7
	Air cooled brine chiller	A35/B –5	35	-	0	- 5

Table 6 — Normal heat transfer media temperatures: Heat recovery heat exchanger

Heat recovery water heat exchanger Inlet temperature Outlet temperature	40 °C 50 °C

Table 7 — Normal heat transfer media temperatures: All appliances in the heating mode [a]

Type of appliance		Test condition designation	Temperature at the outdoor heat exchanger (°C)		Temperature at the indoor heat exchanger (°C)	
			Inlet	Outlet	Inlet	Outlet
Outside air/water	With defrost control	A7(6)/W45	7(6)	-	-	45
	Without defrost control	A7(6)/W45	7(6)	-	-	45
Exhaust air / water		A20 (12)/ W45	20(12)	-	-	45
Water / water		W10/W45	10	-	-	45
Brine / water Monovalent appliance		B0/W45	0	-	-	45
Brine / water Hybrid ground sourced appliance		B7/W45	7	-	-	45
Brine / water Hybrid solar collector sourced appliance		B12/W45	12	-	-	45
[a] All air temperatures in brackets are wet bulb temperatures which are only required for low temperature tests in 7.3.7.						

For hybrid appliances equipped with two burners, safety test should be performed with each burner working separately and both burners working together (if applicable).

7.1.6.5 Influence of thermostats

Precautions shall be taken to prevent thermostats or other controls from operating and affecting the gas rate, unless this is necessary for the test.

7.1.6.6 Electrical supply

The appliance is connected to an electrical supply at the nominal voltage, except where otherwise stated in the clause concerned.

7.1.6.7 Range rated appliances

For appliances that are designed to be range rated, all tests are carried out at their maximum and minimum nominal heat inputs.

7.1.7 Modulating and high/low operation

For appliances with modulating or high/low operation, the tests are carried out at the nominal heat input unless otherwise stated in the particular test.

7.1.8 Tolerances of measurements

Except where otherwise stated in the particular clauses, measurements shall be carried out using equipment with maximum tolerances indicated below:

— atmospheric pressure ± 5 mbar;

— combustion vessel and test flue pressure ± 5 % full scale or 0,05 mbar;

— gas pressure ± 2 % full scale;

— water-side pressure loss ± 5 %;

— water rate ± 1 %;

— gas rate ± 1 %;

— air rate ± 2 %;

— time

  — up to 1 h ± 0,2 s

  — beyond 1 h ± 0,1 %;

— auxiliary electrical energy ± 2 %;

— temperatures:

  — ambient ± 1 K;

  — water ± 2 K;

  — combustion products ± 5 K;

  — gas ± 0,5 K;

— surface ± 5 K;

— CO, CO_2 and O_2 for the calculation of flue losses ± 6 % full scale;

— CO_2 in extracted air ± 0,01 %;

— gas calorific value ± 1 %;

— gas density ± 0,5 %;

— mass ± 0,05 %;

— torque ± 10 %;

— force ± 10 %,

The full range of the measuring apparatus is chosen to be suitable for maximum anticipated value.

For the determination of the leakage rate during the soundness tests, a method is used, which gives such accuracy that the error in its determination does not exceed 0,01 dm^3/h.

The measurement uncertainties indicated concern individual measurements. For measurements requiring a combination of individual measurements (e.g. efficiency measurements), the lower uncertainties associated with individual measurements may be necessary to attain the total required uncertainty.

7.2 Construction and design

7.2.1 Manually operated devices (see 5.2.8.2)

The appliance is installed as described in 7.1.6 and supplied with an appropriate reference gas (see EN 437:2003+A1:2009, Table 7) at the nominal heat input in accordance with 7.1.3.2.1. The start device is manually operated 10 times i.e. once every 5 s.

7.2.2 Extinction safety time (see 5.5)

With the appliance in the running condition, shut off the gas supply to the main burner. Measure the time between when the main burner is extinguished and the signal for valve closure is given.

7.2.3 Safety time (see 5.6)

Shut off the gas supply to the appliance. Attempt to light the appliance in accordance with the appliance's instructions, and measure the time between the signals for valve opening and closure. Compare this time with the declared safety time.

7.3 Safety of operation

7.3.1 Soundness

7.3.1.1 Soundness of the gas circuit

For appliances using 1st and/or 2nd family gases only, the tests are carried out with an air inlet pressure of 50 mbar; the inlet valve is however tested with an air pressure of 150 mbar. For appliances using 3rd family gases, all the tests are carried out with an air pressure of 150 mbar. However, if the appliance is designed to use 3rd family gases at the 112 mbar /148 mbar pressure couple, the tests are carried out at a pressure of 220 mbar. Any gas pressure regulator may be locked in its maximum open position to avoid damage.

Compliance with the requirements of 6.1.1 is verified under each of the following conditions:

— each valve in the main gas supply is tested in turn for soundness in its closed position, all other valves being open;

— with all gas valves open and the injectors for any ignition burner and main burner sealed or removed and the hole sealed.

Where the design of an ignition burner is such that its gas outlet cannot be sealed, this test is carried out with the gasway to the ignition burner sealed at a convenient place. In this case an additional test is also carried out, using soap solution, to verify that there is no leakage from the ignition burner when it is operating at its normal working pressure.

For the determination of the leakage rate a volumetric method is used which gives a direct reading of the leakage rate and which is of such accuracy that the error in its determination does not exceed 0,01 dm^3/h.

These tests are carried out first when the appliance is delivered and again, on completion of all the tests in the standard, after any assembly in the gas circuit that has a gas-tight joint whose removal is provided for in the appliance's instructions has been removed and replaced 5 times.

7.3.1.2 Soundness of the combustion circuit and correct evacuation of the combustion products

7.3.1.2.1 Type B_{12}, B_{13} appliances

7.3.1.2.1.1 General

The appliance is installed as described in 7.1.6 and connected to a flue as described in 7.1.6.3. The test is carried out with one of the reference gases for the category concerned at the nominal heat input under still air and draught free conditions.

Possible leaks are looked for with a dew point plate. This is carried out as described in 7.3.1.2.1.2 and 7.3.1.2.1.3.

7.3.1.2.1.2 Apparatus

The following two forms of dew point plate are suitable:

a) a chromium or rhodium plated, water cooled plate of rectangular cross section (see Figure 1). The overall length of the plate required is dependent upon the appliance design; or

b) a chromium or rhodium plated, water cooled tube of circular or other similar suitable cross section, approximately 12 mm diameter.

An essential characteristic of the detector is that it shall not affect the appliance in any way so as to cause leakage when it is in position; it may, therefore, have to be formed to match the shape of the area under consideration. Another requirement is that it shall not be placed so that it effectively extends the surface under test.

The detector shall be polished, but not with metal polishes containing anti-misting materials, and its surface shall be chemically degreased.

7.3.1.2.1.3 Method

Position the detector such that it detects any leakage from the surface under test, and fix it in that position.

Allow water to flow from a constant head device through the spillage detector at approximately 90 l/h and adjust the inlet temperature of the water to (11 ± 0,5) °C above the dew point of the surrounding air. Turn the appliance on under the conditions specified in 7.3.1.2.1 above. After operating the appliance for 10 min starting from the cold condition, check the surface of the detector for condensation. Condensation on the

detector indicates leakage of products. However, short duration 'puffs' of condensation, provided that there is at least 5 s intervals between each 'puff', shall be ignored.

The condensation is best seen by illuminating the underside of the detector with a bright lamp and making observations from one side at glancing incidence along the length of the detector. It is advantageous to position a black surface so that it is reflected in the polished surface of the detector.

In doubtful cases, however, it is recommended that leaks should be found with a sampling probe connected to a CO_2 analyser. Any instrument used shall be sensitive to a concentration of 0,1 % CO_2. An increase in the CO_2 level above the ambient of more than 0,2 % shall be regarded as unsatisfactory. The method of sampling used shall not disturb the normal flow of products of combustion.

7.3.1.2.2 Type B_{22}, B_{23}, appliances

The appliance is installed as described in 7.1.6 and connected to a flue having the maximum equivalent resistance. The test is carried out with one of the reference gases for the category concerned at the nominal heat input after operating the appliance for 10 min, starting from the cold condition, under still air and draught free conditions.

Possible leaks are looked for with a dew point plate. This is carried out as described in 7.3.1.2.1.2 and 7.3.1.2.1.3.

7.3.1.2.3 Type C_{12}, C_{13}, C_{32} and C_{33} appliances

The test can be carried out either separately on the appliance body and on the ducts, or on the appliance assembled with its ducts.

The combustion circuit of the test object in accordance with Table 3 is connected to a pressure source on one side and blocked on the other side.

The test pressure (difference) is 0,5 mbar unless otherwise stated.

For appliances installed indoor with a fan where the combustion products circuit is not completely surrounded by the combustion air circuit, the test is also carried out on the part of the combustion circuit downstream of the fan, with a test pressure which is increased by the highest pressure between the combustion circuit, in the envelope of the appliance or the ducts, and the atmosphere, measured with the appliance in thermal equilibrium at nominal heat input and fitted with the longest ducts specified in the installation instructions.

7.3.1.2.4 Flue less appliances

Chillers and heat pumps using air as source designed for outdoor installation may feature a flueless system provided that combustion gases are mixed with condensation/evaporation air and the percentage in volume of combustion gases in the mixed air flow remains lower than 10 % of total air flow in all operating conditions.

Appropriate design solutions have to be applied on the appliance in order to prevent any recirculation of the combustion products into the combustion air inlet.

For testing purposes, the combustion products shall be sampled before any dilution.

7.3.1.2.5 Separate combustion products evacuation duct

When tested in accordance with 7.3.1.2 but with a test pressure of 2,0 mbar, it is checked that the requirements of 6.1.2.4 are met.

7.3.1.2.6 Air supply duct

When tested in accordance with 7.3.1.2, it is checked that the requirements of 6.1.2.5 are met.

7.3.2 Heat inputs

For the purposes of this standard all heat inputs are determined from the volumetric rate (V_o) or mass rate (M_o) which relate to the rate obtained with reference gas under reference test conditions (dry gas, 15 °C, 1 013,25 mbar). The heat input (Q_o) in kW is given by one of the following formulae:

$$Q_0 = 0{,}278 \times M_0 \times H_i (or H_s)$$

or

$$Q_0 = 0{,}278 \times V_0 \times H_i (or H_s)$$

where:

M_o is the mass input (in kilogram per hour) obtained at reference conditions;

V_o is the volume input (in cubic metre per hour) obtained at reference conditions;

H_i is the net calorific value of the reference gas in megajoule per kilogram (1st formula) or in megajoule per cubic metre (dry gas, 15 °C, 1 013,25 mbar) (2nd formula);

H_s is the gross calorific value of the reference gas in megajoule per kilogram (1st formula) or in megajoule per cubic metre (dry gas, 15 °C, 1 013,25 mbar) (2nd formula).

The mass and volume rates correspond to a measurement and to a flow of reference gas, under reference conditions, in other words assuming the gas to be dry, at 15 °C and under a pressure of 1 013,25 mbar.

In practice, the values obtained during the tests do not correspond to these reference conditions so they shall then be corrected so as to bring them to the values that would actually have been obtained if these reference conditions had existed at the injector outlet during the test.

The following correction formulas apply:

depending whether it is determined by mass or from the volume rate, the corrected mass rate is calculated from the following formulae:

— determination by mass

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

— determination from volume rate

$$V_0 = V_. \times \sqrt{\frac{1013{,}25 + p}{1013{,}25} \times \frac{p_{at} + p}{1013{,}25} \times \frac{288{,}15}{273{,}15 + T_g} \times \frac{d}{d_r}}$$

The corrected mass rate is calculated by the formula:

$$M_0 = 1{,}226 \times V_0 \times d$$

NOTE The above given correction formulas are valid for appliances with burners using gas nozzles and injectors. For appliances using gas/air ratio control systems, other correction formulas apply (see Annex A).

7.3.2.1 Nominal heat input

The test is carried out at the pressure specified in accordance with the requirements of 7.1.4.

The appliance is fitted successively with each of the prescribed injectors and adjusted in accordance with 7.1.3.2.1. The heat input is determined as described in 7.3.2 for each reference gas.

The measurements are taken with the appliance at thermal equilibrium and with any thermostat put out of action.

The heat input obtained Q_o is compared with the nominal heat input Q_n in order to verify the requirement of 6.2.1.

7.3.2.2 Ignition heat input

The test is carried out at the pressure specified in accordance with the requirements of 7.1.4, using an arrangement which allows operation of the ignition flame on its own.

The appliance is fitted successively with each of the prescribed injectors and adjusted in accordance with 7.1.3.2.1. The heat input is determined as described in 7.3.2 for each reference gas.

The measurements are taken immediately after ignition.

The heat input obtained is compared with the ignition heat input declared in order to verify the requirement of 6.2.2.

7.3.2.3 Effectiveness of the gas rate adjusters

This clause concerns only appliances fitted with gas rate adjusters which are not put out of action.

Test no. 1. The rate is measured with the adjuster fully open and with the minimum supply pressure given in 7.1.4 for the particular reference gas.

Test no. 2. The rate is measured with the adjuster fully closed and with the maximum supply pressure given in 7.1.4 for the particular reference gas.

The tests are carried out for each reference gas for the appliance category with the exception of cases where the adjuster has been set and sealed in a given position. In this case, the adjuster is regarded as non-existent.

7.3.2.4 Effectiveness of the gas pressure regulator

If the appliance has an adjustable gas pressure regulator, this is adjusted if necessary to give the nominal volumetric rate with reference gas at the normal pressure given in 7.1.4 and corresponding to this gas. Keeping the initial adjustment, the supply pressure is varied between the corresponding minimum and maximum values. This test is carried out for all the reference gases for which the gas pressure regulator is not put out of action. However, for 1st family gases, this check is made between the nominal pressure and the maximum pressure.

7.3.2.5 Effectiveness of the range-rating device

The tests are carried out as described in 7.3.2.1 for the two extreme positions of the range rating device.

7.3.3 Limiting temperatures

7.3.3.1 General

The appliance shall be operated with one of the reference gases for the appliance category at the nominal heat input, the minimum circulated air rate specified and any adjustable thermostat at maximum setting.

The appliance shall be installed in accordance with the appliance's instructions taking into account the minimum clearances around the appliance.

7.3.3.2 Temperature of parts of the appliance to be touched during normal use

The temperatures of the parts specified in 6.3.1 shall be measured at thermal equilibrium using an instrument to an accuracy of ± 2 °C, for example using contact thermocouples, and compliance with the requirements of 6.3.1 verified.

7.3.3.3 Temperatures of the outer case of the appliance

The test is carried out when the appliance has reached thermal equilibrium.

The temperatures of the hottest parts of the side walls, front and top of the appliance are measured by a suitable means having an accuracy of ± 2 °C, for example using contact thermocouples, and compliance with the requirements of 6.3.2 verified.

7.3.3.4 Temperatures of the floor, walls and work top/ceiling

The installation instructions shall specify the nature of any effective protection, if required, to be applied between the appliance and the floor, walls or work top/ceiling unless they are made of non-flammable materials. This protection shall be supplied to the test laboratory, which shall check that, when the appliance is fitted with it, the temperature of the floor, walls and work top/ceiling measured, under the conditions of 7.3.3.1, comply with the requirements of 6.3.3.

The temperatures are measured when the appliance has reached thermal equilibrium, using an instrument to an accuracy of ± 2 °C, for example using contact thermocouples.

7.3.3.5 Component temperatures

Component temperatures are measured when thermal equilibrium has been reached in the test described in 7.3.3.2 and after the appliance has been turned off at the end of the test, and compliance with the requirements of 6.3.4 verified.

The component temperatures are measured by means of attached thermocouples having thermoelectric junctions which are accurate to within ± 2 °C. Alternative devices of equivalent accuracy may be used.

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, thermocouples or alternative devices are placed so as to measure the air temperature around the device.

The temperature measurements of the components are deemed to be satisfactory if:

$$t_m \leq t_s + t_a - 25°C \quad 2)$$

where

t_m is the maximum temperature measured in the test (in degrees Celsius);

t_s is the maximum permissible temperature specified for the component (in degrees Celsius);

t_a is the ambient room temperature (in degrees Celsius).

7.3.3.6 Motor temperatures (motor windings)

The appliance is installed according to the conditions of 7.1.6 and supplied with electricity by means of a device that enables the voltage to be varied from 85 % of the minimum to 110 % of the maximum declared voltage range, e.g. a variable voltage transformer.

The test is carried out in still air and with the appliance adjusted to its nominal input, using an appropriate reference gas (see EN 437:2003+A1:2009, Table 7). The voltage is adjusted to the most unfavourable value between the above limits.

Temperature measurements are made when the appliance has reached thermal equilibrium and after the appliance has been switched off by the normal means of control, and compliance with the requirements of 6.3.5 verified.

The resistance of the windings is measured as soon as possible after switching off and then at short intervals so that a curve of the resistance against time from switch-off can be plotted, in order to determine the maximum resistance value.

The temperature rise of the windings is calculated from the formula:

$$\Delta t = \frac{R_2 - R_1}{R_1} \cdot (C + t_1) - (t_2 - t_1)$$

where

Δt is the temperature rise (in kelvin);

R_1 is the resistance at the beginning of the test (in ohm);

R_2 is the maximum resistance at the end of the test (in ohm);

t_1 is the room temperature at the beginning of the test (in degrees Celsius);

t_2 is the room temperature at the end of the test (in degrees Celsius);

C is 234,5 °C for copper.

7.3.4 Ignition, Cross-lighting, Flame stability

These tests are carried out with the appliance in the cold condition and at thermal equilibrium unless otherwise stated.

2) If the maximum temperature of the component was based on an ambient temperature other than 25 °C this ambient temperature is used instead of 25 °C (see in the formula).

7.3.4.1 Ignition and cross-lighting

7.3.4.1.1 All appliances (still air conditions)

7.3.4.1.1.1 General

These tests are carried out with the appliance installed in accordance with 7.1.6.

7.3.4.1.1.2 Tests

Under the supply conditions of each of the tests (1, 2 and 3) it is checked that ignition of the main burner or the ignition burner occurs correctly and that ignition of the main burner by the ignition burner as well as cross-lighting of the various parts of the burner occurs correctly.

The initial burner and ignition burner adjustments are not altered.

The tests are repeated at the minimum heat input given by the controls, if ignition is possible under these conditions during normal operation in accordance with the appliance's instructions for use.

Test no. 1

The appliance is supplied with the appropriate reference and limit gases (see EN 437:2003+A1:2009, Table 7) at the normal pressure in accordance with 7.1.4.

Test no. 2

The appliance is supplied with reference gas with the pressure at the appliance inlet reduced to 70 % of the normal pressure or the minimum pressure given in 7.1.4, whichever is the lower.

Test no. 3

The appliance is supplied successively with the appropriate flame lift and light-back limit gases for the reference gas and the pressure is reduced at the appliance inlet to the minimum pressure given in 7.1.4.

7.3.4.1.2 Ignition burner flame reduction

This test is carried out with the appliance installed in accordance with 7.1.6.

The appliance is initially adjusted in accordance with the requirements of 7.1.3.2.1 and supplied with the appropriate reference gases (see EN 437:2003+A1:2009, Table 7) at nominal heat input.

The ignition burner gas rate is then reduced to the minimum required to hold open the gas supply to the main burner.

The necessary reduction in the ignition burner gas rate may be achieved either:

— by the adjustment of the ignition burner rate adjuster, if this exists, or, if this is not possible,

— by means of an adjuster inserted into the ignition burner gas supply for this purpose.

The correct ignition of the main burner by the ignition burner is then checked.

Where an ignition burner has several ports that are likely to become blocked, the test is carried out with all the ignition burner orifices blocked except for the one that produces the flame that heats the flame sensor.

7.3.4.1.3 Flame ignition and safety time T_{SA}

The appliance is supplied successively with each of the reference gases for the appliance category.

A delayed ignition test is carried out under the following conditions:

— the appliance is installed as indicated in 7.1.6;

— with the appliance at ambient temperature, ignition starts after a delay following the gas valve opening.

7.3.4.1.4 Appliances where the ignition gas is taken from between the two main burner gas valves

The appliance is initially adjusted in accordance with the requirements of 7.1.3.2.1 and supplied with an appropriate reference gas (see EN 437:2003+A1:2009, Table 7) at the nominal heat input.

With the downstream automatic gas valve in the main gas line kept open artificially, ignite the appliance.

7.3.4.1.5 Special conditions

7.3.4.1.5.1 Type B_{12}, B_{13} appliances

The appliance is supplied with an appropriate reference gas (see EN 437:2003+A1:2009, Table 7) at the corresponding normal pressure (see 7.1.4). It is connected to a flue of the same nominal diameter as the flue connection and straight for a length of not less than 10 diameters immediately above the draught diverter. A down-draught of 1 m/s and 3 m/s is applied through the flue using a suitable down-draught apparatus (see Figure 2).

A second test is carried out with the test flue blocked.

7.3.4.1.5.2 Type C_{12} and C_{13} appliances

The appliance is installed on the apparatus described in Figure 3.

The tests are carried out using the air supply and combustion products ducts of the minimum equivalent resistance specified in the appliance's instructions.

The appliance is supplied with an appropriate reference gas in accordance with EN 437:2003+A1:2009, Table 7, and adjusted to obtain the nominal heat input.

Three series of tests are carried out:

Series 1

The appliance terminal is subjected to winds of different speeds in the three planes:

— Horizontal;

— Ascending, at 30° to the horizontal;

— Plunging, at 30° to the horizontal.

In each of these three planes, the incident angle of the wind is varied by 15° increments between 0° and 90° inclusive. If the terminal is not symmetrical about the vertical axis, the tests are carried out at 15° increments between 0° and 180° inclusive.

The tests are carried out at three wind speeds, 1 m/s, 2,5 m/s and 12,5 m/s.

Under each of these 63 conditions (117 if not symmetrical) a visual check is made of:

a) the ignition and stability of any ignition burner without the main burner alight;

b) the ignition of the main burner by any ignition burner;

c) the ignition and stability of the main burner at any ignition rate;

d) the cross-lighting of the main burner;

e) where applicable, the stability of any ignition burner (and the main burner when operating simultaneously).

These tests are carried out with the appliance at thermal equilibrium.

For each of the three planes of incidence:

f) the three combinations of wind speed and angle of incidence are found giving the lowest CO_2 concentration;

g) the three combinations are found for which the highest CO concentrations are measured, in the dry air-free combustion products.

Series 2

For each of the nine combinations that produce the lowest CO_2 concentration, noted in the first test series, that it is checked that, with the appliance cold, it is possible to light the ignition burner, if any, and then the main burner by means of either the ignition burner or the device for direct ignition.

Series 3

The 1st and 2nd series are repeated at the minimum heat input given by the controls if such operation is intended.

7.3.4.1.5.3 Type C_{32} and C_{33} appliances

The appliance is installed on the apparatus described in Figures 4a and 4b, with flue/air ducts of the minimum equivalent resistance declared.

The appliance is supplied with an appropriate reference gas in accordance with EN 437:2003+A1:2009, Table 7, and adjusted to obtain the nominal heat input.

Three series of tests are carried out:

Series 1

The appliance terminal is subjected to winds of different speeds in the three planes:

— Horizontal;

— Ascending, at 20° to the horizontal;

— Plunging, at 45° to the horizontal.

In each of these three planes, the incident angle of the wind is varied between 0° and 90° inclusive, with intermediate tests carried out at 35° and 70°. In addition, if the terminal is suitable for use on a sloping roof, the tests are repeated with the test surface angled at 25° and 55° (see Figure 4b).

The tests are carried out at three wind speeds, 1 m/s, 2,5 m/s and 12,5 m/s.

Under each of these conditions a visual check is made of:

a) the ignition and stability of any ignition burner without the main burner alight;

b) the ignition of the main burner by any ignition burner;

c) the ignition and stability of the main burner at any ignition rate;

d) the cross-lighting of the main burner;

e) where applicable, the stability of any ignition burner (and the main burner when operating simultaneously).

These tests are carried out with the appliance at thermal equilibrium.

For each of the three planes of incidence:

f) the three combinations of wind speed and angle of incidence are found giving the lowest CO_2 concentration;

g) the three combinations are found for which the highest CO concentrations are measured, in the dry air-free combustion products.

Series 2

For each of the nine combinations that produce the lowest CO_2 concentration, noted in the first test series, that it is checked that, with the appliance cold, it is possible to light the ignition burner, if any, and then the main burner by means of either the ignition burner or the device for direct ignition.

Series 3

The 1st and 2nd series are repeated at the minimum heat input given by the controls if such operation is intended.

7.3.4.1.5.4 Flue less appliances

The appliance is installed on the apparatus described in Figure 3.

The appliance is supplied with an appropriate reference gas in accordance with EN 437:2003+A1:2009, Table 7, and adjusted to obtain the nominal heat input.

Three series of tests are carried out:

Series 1

The appliance flue outlet is subjected to winds of different speeds in the three planes:

— Horizontal;

— Ascending, at 30° to the horizontal;

— Plunging, at 30° to the horizontal.

In each of these three planes, the incident angle of the wind is varied by 15° increments between 0° and 90° inclusive. If the appliance flue outlet is not symmetrical about the vertical axis, the tests are carried out at 15° increments between 0° and 360° inclusive.

The tests are carried out at three wind speeds, 1 m/s, 2,5 m/s and 12,5 m/s.

Under each of these conditions a visual check is made of:

a) the ignition and stability of any ignition burner without the main burner alight;

b) the ignition of the main burner by any ignition burner;

c) the ignition and stability of the main burner at any ignition gas rate;

d) the cross-lighting of the main burner;

e) where applicable, the stability of any ignition burner (and the main burner when operating simultaneously).

These tests are carried out with the appliance at thermal equilibrium.

For each of the three planes of incidence:

f) the three combinations of wind speed and angle of incidence are found giving the lowest CO_2 concentration;

g) the three combinations are found for which the highest CO concentrations are measured, in the dry air-free combustion products.

Series 2

For each of the nine combinations that produce the lowest CO_2 concentration, noted in the first test series, it is checked that, with the appliance cold, it is possible to light the ignition burner, if any, and then the main burner by means of either the ignition burner or the device for direct ignition.

Series 3

The 1st and 2nd series are repeated at the minimum heat input given by the controls if such operation is intended.

7.3.4.2 Flame stability

7.3.4.2.1 All appliances (still air conditions)

Test no. 1

Without altering the initial main burner or ignition burner adjustment, the appropriate light-back gas is substituted successively for the reference gas and the pressure is reduced at the appliance inlet to the minimum pressure given in 7.1.4.

Under these conditions it is checked that the flames are stable.

This test is then repeated at the minimum input given by the controls at which the appliance can operate normally in accordance with the appliance's instructions.

Test no. 2

Without altering the initial main burner or ignition burner adjustment, the appropriate flame lift and light-back limit gases are substituted successively for the reference gas and the pressure is increased at the appliance inlet to the maximum given in 7.1.4.

Under these conditions it is checked that the flames are stable.

This test is then repeated at the minimum input given by the controls at which the appliance can operate normally in accordance with the appliance's instructions.

7.3.4.2.2 Special conditions (Type B_{12}, B_{13} appliances)

The appliance is supplied with the reference gas at normal pressure and is subjected at burner level to a wind stream of 2 m/s which has a minimum diameter of 0,5 m (or an equivalent cross-sectional area if the wind stream is not circular).

The axis of the wind stream is in a horizontal plane and is moved through one or more (at the discretion of the laboratory) angles of incidence within a full 360° circle around the appliance, the centre of the circle passing through the two vertical planes of symmetry of the appliance.

The test is carried out with the main burner and any ignition burner alight together and, if appropriate, with only the ignition burner alight. Any lighting door remains closed during the test.

The test is repeated at the minimum input given by the controls if such operation is intended.

During the test, precautions are taken to screen the draught diverter from the effects of the wind.

7.3.4.2.3 Special conditions for appliances designed for outdoor installation

7.3.4.2.3.1 The appliance is tested as described in 7.3.4.2.1, at normal pressure only, with a wind stream of 12,5 m/s directed at the appliance.

A shield large enough to cover the fan outlet is placed downstream of the fan and between the fan and the appliance.

Immediately after lighting the appliance, the shield is removed for periods of 3 s so that gusting is produced. This test is repeated at steps of 30° around the appliance in the horizontal plane

7.3.4.2.3.2 The appliance is installed according to the conditions of 7.1.6 using the appropriate reference gas (see EN 437:2003+A1:2009, Table 7).

Using the apparatus described in 7.3.4.2.2, the appliance is subjected to a horizontal wind speed of 12,5 m/s. The appliance is slowly rotated about a vertical axis relative to the fan and the flames are observed. At positions of the appliance where, by inspection, there appears to be maximum flame interference, the rotation of the appliance is stopped.

The appliance is turned off and allowed to cool to room ambient temperature.

A shield large enough to cover the fan outlet, is placed between the fan and the flue gas outlet.

Immediately after lighting the appliance, the shield is removed for periods of 3 s so that gusting is produced. The flames are observed once again.

Tests with ascending and plunging winds are carried out as for horizontal winds except that the wind is continuous and directed at an angle of 45° to the horizontal plane upwards and downwards.

All the above tests are repeated with the appliance subjected to horizontal, plunging and ascending winds of speeds 2,5 m/s and 1,0 m/s.

7.3.5 Combustion

7.3.5.1 General

The appliance is supplied with the reference gases for the category to which it belongs and adjusted at the nominal heat input.

For range rated appliances, the tests are carried out at the maximum and minimum rated heat inputs. For modulating appliances, the tests are carried out at the nominal input and the minimum input given by the control.

A sample of the combustion products is taken when the appliance has reached thermal equilibrium.

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

$$CO = (CO)_M \times ((CO_2)_N / (CO_2)_M)$$

where

CO is the carbon monoxide concentration of the dry air-free combustion products in %;

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

$(CO)_M$ is the measured concentrations in the samples taken during the combustion test, both expressed in %;

$(CO_2)_M$ is the measured concentrations in the samples taken during the combustion test, both expressed in %.

The concentrations, in percent, of $(CO_2)_N$ for the test gases are given in Table 8.

Table 8 — $(CO_2)_N$ concentration of the combustion products, in percent

Designation of the gas	G 20	G 21	G 23	G 25	G 26	G 27	G 30	G 31
$(CO_2)_N$	11,7	12,2	11,6	11,5	11,9	11,5	14,0	13,7
Designation of the gas			G 231			G 271		
$(CO_2)_N$			11,5			11,2		

The CO concentration, in percent, of the dry, air-free combustion products may also be calculated by the formula:

$$CO = (CO)_M \times (21 - (O_2)_M)$$

where

$(O_2)_M$ and $(CO)_M$ are the measured concentrations of oxygen and carbon monoxide in the samples taken during the combustion test, both expressed in percent.

The use of this formula is recommended where the CO_2 concentration is less than 2 %.

7.3.5.2 Limit conditions

7.3.5.2.1 Appliances without gas/air ratio controls

The tests are carried out under the following conditions:

a) at maximum test pressure p_{max} for appliances without a regulator;

b) at 1,07 times the nominal heat input for appliances with a regulator using first family gas;

c) at 1,05 times the nominal heat input for appliances with a regulator using second and third family gas;

d) additional test condition for condensing appliances, see 6.5.5.

The combustion characteristics are verified under the temperature conditions of Tables 5 to 7.

The still air tests shall also be carried out when the appliance is operating in the condensing mode (Inlet heating temperature 30 °C).

Appliances with a gas rate adjuster or a pressure regulator that is put out of action for one or more gas families, is tested successively in accordance with the various supply situations specified.

7.3.5.2.2 Appliances using Gas/air Ratio Controls

Appliances using gas/air ratio control systems are subjected to the following tests. The CO and CO_2 concentrations are measured:

a) the gas/air ratio control is adjusted in accordance with the installation instructions (or left as factory set if the control is not adjustable). The appliance is operated at both maximum and minimum heat input allowed by the control system;

b) simulate reasonable maladjustment of any adjustable “throttle” setting by adjusting the CO_2 at maximum rate to be 0,5 % higher than the maximum value to which the gas/air ratio control should be set. For gas/air ratio controls that are adjustable then the maximum value shall include the maximum extent of the setting tolerance.

For non - adjustable gas/air ratio controls the maximum value shall include the maximum extent of the factory setting tolerance. Following this adjustment, the appliance is operated at both maximum and minimum heat input allowed by the control system.

c) simulate reasonable maladjustment of any adjustable “offset” setting by measuring the gas/air ratio control differential pressure (with the appliance operating at minimum rate) and adjusting the offset screw sufficiently to increase the differential pressure by 5 Pa. Following this adjustment, the appliance is again operated at both maximum and minimum heat input allowed by the control system. The tests are repeated by adjusting the offset screw sufficiently to decrease the differential pressure by 5 Pa.

For each test condition it is checked that the requirement of 6.5.2 is met.

7.3.5.3 Special conditions

7.3.5.3.1 Incomplete combustion

The adjustment is modified as follows:

a) appliances without regulators are adjusted to 1,075 times the nominal heat input;

b) appliances with gas/air ratio controls are operated at the specified maximum and minimum rate;

c) appliances with regulators or appliances which are intended to be installed solely on a gas installation with a governed meter, are adjusted to 1,05 times the nominal heat input.

The reference gas is then replaced by the incomplete combustion limit gas. It is checked that the requirements of 6.5.3 are met.

7.3.5.3.2 Supply voltage variation

Fan assisted appliances are supplied with the reference gases for the category to which it belongs at normal pressure. It is checked that the requirements of 6.5.3 are met when the supply voltage is varied between 85 % and 110 % of the nominal voltage stated by the appliances instructions.

7.3.5.3.3 Flame Lift

The adjustment is modified as follows:

a) for appliances without pressure regulators, the pressure at the appliance inlet is reduced to the minimum supply pressure given in EN 437 for the gas category, and the appliance is adjusted to the minimum heat input;

b) for appliances with gas/air ratio controls, the appliance is adjusted to the minimum heat input;

c) for appliances with pressure regulators, the appliance is adjusted to a heat input equal to 0,95 times the minimum heat input.

The reference gas is then replaced by the flame lift limit gas. It is checked that the requirements of 6.5.3 are met.

7.3.5.3.4 Special flue conditions

7.3.5.3.4.1 Type C_1, C_3 appliances

The test is carried out as stated in the first and third test series in 7.3.4.1.5.2 or 7.3.4.1.5.3, as appropriate.

For each of the test series, the value of the arithmetic mean of the CO concentrations determined at the nine combinations of wind speed and angle of incidence that produce the highest CO concentration in the combustion products is calculated.

It is checked that the requirement of 6.5.3 is met.

7.3.5.3.4.2 Type B_2 appliances

Under the test conditions of 7.3.4.1.5.1 it is checked that the requirement of 6.5.3 is met.

7.3.5.3.5 Appliances designed for outdoor installation

Without altering the initial burner adjustment, the appliance is supplied with the appropriate reference gases (see EN 437:2003+A1:2009, Table 7) according to its category and operated at the nominal heat input.

Using the apparatus described in 7.3.4.2.3, the appliance is subjected to a horizontal wind speed of 1 m/s centring on the terminal. The appliance is slowly rotated about a vertical axis relative to the fan.

The test is repeated at wind speeds of 2,5 m/s and 12,5 m/s. The above tests are repeated with ascending and plunging winds at an angle of 45° to the horizontal. It is checked that the requirement of 6.5.3 is met.

7.3.5.4 Sooting

The appliance is adjusted as stated in 7.3.5. The incomplete combustion limit gas is replaced by the sooting limit gas. The appliance is operated for 1 h.

It is checked that the requirements of 6.5.4 are met.

7.3.5.5 Supplementary test for condensing appliances

The appliance is supplied with one of the reference gases or a distributed gas for the category to which it belongs.

The condensate discharge is blocked.

The appliance is operated with the temperature and heat input conditions specified for the category to which it belongs.

NOTE Artificially filling the condensate discharge system with water may shorten the test.

It is checked that the requirement of 6.5.5 are met.

7.3.5.6 Supplementary test for B_{12} and B_{13} appliances

The tests are carried out with each of the reference gases for the appliance category at the nominal heat input; the appliance is connected to the test flue of the largest diameter stated by the installation instructions.

A first test is carried out with the flue blocked.

A second test is carried out by applying at the top of the test flue a continuous down-draught of speeds 1 and 3 m/s (Figure 5a and 5b).

The test report shall state clearly (e.g. by means of a sketch) the sampling method used.

NOTE The intention of this test is to determine the average value in the flue gases above the heat exchanger.

The combustion products discharge safety device, if installed on the appliance, is put out of operation.

It is checked that the requirement of 6.5.6 are met.

7.3.6 Safety of operation in various temperature environments

7.3.6.1 Temperature operating range

7.3.6.1.1 General

The appliance is installed as described in 7.1.6 and supplied with an appropriate reference gas according to the appliance category (see EN 437:2003+A1:2009, Table 7) at the maximum nominal heat input.

Tests are carried out with the appliance operating in either the cooling mode or the heating mode. Both modes are used if this is in accordance with the appliance design. Each test is carried out at the limits of the declared temperature operating range for that mode of operation, under the conditions given in Table 9.

Table 9 — Temperature operating range

Condition	Temperature at indoor heat exchanger °C	Temperature at outdoor heat exchanger °C
1	Upper limit of use	Upper limit of use
2	Lower limit of use	Lower limit of use

The temperatures are set at the beginning of each test using the test apparatus described in 7.1.6.4 and maintained constant during the tests.

7.3.6.1.2 Cooling mode

7.3.6.1.2.1 Maximum temperature conditions

Ignite the appliance and operate it as given in Table 9 (condition 1) for a period of 1 h. It is then turned off by the appliance control(s) for a period of:

— 3 min; or

— the overrun period given by the appliance control(s) where this is longer than 3 min.

The appliance is then turned on again for a further 1 h period of operation under the same conditions.

7.3.6.1.2.2 Minimum temperature conditions

Ignite the appliance and operate it as given in Table 9 (condition 2) for a period of 2 h.

7.3.6.1.3 Heating mode

Ignite the appliance and operate it as given in Table 9 (condition 1) for a period of at least 20 min. Repeat the test, operating the appliance as given in Table 9 (condition 2).

During each test, it is verified that the operation of the appliance is not stopped by the action of any safety devices.

7.3.6.2 Safety in the event of operation outside the temperature operating range

7.3.6.2.1 General

The appliance is installed as described in 7.1.6 and supplied with an appropriate reference gas according to the appliance category (see EN 437:2003+A1:2009, Table 7) at the maximum nominal heat input. Tests are carried out with the appliance operating in either the cooling mode or the heating mode. Both modes are used if this is in accordance with the appliance design.

Test No. 1 is then carried out, followed, if necessary, by test No. 2.

7.3.6.2.2 Test No. 1

The appliance is ignited and operated in its cooling or heating mode, as appropriate, until thermal equilibrium is achieved under the relevant conditions of operation given in 7.1.6.4.

The flow of heat transfer medium in one of the following heat exchanger circuits is stopped, for example by means of interrupting the electrical supply to the pump or fan concerned, for a period of 1 h.

a) The indoor heat exchanger circuit;

b) the outdoor heat exchanger circuit;

c) the heat recovery circuit, if this exists, but only when the appliance is operating in the cooling mode.

After the 1 h period, the flow of heat transfer medium is restored and the requirements of 6.6.2 are checked.

The appliance is allowed to return to the initial thermal equilibrium conditions and the procedure repeated for each of the above heat exchanger circuits.

If an appliance is capable of operating in the cooling and heating modes, test No. 1 is carried out in one mode and then in the other.

7.3.6.2.3 Test No. 2

This test is only applied when one or more heat exchanger circuits of the appliance are equipped with a safety device, which shuts off the appliance as soon as the flow of the heat exchange medium is stopped. The test is only carried out for the heat exchanger circuits that have such a device.

The appliance is ignited and operated in its cooling or heating mode, as appropriate, until thermal equilibrium is achieved under the relevant conditions of operation given in 7.1.6.4.

Using the test apparatus described in 7.1.6.4, the conditions within the heat exchanger circuit to be tested are altered to achieve the following conditions as appropriate.

a) **Indoor heat exchanger circuit** – a temperature rise at the inlet to the heat exchanger(s) of about 2 °C/min at the upper limit of the temperature operating range.

b) **Outdoor heat exchanger circuit** – a temperature fall at the inlet to the heat exchanger of about 2 °C/min at the lower limit of the temperature operating range.

c) **Heat recovery circuit, if it exists** - a temperature rise at the inlet to the heat exchanger of about 2 °C/min at the upper limit of the temperature operating range when the appliance is operating in the cooling mode.

The appliance is then operated for a period of 1 h. After the 1 h period the initial heat transfer medium conditions are restored and the requirements of 6.6.2 are checked.

The appliance is allowed to return to the initial thermal equilibrium conditions and the procedure repeated, if applicable, for each of the above heat exchanger circuits.

If an appliance is capable of operating in the cooling and heating modes, test No. 2 is carried out in one mode and then in the other.

7.3.7 Overheat cut-off device

7.3.7.1 General

The appliance is installed as described in 7.1.6 and supplied with the appropriate reference gas according to its category (see EN 437:2003+A1:2009, Table 7) at the maximum nominal heat input. The following tests are carried out with the appliance operating in its cooling and/or its heating modes.

7.3.7.2 Test No. 1

Without altering the initial burner adjustment, the gas pressure at the appliance inlet is increased to the maximum test pressure given in 7.1.4.

Before carrying out the test, the test apparatus described in 7.1.6.4 is used to adjust the conditions within the indoor heat exchanger circuit to achieve a temperature rise at the inlet to the heat exchanger(s) of about 2 °C/min at the upper limit of the temperature operating range.

With the appliance initially at the ambient room temperature, ignite the appliance and operate it continuously with the normal appliance control(s) set to achieve the highest temperatures. The appliance is then cycled under the action of any normal appliance control, e.g. thermostat, room thermostat, etc.

During the test it is verified that the overheat cut-off device does not operate to shut off the burner.

7.3.7.3 Test No. 2

For the purposes of this test the appliance shall be fitted with the following:

a) a temperature sensor, e.g. thermocouple, accurate to within ± 2 K. This sensor shall be installed as close as possible to that of the overheat cut-off device in order to monitor the temperature of the vessel in the same way as the overheat cut-off device;

b) a means of monitoring the internal pressure within the heated vessel;

c) an independent means of relieving the internal pressure within the heated vessel.

The test is carried out with any normal means of temperature control put out of action.

Without altering the initial burner adjustment, and with the appliance initially at the ambient room temperature, ignite the appliance and allow it to operate continuously until thermal equilibrium is achieved. The conditions within the indoor heat exchanger circuit are then altered to whichever of the following achieves the more severe conditions:

— with the flow of the heat transfer medium reduced to the minimum flow allowed by any safety device monitoring this flow, or

— with the conditions adjusted to achieve a temperature rise at the inlet to the heat exchanger(s) of about 2 °C/min at the upper limit of the temperature operating range.

These conditions are maintained until the burner is shut off by the overheat device. The temperature of the heated vessel is recorded at the moment when the burner is shut off and, following shut off, until the highest temperature has been achieved.

The initial conditions within the indoor heat exchanger circuit are restored and the overheat device reset as soon as it is possible to do so. The conditions within the indoor heat exchanger circuit are altered again as indicated above and the test repeated, starting from the vessel temperature at which reset of the overheat device is possible.

If either the operating (cut-off) temperature or the highest temperature achieved is higher than first recorded, the test is repeated until the highest temperature(s) are attained. During this test, precautions shall be taken to ensure that a hazardous condition does not arise. In particular, the internal pressure within the heated vessel shall be monitored continuously in order that the burner can be shut off and the vessel pressure relieved if the working pressure is exceeded.

7.3.8 Maximum working pressure of pressurized vessels

7.3.8.1 Heated vessel protected by overheat cut-off device

For the purposes of this test the appliance shall be fitted with the following:

a) a temperature sensor, e.g. thermocouple, accurate to within ± 2 K. This sensor shall be installed as close as possible to that of the overheat cut-off device in order to monitor the temperature of the vessel in the same way as the overheat cut-off device;

b) the above sensor, or a second sensor, shall be connected to a control which serves the same function as the overheat cut-off device. This control shall be adjusted so that it shuts off the burner when the sensor described in a) records a vessel temperature 10 °C higher than the maximum vessel temperature recorded in 7.3.7.3;

c) a means of monitoring the internal pressure within the heated vessel;

d) an independent means of relieving the internal pressure within the heated vessel.

The test is carried out with any normal means of temperature control and the overheat cut-off device put out of action.

The appliance is installed as described in 7.1.6 and supplied with an appropriate reference gas according to its category (see EN 437:2003+A1:2009, Table 7) at the maximum nominal heat input.

With the appliance initially at the ambient room temperature, ignite the appliance and allow it to operate continuously until thermal equilibrium is achieved. The water flow through the heat exchanger is then reduced gradually until the burner is shut off by the sensor and control described in b) above. The temperature of the heated vessel is recorded at the moment when the burner is shut off and, following shut off, until the highest temperature has been achieved.

The internal vessel pressure is monitored throughout the test and the highest pressure achieved is recorded in order to verify the requirements of 6.8.

During this test, precautions shall be taken to ensure that a hazardous condition does not arise. In particular, the internal pressure within the heated vessel shall be monitored continuously in order that the burner can be shut off and the vessel pressure relieved if the maximum working pressure is exceeded.

7.3.8.2 Other pressurized vessels

This test is carried out when a vessel is subjected to increased pressure as a result of pressure relief from a higher pressure vessel.

For the purposes of this test the appliance shall be fitted with the following:

a) a temperature sensor, e.g. thermocouple, accurate to within ± 2 K. This sensor shall be installed as close as possible to that of the overheat cut-off device in order to monitor the temperature of the vessel in the same way as the overheat cut-off device;

b) a means of monitoring the internal pressure within the heated vessel;

c) separate independent means of relieving the internal pressure within the heated vessel and the lower pressure vessel. These devices shall be so designed and arranged that the internal pressure is relieved automatically if the maximum relief pressure for the vessel is exceeded;

d) in addition, means shall be provided to enable the appliance to be operated, monitored and shut off remotely.

The test is carried out with any normal means of temperature control and the overheat cut-off device put out of action.

The appliance is installed as described in 7.1.6 and supplied with an appropriate reference gas according to its category (see EN 437:2003+A1:2009, Table 7) at the maximum nominal heat input.

With the appliance initially at the ambient room temperature, ignite the appliance and allow it to operate continuously until thermal equilibrium is achieved. The water flow through the heat exchanger is then reduced gradually until the heated vessel pressure relief opens. No further reduction in the water flow is made.

The internal pressures within the heated vessel and the lower pressure vessel are monitored continuously during the test. In order to verify the requirements of 6.8, the test is continued after the pressure relief has opened until the internal pressure within the lower pressure vessel has reached its highest value.

During this test, precautions shall be taken to ensure that a hazardous condition does not arise. These precautions include the possibility of rupture of pressurized vessels and for this reason the test is to be controlled remotely.

In particular, the internal pressure within the heated vessel and the lower pressure vessel should be monitored continuously in order that the burner can be shut off and the vessel pressure relieved remotely if:

— the maximum relief pressure of the heated vessel is exceeded, or

— the maximum working pressure of the lower pressure vessel is exceeded.

7.3.9 Pressure relief devices

7.3.9.1 Pressure activated pressure relief devices

7.3.9.1.1 Heated vessel

For the purposes of this test the appliance shall be fitted with the following:

a) a temperature sensor, e.g. thermocouple, accurate to within ± 2 K. This sensor shall be installed as close as possible to that of the overheat cut off device in order to monitor the temperature of the vessel in the same way as the overheat cut off device;

b) a means of monitoring the internal pressure within the heated vessel;

c) separate independent means of relieving the internal pressure within the heated vessel and the lower pressure vessel. These devices shall be so designed and arranged that the internal pressure is relieved automatically if the maximum relief pressure for the vessel is exceeded;

d) in addition, means shall be provided to enable the appliance to be operated, monitored and shut off remotely.

The test is carried out with any normal means of temperature control and the overheat cut off device put out of action.

The appliance is installed as described in 7.1.6 and supplied with an appropriate reference gas according to its category (see EN 437:2003+A1:2009, Table 7) at the maximum nominal heat input.

With the appliance initially at the ambient room temperature, ignite the appliance and allow it to operate continuously until thermal equilibrium is achieved. The flow of the heat transfer medium through the indoor heat exchangers is then reduced gradually until the heated vessel pressure relief opens.

The internal pressure within the heated vessel is monitored continuously during the test and the maximum internal pressure recorded in order to verify the requirements of 6.9.1.

If the pressure from the heated vessel is relieved to a lower pressure vessel, this test may be carried out at the same time as that described in 7.3.9.2.

NOTE During this test, precautions are to be taken to ensure that a hazardous condition does not arise. These precautions include the possibility of rupture of pressurized vessels and for this reason the test is to be controlled remotely.

In particular, the internal pressure within the heated vessel and the lower pressure vessel should be monitored continuously in order that the burner can be shut off and the vessel pressure relieved remotely if:

— the maximum relief pressure of the heated vessel is exceeded, or

— the maximum working pressure of the lower pressure vessel is exceeded.

7.3.9.1.2 Other pressurized vessels

This test is carried out when a vessel is subjected to increased pressures as a result of pressure relief from a higher pressure vessel.

For the purposes of this test the appliance is isolated from the gas supply and all refrigerant is removed. The lower pressure vessel is then fitted with the following:

a) a means of filling (and draining) the vessel with water;

b) a high pressure water tap;

c) a suitable means of monitoring the hydrostatic water pressure within the vessel.

Fill the vessel completely with cold water and then start the pump and gradually increase the internal pressure until the pressure relief device opens.

The maximum internal pressure is recorded in order to verify the requirements of 6.9.1.

7.3.9.2 Temperature activated pressure relief devices

For the purposes of this test the appliance shall be fitted with the following:

a) a temperature sensor, e.g. thermocouple, accurate to within ± 2 K. This sensor is installed as close as possible to the temperature activated pressure relief device in order to monitor its temperature;

b) a means of monitoring the internal pressure within the heated vessel of the refrigerant circuit;

c) separate independent means of relieving the internal pressure within the heated vessel of the refrigerant circuit. This means shall be so designed and arranged that the internal pressure is relieved automatically if the maximum relief pressure for the vessel is exceeded;

d) in addition, means shall be provided to enable the appliance to be operated, monitored and shut off remotely.

The test is carried out with any normal means of temperature control and the overheat cut-off device put out of action.

The appliance is installed as described in 7.1.6 and supplied with an appropriate reference gas according to its category (see EN 437:2003+A1:2009, Table 7) at the maximum nominal heat input.

With the appliance initially at the ambient room temperature, ignite the appliance and allow it to operate continuously until thermal equilibrium is achieved. The flow of the heat transfer medium through the indoor heat exchanger and, if necessary, the outdoor heat exchanger is then reduced gradually until the pressure relief opens.

The temperature of the pressure relief and the internal pressures within the refrigerant circuit are monitored continuously during the test. The maximum temperature and internal pressure at which the pressure relief valve opens are recorded to verify the requirements of 6.9.2.

NOTE During this test, precautions are to be taken to ensure that a hazardous condition does not arise. These precautions include the possibility of rupture of pressurized parts and for this reason the test is to be controlled remotely.

In particular, the internal pressure within the heated vessel of the refrigerant circuit should be monitored continuously in order that the burner can be shut off and the pressure relieved if the maximum relief pressure is exceeded.

7.3.10 Effectiveness of the pre-purge for all appliances

The appliance is installed and adjusted in accordance with the appliance's instructions as specified in 7.1.6.

Without altering the initial burner adjustment the appliance is supplied with the appropriate reference gas(es) (see EN 437:2003+A1:2009, Table 7) at the nominal heat input.

The products of combustion shall be collected as described in 7.3.5, when the appliance has reached equilibrium.

The volume of air available for combustion, V_c (in m^3), is calculated as follows:

$$V_c = (A_s + A_e) Q_g \cdot \frac{T_p}{3600}$$

where

A_s is the stoichiometric air requirement for the fuel (*V/V*);

A_e is the excess air (*V/V*);

Q_g is the gas rate in cubic metres per hour (m^3/h);

T_p is the pre-purge time in seconds (s).

The stoichiometric air requirement for the fuel, A_s, is calculated as follows:

$$A_s = \frac{100}{21}\left[V_{CO_2,P} + \frac{V_{H_2O,P}}{2}\right]$$

The excess air, A_e, is calculated as follows:

$$A_e = \frac{\left(V_{CO_2,P} \cdot 100\right)}{V_{CO_2,M}} - K \cdot \left(A_s + 1\right) - V_{H_2O,P}$$

where

$V_{CO2,P}$ is the volume of carbon dioxide produced by the complete combustion of one cubic metre of reference gas (*V/V*);

$V_{CO2,M}$ is the carbon dioxide concentration measured in the sample of the products of combustion;

$V_{H2O,P}$ is the volume of water produced by the complete combustion of one cubic metre of reference gas (*V/V*);

K is the ratio of the total volume of wet products of combustion and the total volume of gas and air supplied to the appliance.

The values of A_s and K for the reference gases are given in Table 10.

Table 10 — Values for As and K

Reference Gas	G 110	G 120	G 20	G 25	G 30	G 31
A_s	3,67	4,14	9,52	8,19	30,95	23,8
K	0,26	0,32	1	0,86	4	3
	1,02	1,11	2	1,72	5	4
	0,946	0,955	1	1	1,047	1,04

Compare the value of Vc with the measured volume of the combustion circuit.

7.3.11 Weather resistance

Two independent sets of adjustable spray units, each as shown in Figure 8 and Figure 9, are used. Each spray unit is adjustable in height from 2 m to 3 m above the floor and in any lateral direction.

The two spray units are placed in opposition with the spray heads equidistant from the floor and from the appliance under test.

The appliance is installed as described in 7.1.6 on a test platform of such size as to accommodate the appliance easily and supplied with the reference gas corresponding to the appliance category at the normal pressure.

The spray heads are set to operate at 350 mbar and the units adjusted to varying elevations and horizontal distances from the appliance to determine the most critical location. Exposure at the location deemed to be most critical is maintained throughout the test.

After adjustment of the spray units, any ignition burner is ignited and the test applied for a period of 15 min. The main burners are then ignited and the test continued for a further 15 min.

The test is repeated with the appliance located in any other position relative to the spray units as may be required.

7.3.12 NO_x Measurement

7.3.12.1 General

The NO_x measurements are carried out when the appliance is at thermal equilibrium, conforming with details given in CR 1404.

For flueless appliances, CR 1404 is to be applied, flue gas samples are to be taken before dilution.

The following symbols are used throughout this section and in Annex C:

Q_{min} the minimum modulating heat input, expressed in kilowatts (kW);

Q_n the nominal heat input, expressed in kilowatts (kW - NCV);

Q_{pi} the partial heat input for weighting, expressed in percent of Q_n;

F_{pi} the weighting factor corresponding to the partial heat input Q_{pj};

$NO_{x,pond}$ the weighted value of the NOx concentration, in milligrams per kilowatt-hour (mg/kWh);

$NO_{x,mes}$ the measured (and possibly corrected) value:

— at the partial heat input: $NO_{x,mes}$ (70)', $NO_{x,mes}$ (60), $NO_{x,mes}$ (40), $NOx_{,mes}$ (20)

— at the minimum heat input (modulating appliances): $NO_{x,mes}$,Q_{min}

— at the heat input corresponding to a single rate: $NO_{x,mes\ (rate)}$;

$Q_{high\ rate}$ the rate greater than Q_{pi};

$Q_{low\ rate}$ the rate less than Q_{pi};

$F_{phigh\ rate}$ the apportioned weighting factor, high rate;

$F_{plow\ rate}$ the apportioned weighting factor, low rate.

GUEh is the gas utilization efficiency in heating mode calculated according to EN 12309-4:2014, 4.2.6.1, at working point conditions of:

— A7W45 for air source appliance in heating mode (Table 7);

— A20W45 for exhaust air source appliance in heating mode (Table 7);

— W10W45 for water source appliance in heating mode (Table 7);

— B0W45 for brine source appliance in heating mode (Table 7);

— B7W45 for hybrid brine source appliance in heating mode (Table 7);

— B12W45 for hybrid solar collector source appliance in heating mode (Table 7).

The appliance is installed as indicated in 7.1.6.

For appliances intended to use second family gases, the tests are carried out with reference gas G 20.

For appliances intended to use only G 25, the tests are carried out with reference gas G 25.

For appliances intended to use only third family gases, the tests are carried out with reference gas G 30 and the limit NOx value is multiplied by a factor of 1,30.

For appliances intended to use propane only, the tests are carried out with reference gas G 31 and the limit NOx value is multiplied by a factor of 1,20.

The appliance is adjusted to its nominal heat input for a flow water temperature of 45 °C and a return temperature of 35 °C. Air temperature condition, if any, is specified below.

For measurements at partial heat inputs lower than the nominal heat input Q_n the return water temperature T_r is calculated as a function of the particular heat input using the following formula:

$$T_{\text{return}} = 0,15 \times \text{Q} + 20$$

where

T_{return} is the return water temperature, expressed in degrees Celsius (°C)

Q is the partial heat input, expressed in percent of Q_{n}.

The water flow is kept constant, flow temperature is a free variable.

The NOx measurements are carried out when the appliance is at thermal equilibrium, conforming with details given in CR 1404.

No wet meters are used.

The reference conditions for the combustion air are:

— temperature: 20 °C;

— relative humidity: 10 g H_2O /kg air.

If the test conditions are different to these reference conditions, it is necessary to correct the NOx values as specified below.

$$NO_{x,0} = NO_{x,m} + \frac{0,02 \times NO_{x,m} - 0,34}{1 - 0,02(h_m - 10)} \cdot (h - 10) + 0,85 \times (20 - T_m)$$

where

$NO_{\text{x,m}}$ is the NO_{x} measured at h_{m} and T_{m} in milligram per kilowatt-hour (mg/kWh) in the range 50 mg/kWh to 300 mg/kWh;

h_{m} is humidity during the measurement of $NO_{\text{x,m}}$ in g/kg in the range 5 g/kg to 15 g/kg;

T_{m} is the temperature during the measurement of $NO_{\text{x,m}}$ in °C in the range 15 °C to 25 °C;

$NO_{\text{x,0}}$ is the value of NO_{x} corrected to the reference conditions expressed in milligram per kilowatt-hour (mg/kWh).

Where appropriate, the measured NO_{x} values are weighted in accordance with 7.3.12.2.

It is checked that the weighted NO_{x} values comply with the values of Table 4, depending on the NO_{x} class chosen.

For the calculation of conversions of NO_{x} see Annex B.

7.3.12.2 Weighting

The weighting of the NO_{x} measured values shall be as described in Annex C, on the basis of the values in Table 11.

Table 11 — Weighting factors

Partial heat input Q_{pi} as a % of Q_n	70	60	40	20 if applicable
Weighting factor F_{pi}	0,15	0,25	0,30	0,30
Return water temperature	31	29	26	23

For range rated appliances Q_n is replaced by Q_a, the arithmetic mean of the maximum and minimum declared heat input.

7.3.12.3 On/off appliances

The NO_x concentration is measured at the nominal heat input, Q_n.

$NO_x = NO_x\ (Q_n)$

7.3.12.4 Appliances with several rates

The NO_x concentration is measured at the partial heat input corresponding to each of the rates and weighted in accordance with Annex C. If necessary, the weighting factor specified in Annex C is recalculated for each rate as specified below.

If the heat inputs of two rates are between the partial heat inputs specified in Table 11, it is necessary to apportion the weighting factor between the heat inputs of the higher and lower rates, as follows:

$$F_{p,highrate} = F_{pi} \bullet \frac{Q_{pi} - Q_{lowrate}}{Q_{highrate} - Q_{lowrate}} \bullet \frac{Q_{highrate}}{Q_{pi}}$$

$$F_{p,lowrate} = F_{pi} - F_{p,highrate}$$

If the heat inputs of two rates cover more than one partial heat input specified in Table 11, then it is necessary to apportion each weighting factor between the heat inputs of the higher and lower rate as indicated above.

The weighting NO_x value is then equal to the sum of the products of the measured NO_x values at the different rates, NO_x mes(rate), multiplied by their weighting factor, calculated as specified above:

$$\mathrm{NO_{x,\,pond}} = \sum (\mathrm{NO_{x,\,mes(rate)}} \times F_{\mathrm{P,\,rate}})$$

NOTE See calculation example in Annex C.

7.3.12.5 Modulating appliances in which the minimum modulating heat input is less than or equal to 20 % of the nominal heat input

The NO_x concentration is measured at the partial heat inputs specified in Table 11.

The NO_x value is weighted as specified below:

$$NO_{x,pond} = \left(0{,}15 \times NO_{x,mes(70)} + 0{,}25 \times NO_{x,mes(60)} + 0{,}30 \times NO_{x,mes(40)} + 0{,}30 \times NO_{x,mes(20)}\right)$$

7.3.12.6 Modulating appliances in which the minimum modulating heat input is greater than 20 % of the nominal heat input

The NO_x concentration is measured at the minimum modulating rate and at the partial heat inputs Q_{pi} specified in Table 11, which are greater than the minimum modulation rate.

The weighting factors for the partial heat inputs in Table 11, which are no greater than the minimum modulation rate are added and multiplied by this heat input.

The NO_x value is therefore weighted as follows:

$$NO_{x,pond} = NO_{x,mesQ\min} \cdot \sum F_{pi}\left(Q \le Q_{\min}\right) + \sum \left(NO_{x,mes} . F_{pi}\right)$$

7.3.12.7 NO_x concentrations on GCV basis

$NO_{x,pond,GCV}$ based on GCV is determined in accordance with 7.3.12.1 shall be calculated according following equation:

$$NO_{x,pond,GCV} = \frac{H_i}{H_s} \times NO_{x,pond}$$

with

$NO_{x,pond,GCV}$	the weighted value of the NOx concentration, in milligrams per kilowatt-hour (mg/kWh) on a GCV basis;
$\frac{H_i}{H_s}$	the ratio of the Net to Gross Calorific Value for the appropriate gas family taken from Annex D.

7.3.12.8 NO_x concentrations on heat output basis

Alternative method for expressing the NO_x concentration is to define it on the heat output basis. The formulas are the followings:

a) For the on/off appliance, with Q_n, the nominal heat input

$$\mathrm{NO_{x,\,pond}} = \frac{NO_{x(Q_n)}}{GUE_h}$$

b) For appliances with several rates:

$$\mathrm{NO_{x,\,pond}} = \sum (\mathrm{NO_{x,\,mes(rate)}} \times F_{\mathrm{P,\,rate}})/\mathrm{GUE_h}$$

c) For modulating appliances in which the minimum modulating heat input is less than or equal to 20 % of the nominal heat input::

$$NO_{x,pond} = \frac{\left(0{,}15 \times NO_{x,mes(70)} + 0{,}25 \times NO_{x,mes(60)} + 0{,}30 \times NO_{x,mes(40)} + 0{,}30 \times NO_{x,mes(20)}\right)}{GUE_h}$$

d) For modulating appliances in which the minimum modulating heat input is greater than 20 % of the nominal heat input:

$$NO_{x,pond} = \frac{\left(NO_{x,mesQ\min} \cdot \sum F_{pi}\left(Q \le Q_{\min}\right) + \sum\left(NO_{x,mes} . F_{pi}\right)\right)}{GUE_h}$$

7.3.13 Combustion product temperature

The appliance is installed as specified in the general test conditions as applicable, and supplied with one of the corresponding reference gases for the appliance category at the nominal heat input. The use of an actually distributed gas, appropriate to the appliance category, is permitted.

Type B appliances are connected to a 1 m test flue and type C appliances are fitted with the shortest ducts specified in the appliances instructions.

The control thermostat or control temperature set point in electronic temperature control system is put out of operation.

Where fitted the control to limit the temperature of combustion products remains in operation.

The temperature of the combustion products is progressively raised, either by increasing the gas rate or by another means which increases the temperature (e.g. removal of baffles) as specified. The temperature rise shall be within the range 1,0 K/min and 3,0 K/min.

It is verified that the requirement of 6.14 is fulfilled.

7.3.14 Supervision of the combustion air rate or the combustion products rate

7.3.14.1 Air proving

The test is carried out when the appliance is at thermal equilibrium, either at the nominal heat input, or for modulating appliances at the maximum and minimum heat input and the heat input corresponding to the arithmetic mean of these two inputs. When several rates are provided, supplementary tests are needed at each of these rates.

The CO and CO_2 concentrations are measured continuously.

The means of carrying out the blockage shall not give rise to recirculation of the products of combustion.

It is checked that for each of the 3 methods of flow reduction at least one of the alternative requirements of 5.1.8.2 is met.

7.3.14.2 Gas air/ratio control

The test is carried out when the appliance is at thermal equilibrium, either at the nominal heat input, or for modulating appliances at the maximum and minimum heat input.

When several rates are provided, supplementary tests are needed at each of these rates.

The CO and CO_2 concentrations are measured continuously.

The means of carrying out the blockage shall not give rise to recirculation of the products of combustion.

It is checked that for each of the 3 methods of flow reduction at least one of the alternative requirements of 5.1.9.3 is met.

7.3.15 Leakage of control tubes

The appliance is installed as stated in 7.1.6.4 and supplied with the reference gas at its nominal heat input. The above requirements are checked under the various situations that could occur, in particular:

— simulated leak from the air pressure tube;

— simulated leak from the combustion vessel pressure tube;

— simulated leak from the gas pressure tube.

It is checked that the requirement of 5.1.9.2 are met.

7.3.16 Adjustment of the gas/air ratio

The test conditions 7.3.14.2 shall be repeated under the following conditions:

a) adjust the CO_2 at maximum heat input to the maximum CO_2 value and at the minimum heat input to the minimum CO_2 value;

b) adjust the CO_2 at maximum heat input to the minimum CO_2 value and at the minimum heat input to the maximum CO_2 value.

It is checked that under these conditions the requirements of 5.1.9.4 are met

7.3.17 Flame ignition and safety time T_{SA}

The appliance is supplied successively with each of the reference gases for the appliance category

The ignition safety time T_{SA} is checked with reference gas, the appliance being adjusted to its nominal heat input under extreme conditions of electrical supply and temperature, (at ambient temperature and at thermal equilibrium).

It is checked that under these conditions the requirements of 5.6 are met.

7.3.18 Discharge of condensate

By measurements, visual inspection or manual tests it is checked whether the requirements for the condensate discharge are fulfilled. It is checked that under these conditions the requirements of 5.15.1 are met.

8 Marking and instructions

8.1 Appliance marking

8.1.1 Data plate

Each appliance shall carry an indelible data plate, which is visible on installation, possibly after the removal of part of the case, which is solidly fixed and durable, The indelibility of markings shall be checked by a test carried out in accordance with EN 60335-1:2006, 7.14.

The data plate shall carry at least the following information:

— the manufacturer's name[3)] or his identifying symbol;

3) Manufacturer means the organization or company which assumes responsibility for the product.

— the trade name of the appliance;

— fixing the CE mark and the code of the surveillance notified body;

— the last two digits of the year in which the CE marking was affixed;

— the serial number and optional the year of manufacture;

— the country(ies) of destination, in accordance with EN ISO 3166-1;

— the appliance category(ies) in relation to the direct countries of destination. Any category shall be specified in accordance with EN 437:2003+A1:2009;

— the gas supply pressure in millibar, if several normal pressures can be used for the same gas group. They are indicated by their numerical value and the unit ”mbar”;

— the appliance type(s) shall be specified in accordance with CEN/TR 1749;

— the nominal output or, for range-rated appliance, the maximum and minimum useful outputs in kilowatts, either heating or cooling output (in kW) in accordance with EN 12309-5:2014, 4.1;

— the nominal heat input or, for range-rated appliance, the maximum and minimum heat inputs in kilowatts, given by the symbol ”Q_n“, followed by the equals sign, the numerical value(s) and the unit ”kW”;

— the maximum water pressure at which the appliance can be used, in bars given by the symbol ”PMS“, followed by the equals sign, the numerical value and the unit ”bar”;

— the electrical supply;

— the nature of the electrical supply given by the symbol “~” or ” = ”;

— the rated voltage of the electrical supply in Volts given by the numerical value followed by the unit ”V”;

— the rated power input in Watts given by the numerical value followed by the unit ”W”;

— the nature of heat transfer medium, including any additives;

— the flow rate and max pressure of the heat transfer medium;

— the working fluids, their quantities, their type according to EN 378-3 and, where appropriate, a safety sign in accordance with ISO 3864-2;

8.1.2 Supplementary markings

8.1.2.1 General

On an additional plate, the appliance shall carry visible and indelible information relating to its state of adjustment. The indelibility of markings shall be checked by a test carried out in accordance with EN 60335-1:2006, 7.14.

The additional plate shall carry at least

— the direct country(ies) of destination in accordance with the symbols in EN ISO 3166-1;

— the gas group or range, the symbol of gas type, the gas supply pressure and/or the pressure couple in accordance EN 437.

This information may be carried on the data plate.

8.1.2.2 Type B appliances

The appliance shall be marked with the following text:

“This appliance shall be installed in accordance with the rules in force, and used only in a sufficiently ventilated space. Consult instructions before installation and use of this appliance.”

In the case of appliances of Type B_{12}, Type B_{13}, the appliance shall be marked with the following statement, or with equivalent wording indicating the same restriction in use.

“This appliance is not suitable for installation and use inside domestic residential dwellings or inside any room in which people live.”

8.1.2.3 Type C appliances

The appliance shall be marked with the following text:

“This appliance shall be installed in accordance with the rules in force, and used only in a sufficiently ventilated space. Consult the instructions before installation and use of this appliance.”

8.1.2.4 Outdoor appliances

For an appliance that is designed specifically for outdoor use, the appliance shall be marked with the following text: “This appliance is for outdoor use only.”

8.1.3 Packaging

The packaging shall carry the category(ies), the appliance type and information given on the additional data plate (see 8.1.2) as well as warnings in accordance with 8.1.4.

In addition, the appliance shall be marked with the following text.

“This appliance must be installed in accordance with the rules in force, and used only in a sufficiently ventilated space. Consult instructions before installation and use of this appliance.”

In the case of appliances of Type B_{12}, Type B_{13}, the appliance shall be marked with the following statement, or with equivalent wording indicating the same restriction in use:

“This appliance is not suitable for installation and use inside domestic residential dwellings or inside any room in which people live.”

For an appliance that is designed specifically for outdoor use, the appliance shall be marked with the following text: “This appliance is for outdoor use only.”

8.1.4 Warnings on the appliance and the packaging

One or more labels shall give at least the following warnings, such that they are visible and readable:

— read the technical instructions before installing the appliance;

— read the user‘s instructions before lighting the appliance.

8.1.5 Other information

No other information shall be carried on the appliance or the packaging if it is likely to create confusion in relation to the actual state of adjustment of the appliance, the corresponding category(ies) and the direct country(ies) of destination in accordance with EN ISO 3166-1.

8.2 Instructions

8.2.1 Technical instructions

8.2.1.1 Introduction

Each appliance shall be accompanied by technical instructions intended for installation.

These instructions shall at least include the following instructions stated in 8.2.1.2 to 8.2.1.5.

8.2.1.2 General

— the information on the data plate, with the exception of the serial number and the year of manufacture (see 8.1.1);

— the meaning of the symbols used on the appliance and its packaging, in accordance with 8.1.1 and 8.1.3;

— reference to certain standards and/or particular regulations if these prove to be necessary for the correct installation and use of the appliance;

— information, if necessary (see 6.3.2 and 6.3.3) about the minimum distances to be met from inflammable materials;

— that walls sensitive to heat, for example wood, shall be protected by suitable insulation;

— that the clearance between the appliance installation and any surroundings walls are observed;

— a general description of the appliance, with an illustration of the principal parts (sub-assemblies) which shall be removed to rectify operational faults;

— for electrical installation;

— the obligation to earth appliances incorporating mains supplied electrical equipment;

— a circuit diagram with terminals (including those for external control);

— the recommended method for cleaning the appliance;

— the servicing necessary and the recommended service interval;

— indication that, following installation of the appliance, the user shall be instructed about the operation of the appliance and the safety devices and shall be given at least the user‘s instructions;

— that the appliance is intended exclusively to be installed on a gas supply with a meter with gas pressure regulator, where applicable;

— the NOx class of the appliance;

— reference to the national and/or local regulations for the discharge of condensate, in particular instructions for condensing appliances where a condensate neutralization system is necessary.

8.2.1.3 For installation and adjustment of the gas circuit

a) checks that the information of 8.1.2 concerning the state of adjustment given on the data plate or on the additional data plate shall be compatible with the local supply conditions;

b) adjustment instructions for appliances which are adjustable during installation, incorporating an adjustment table in which the volume or mass rates are stated in m^3/h or kg/h, or the burner pressure in relation to the possible adjustment data in accordance with the category(-ies). The reference conditions are 15 °C, 1 013,25 mbar, dry gas;

c) for appliances capable of operating on several gases, information of the operations required to convert from one gas to another and indication that the adjustments and modifications shall only be carried out by a qualified professional or competent person; when an adjustment is carried out during installation the adjuster shall be sealed after the adjustment.

8.2.1.4 For installation on the central heating circuit

a) information about the maximum water temperature in °C;

b) an indication of the controls which can be used;

c) the precautions to be taken to limit the level of operating noise of the installation;

d) for sealed water loop systems, instructions concerning the installation of a pressurized expansion vessel when the appliance is not originally fitted with such a device;

e) information on:

— either the characteristic curve of the water pressure head available at the appliance outlet connection if the appliance has an integral pump;

— or the pressure loss as a function of water rate, in graphical or tabular form, for an appliance supplied without a pump.

8.2.1.5 For installation of the combustion circuit

a) information about the type of installation for which the appliance is approved;

b) the instruction that the appliance has to be installed with the necessary accessories (e.g. ducts, terminal, fitting piece) supplied with the appliance or give the specification of the necessary accessories that shall be applied;

c) the instruction for the installation of parts intended to be fitted to the appliance;

d) information necessary to connect the appliance to a flue system or to design the flue system;

e) detailed specifications for the means of discharging the combustion products and any condensate. Attention shall be drawn to the necessity of avoiding horizontal runs in the flue gas duct and the condensate draining duct, furthermore the minimum slope for these ducts shall be indicated;

f) for type C appliance, the measures to be taken to avoid continuous discharge of condensate from the terminal;

g) when the appliance complies with the requirements of 5.15.2 and 7.3.13 for combustion products temperature, the flue ducts and accessories to be used shall be either specified or supplied, otherwise it shall be specified that the appliance is not intended to be connected to flues that are likely to be affected by heat (e.g. plastic ducts or ducts with internal plastic coatings).

8.2.2 User's instructions

Each appliance shall be accompanied by instructions intended for the user. They shall include the necessary information on using and maintaining the appliance and incorporate at least the following:

a) point out that a qualified professional or competent person should be called on to install, convert and adjust the appliance where appropriate;

b) specify the operations to start up and stop the appliance;

c) for appliances with manual ignition, mention the precautions to be taken before carrying out new ignition attempts;

d) specify that it is necessary to abide by the warnings;

e) explain the operations necessary for normal operation, cleaning and day-to-day maintenance of the appliance;

f) explain any precautions to be taken against frost;

g) warn against incorrect use;

h) forbid any interference with a sealed component;

i) point out that the appliance should be checked and maintained periodically by a qualified professional or competent person;

j) if necessary, draw the user‘s attention to the risks of burning if in direct contact with the viewing window or its immediate surroundings;

k) the instructions shall state that condensate outlet(s), if any, shall not be modified or blocked and shall include instructions relating to the cleaning and servicing of any condensate neutralization system.

8.2.3 Conversion instructions

Parts intended for conversion to another gas family, another group, another range and/or another supply pressure, shall be accompanied by conversion instructions intended for the specialist.

The instructions shall:

a) specify the parts necessary to carry out the conversion and their means of identification;

b) clearly specify the operations necessary to change the parts and make the correct adjustment, where appropriate;

c) specify that any broken seals shall be re-made and/or any adjusters shall be sealed;

d) state that for appliances operating with a pressure couple, any regulator shall either be made inoperative within the range of normal pressures, or be put out of operation and sealed in that position.

A self-adhesive label, which is intended to be fitted on the appliance, shall be supplied with the parts and the conversion instructions. It shall be possible to state on this label the marking specified in 8.1.2, indicating:

— the gas group or range;

— the gas type;

— the gas supply pressure and/or the pressure couple;

— the adjusted heat input, where appropriate.

8.3 Presentation

All the information of 8.1 and 8.2 shall be given in the language(s) and in accordance with the rules of installation in the countries in which the appliance is to be installed.

8.4 Supplementary marking and instructions in the case of appliances to be installed outdoor or in partially protected places

8.4.1 General information

For appliances intended to be installed outdoor or in a partially protected place the minimum declared installation temperature, and if necessary the maximum declared installation temperature, shall be indicated.

8.4.2 Warning on the appliance and the packaging

Additional to the existing requirements of 8.1.5 the information shall be added that the appliance is intended to be installed outdoor or in a partially protected place.

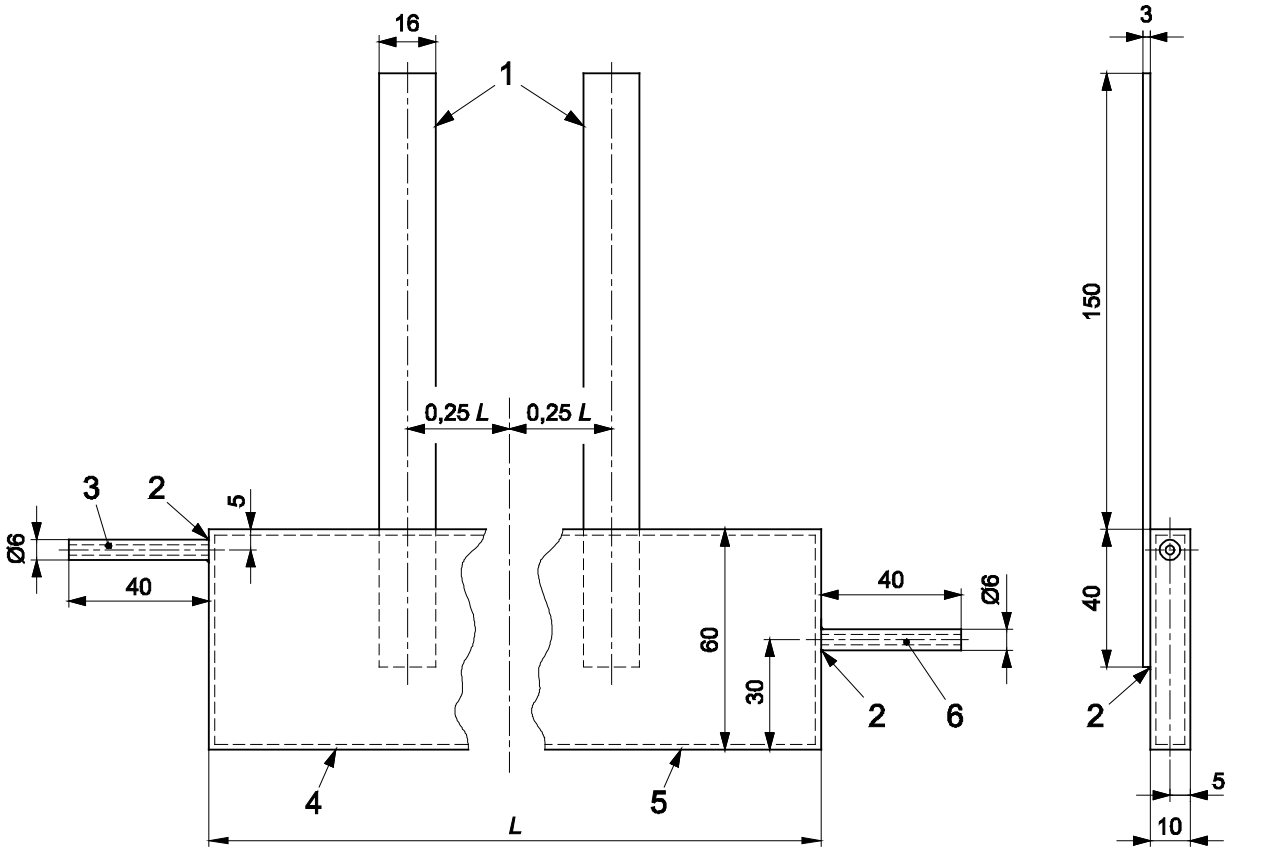
8.4.3 Technical instructions

Additional to the existing requirements of 8.2 more information shall be added concerning the installation outdoor or in a partially protected place. All necessary instructions and requirements for a correct installation location, including exterior pipe work, shall be specified.

The frost protection system, if any, shall be described in general terms in the technical instructions. It shall be included in the technical instructions that materials used in the installation of the appliance should be such as to maintain their function within the declared installation temperatures (see 8.4.1).

9 Figures

All dimensions in millimetres



Key

1 brass, dull nickel plate

2 braze

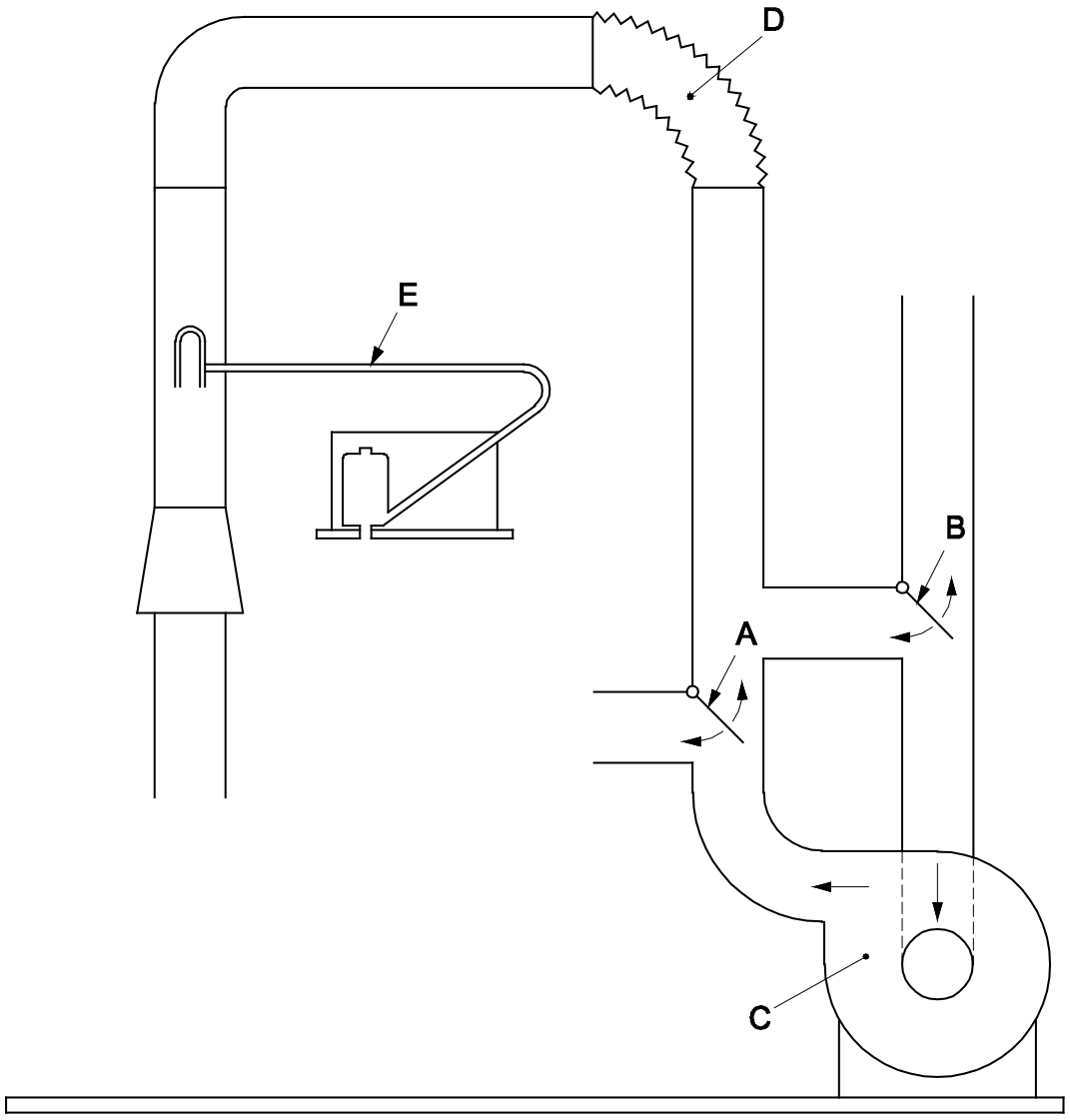
3 water outlet

4 1 mm thick hard brass rhodium plated

5 surface to be highly polished and free from wrinkles

6 water inlet

Figure 1 — Leakage indicator



Key

A	diverter	valve to obtain downdraught or up draught
B	diverter	valve to obtain downdraught or up draught
C	fan	
D	flexible	
E	velocity measurement by means of a Pitot tube	

Figure 2 — Test of an appliance under abnormal draught conditions

α = 0° (horizontal winds) + 30° and - 30°

β = 0° (glancing winds) 15°, 30°, 45°, 60°, 75°, 90° (perpendicular to the test walls)

When the terminal is not symmetrical, the tests are continued with the following incident angles: 105°, 120°, 135°, 150°, 165°, 180°.

Angle β may be varied either by modification of the position of the wind generator (fixed wall) or by rotation of the test wall about a central vertical axis.

The test walls consists of a strong vertical wall at least 1,8 m square with a removable panel at its centre. The terminal of the appliance is mounted so that its geometric centre is at the centre O of the test wall, and its projection from the wall is as recommended in the instructions.

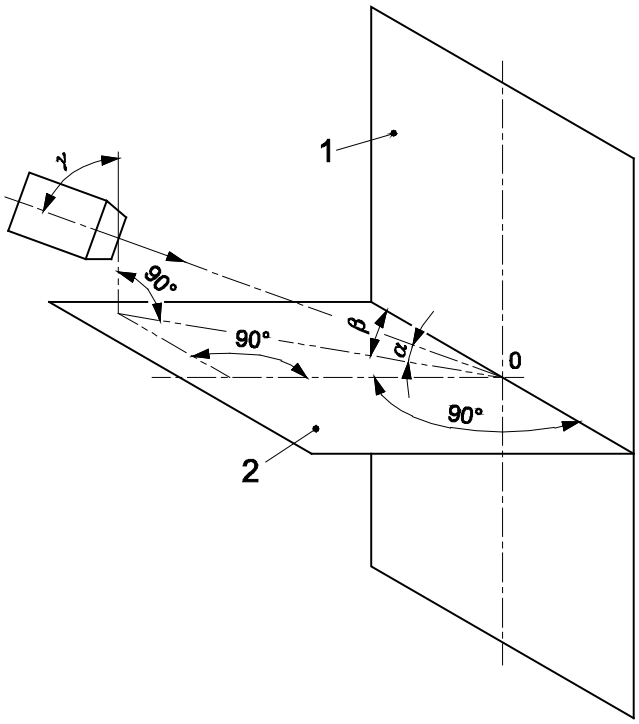
The characteristics of the wind generator and the distance from the test wall at which it is placed are chosen such that the following criteria are met at the level of the test wall, after the central panel has been removed:

— the wind front is either approximately 90 cm square or of circular section with a diameter of 60 cm;

— wind speeds of 1 m/s, 2,5 m/s and 12,5 m/s can be obtained, with an accuracy of 10 %, over the whole of the wind front;

— the wind stream is essentially parallel and has no residual rotational movement.

When the central removable panel is not large enough to allow checking of these criteria, they are checked without the wall and measured at a distance corresponding to the distance existing in practice between the test wall and the wind generator discharge nozzle.



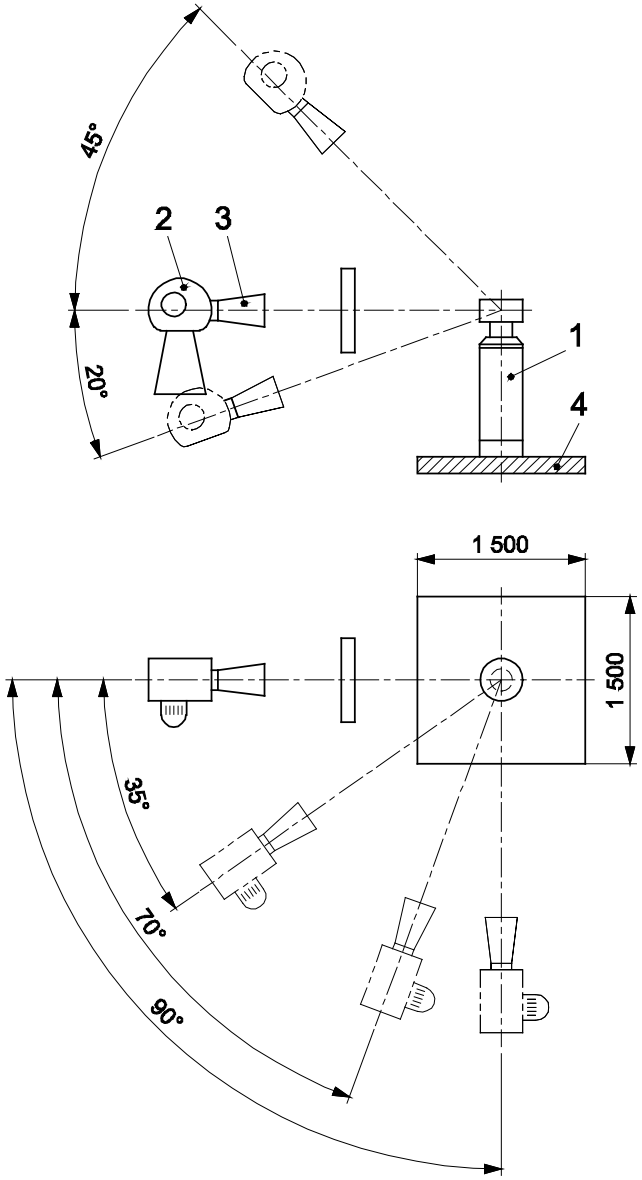
Key

1 vertical

2 horizontal

Figure 3 — Test apparatus for type C_1 appliances

Dimensions in millimetres



Key

1 combustion air intake and flue outlet

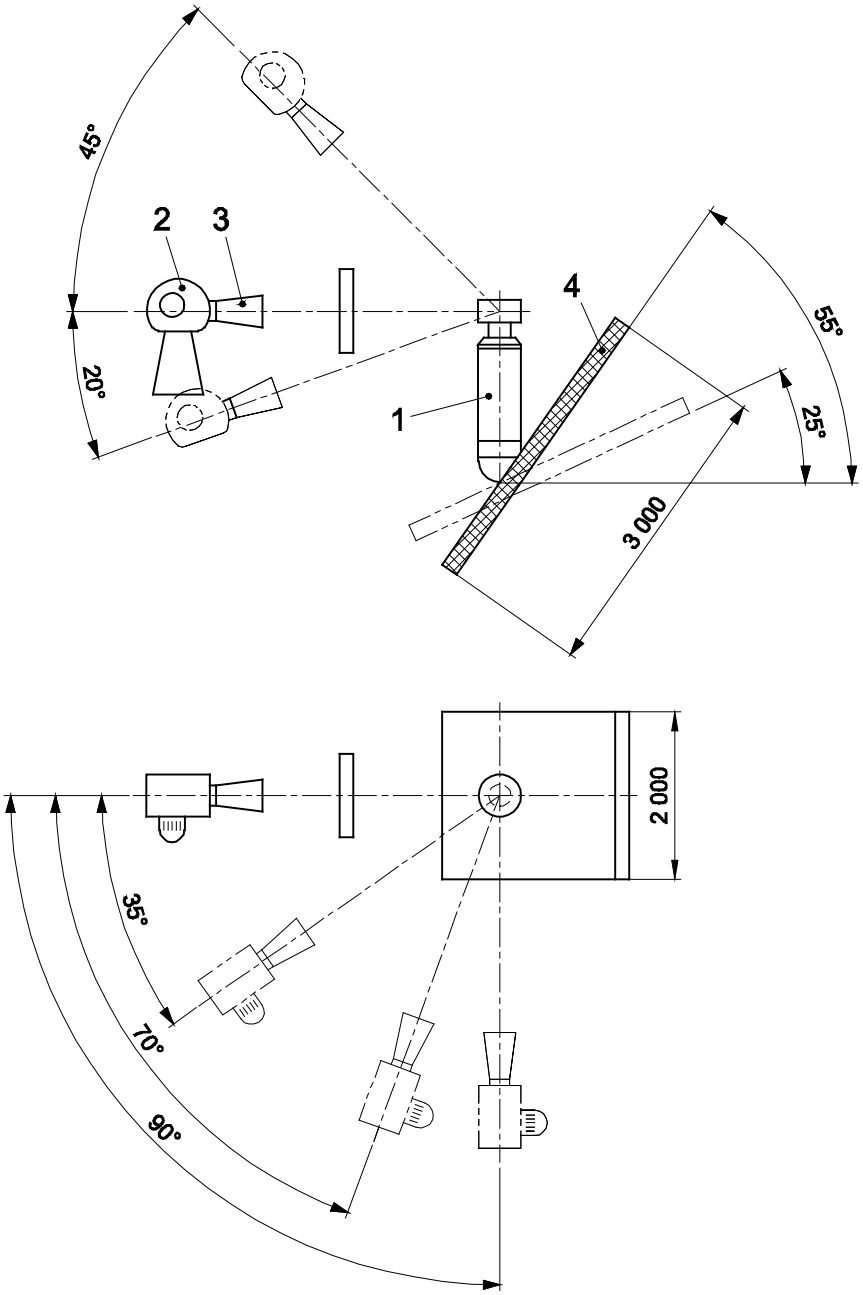
2 fun

3 diffuser

4 test surface

Figure 4a — Test apparatus for type C_3 appliances - flat roof

Dimensions in millimetres



Key

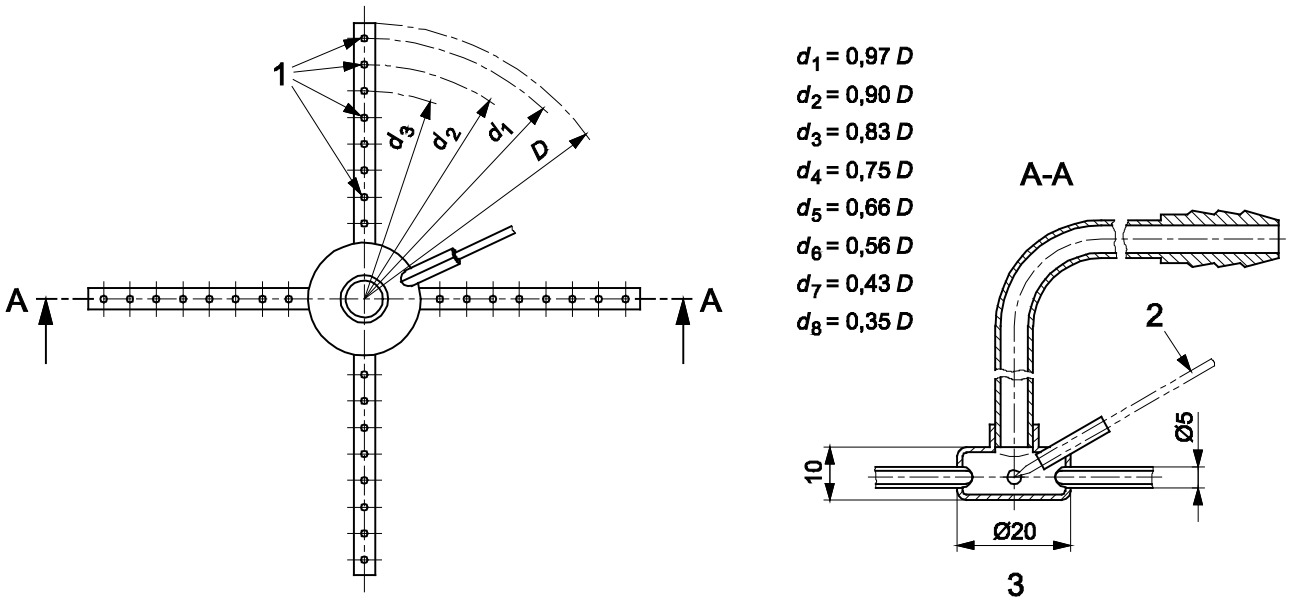
1 combustion air intake and flue outlet

2 fun

3 diffuser

4 test surface

Figure 4b — Test apparatus for type C_3 appliances - angled roof



Key

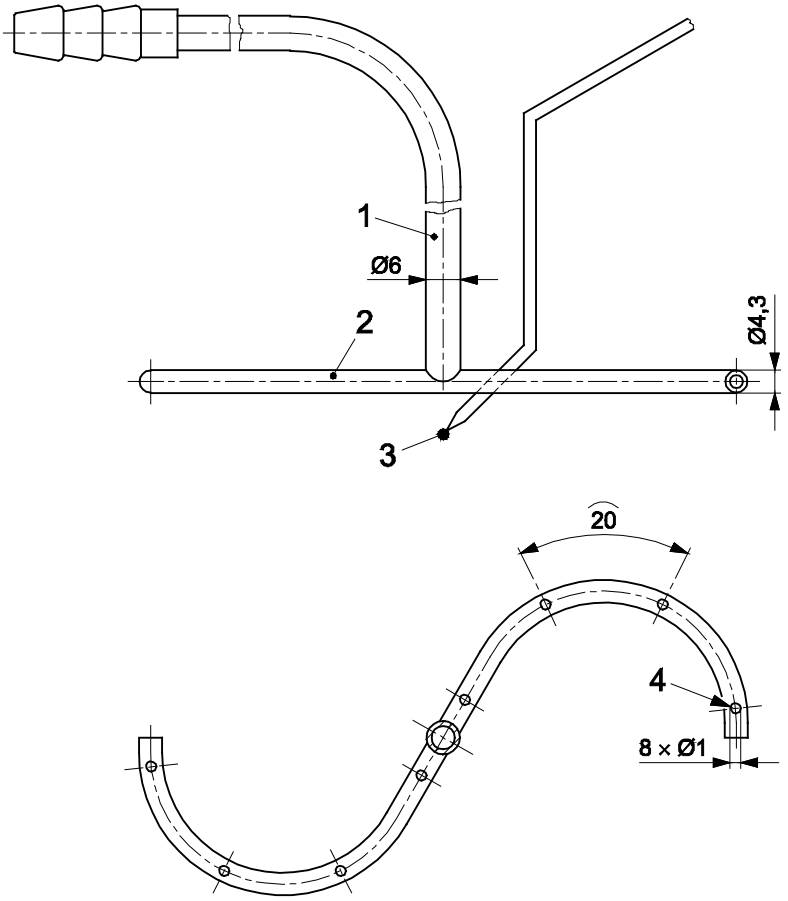
1 holes in each branch 8 x ø 1

2 thermocouple

3 sampling probe

Figure 5a — Sampling probe for type B appliances: sampling probe for test flues of diameter equal or greater than DN 100

Dimension in millimetres



Key

1 tube ø 6

2 tube ø 4,3

3 thermocouple

4 holes: 8 x ø 1

Figure 5b — Sampling probe for type B appliances: sampling probe for test flues of diameter less than DN 100

NOTE 1 The material is stainless steel with a polished finish.

NOTE 2 Dimension is to be chosen according to the diameter of the air inlet duct and its insulation.

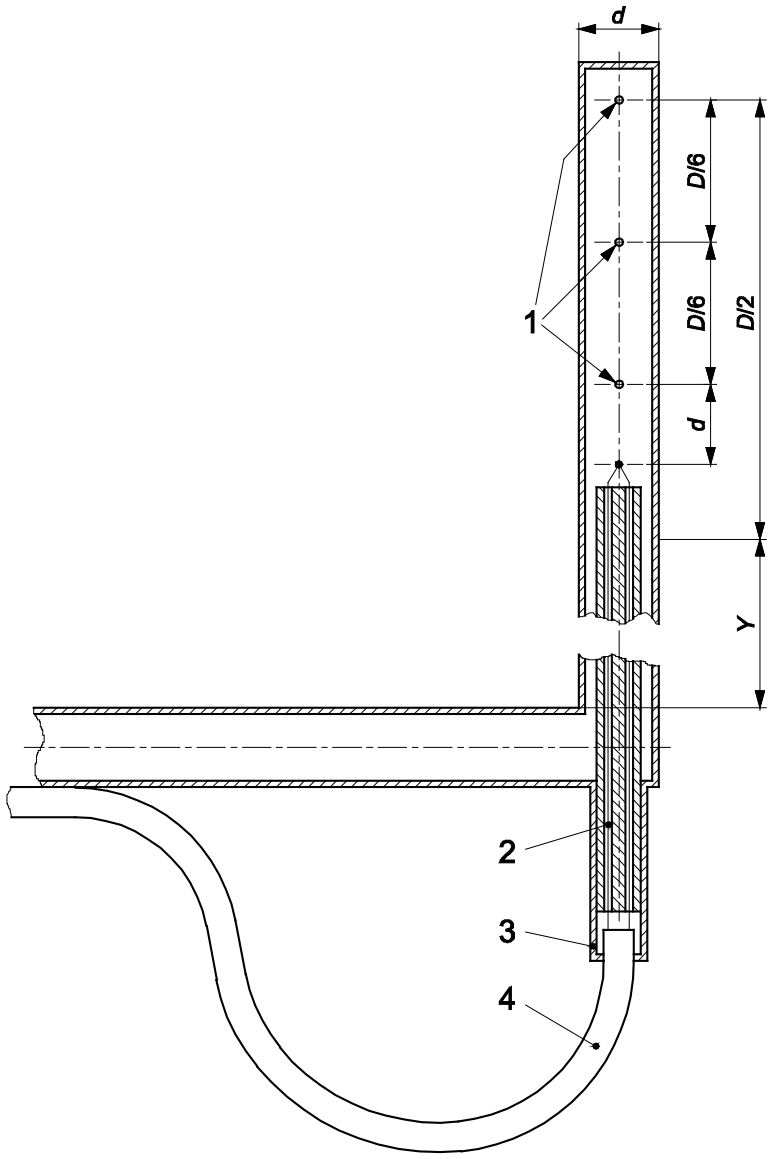
NOTE 3 Dimensions for 6 mm diameter probe (suitable for products outlet ducts of diameter (*D*) over 75 mm) are as follows:

outside diameter of probe (*d*)	6 mm
wall thickness	0,6 mm
diameter of sampling holes (*x*)	1,0 mm
twin bore ceramic sleeve	ø 3 mm × 0,5 mm bore
thermocouple wire	ø 0,7 mm

For products outlet ducts less than 75 mm diameter a smaller probe is used with *d* and *x* chosen such that:

a) the area obstructed by the probe is less than 6 % of the cross section of the duct;

b) the total area of the sampling holes is less than three quarters of the cross section of the probe.



Key

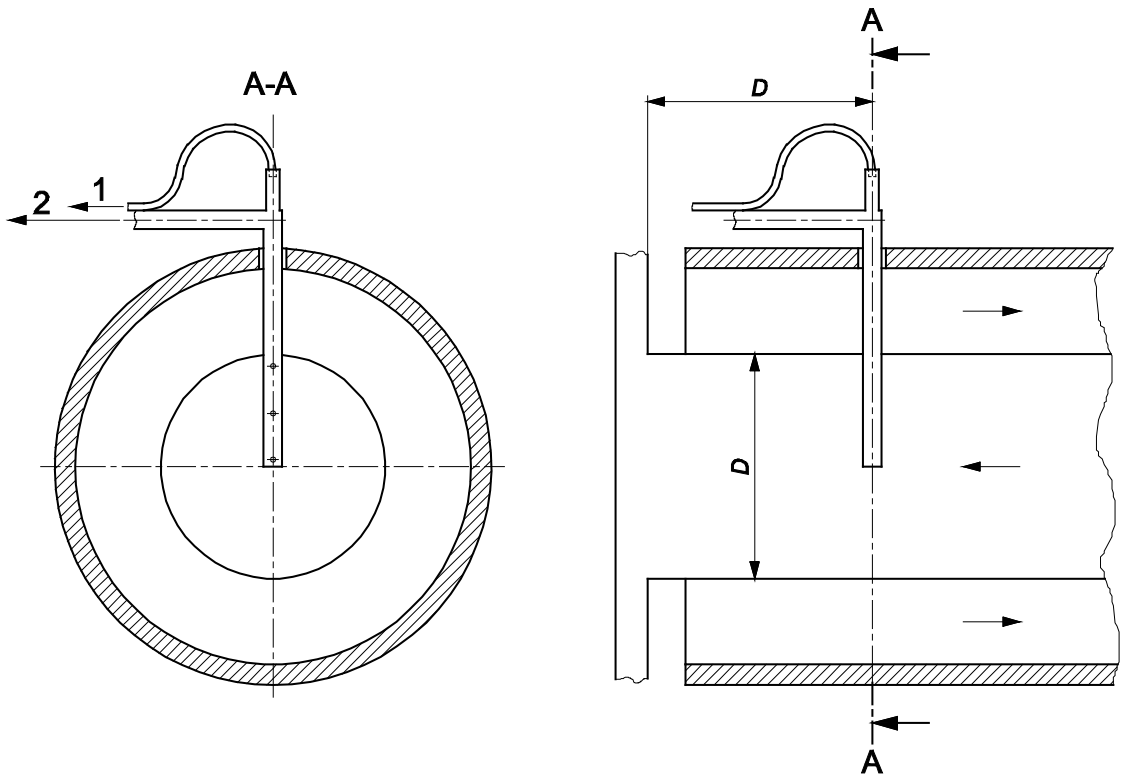
1 3 sampling holes ø x mm

2 twin bore ceramic sleeve

3 insulating cement

4 chromel / alumel thermocouple wire

Figure 6 — Sampling probe for type C_1 and C_3 appliances

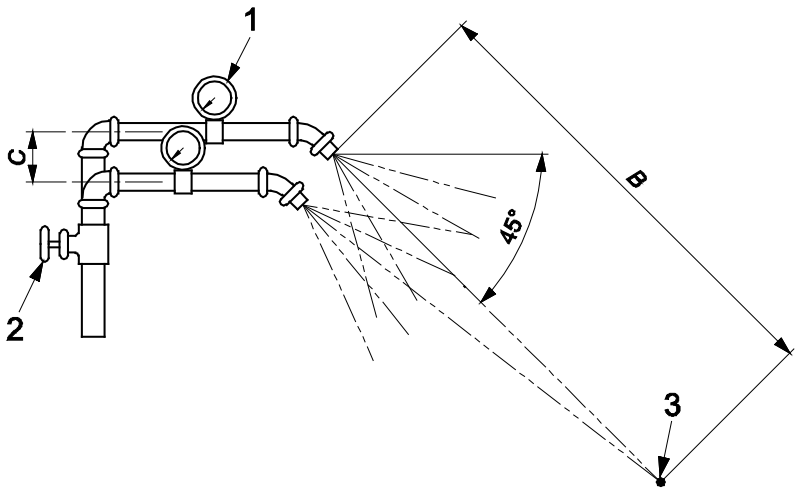


Key

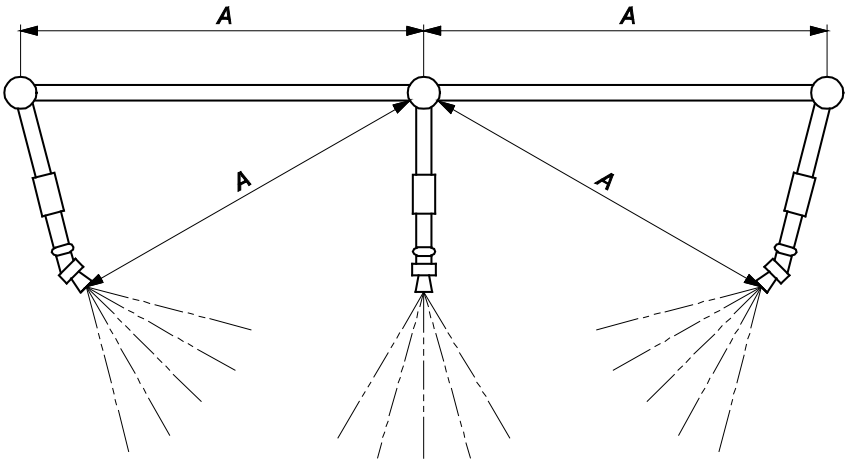
1 to temperature indicator

2 to sampling pump

Figure 7 — Sampling position for type C_1 and C_3 appliances



4



5

Key

1 water pressure gauge for each spray head

2 control valve for each spray head

3 focal point

4 plan view

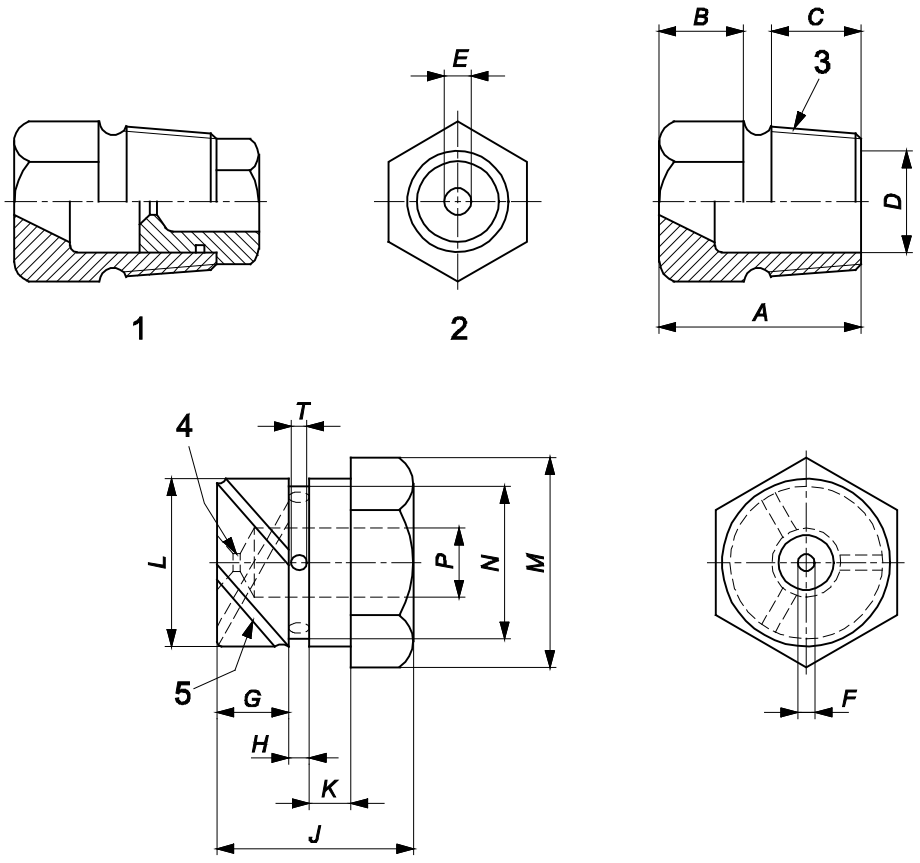
5 side elevation

A 710 mm

B 1 400 mm

C 75 mm

Figure 8 — Arrangement of spray heads and associated piping for the weather resistance test



Key

1 assembly

2 body

3 Rc 1/2

4 straight throat not more than 0,8 mm long. Drill relief 115°, 0,8 mm deep

5 3 square section slots: R wide, S deep, equally spaced (120') 60' helix heading edges tangential to radial edges

A	31,0 mm	B	11,0 mm
C	14,0 mm	D	14,7 mm
E	5,0 mm	F	2,5 mm
G	6,4 mm	H	2,4 mm
J	18,3 mm	K	4,0 mm
L	14,6 mm	M	16,0 mm
N	11,5 mm	P	6,4 mm
R	1,5 mm	S	1,6 mm
T	2,8 mm		

Figure 9 — Details of spray head assembly and construction

Annex A
(informative)

Alternative method for the determination of the nominal heat input or the maximum and minimum heat input for appliances using a pneumatic gas/air ratio control system

The calculation of the corrected heat input Q_c according to the formulas given in 7.3.2 is valid for appliances where the gas flow is governed by a constant gas pressure, i.e. by an adjuster or a pressure regulator, and a gas nozzle, and the gas is flowing out into an injector or any volume at about atmospheric pressure.

If the gas flow is governed by a pneumatic gas/air ratio control, having e.g. a zero pressure regulator and restrictors for gas and air or a mixing venturi, followed by a fan sucking the mixture into a burner, the following alternative formulas apply:

— If the volumetric gas rate V is measured in m^3/h:

$$Q_c = H_i \cdot \frac{10^3}{3600} \cdot V \cdot \frac{1013{,}25 + p_g}{1013{,}25} \cdot \sqrt{\frac{288{,}15}{273{,}15 + t_g} \cdot \frac{273{,}15 + t_a}{293{,}15} \cdot \frac{d}{d_r}}$$

— If the mass gas rate M is measured in kg/h:

$$Q_c = H_i \cdot \frac{10^3}{3600} \cdot M \cdot \frac{1013{,}25}{p_a} \cdot \sqrt{\frac{273{,}15 + t_g}{288{,}15} \cdot \frac{273{,}15 + t_a}{293{,}15} \cdot \frac{d_r}{d}}$$

where

Q_c is the corrected heat input (1 013,25 mbar, 15 °C, dry gas) with respect to the net calorific value in kilowatt (kW);

V is the measured volumetric gas rate expressed under the humidity, temperature and pressure conditions at the meter, in cubic metres per hour (m^3/h);

M is the measured mass gas rate, in kilograms per hour (kg/h);

H_i is, as appropriate, the net calorific value of dry reference gas at 15 °C, 1 013,25 mbar, in MJ/m^3, or in MJ/kg;

t_g is the gas temperature at the meter, in degrees Celsius (°C);

d is the density of the test gas [4)];

d_r is the density of the reference gas;

p_g is the gas pressure at the meter in millibar (mbar);

---

4) If a wet meter is used to measure the volumetric rate, it may be necessary to make a correction to the density of the gas in order to take account of its humidity. The value of d is then replaced by d_h given by the following formula:

$$d_h = \frac{d(p_a + p_g - p_s) + 0{,}6222\,p_s}{p_a + p_g}$$

where: p_s is the saturated vapour pressure of water at t_g in mbar.

p_a is the atmospheric pressure at the time of the test, in millibar (mbar);

t_a is the temperature of the combustion air used from the surrounding, in degrees Celsius (°C).

For an electronic gas/air ratio control system the correction formulas have to be checked according to the system in use.

Annex B
(informative)

Calculation of conversions of NO_x

Table B.1 — Conversion of the emission value of NO_x for first family gases

1 ppm = 2,054 mg/m³		**G 110**	
(1 ppm = 1 cm³/m³)		**mg/kWh**	**mg/MJ**
O_2 = 0 %	1 ppm = 1 mg/m³ =	1,714 0,834	0,476 0,232
O_2 = 3 %	1 ppm = 1 mg/m³ =	2,000 0,974	0,556 0,270

Table B.2 — Conversion of the emission value of NO_x for second family gases

1 ppm = 2,054 mg/m³		**G 20**		**G 25**	
(1 ppm = 1 cm³/m³)		**mg/kWh**	**mg/MJ**	**mg/kWh**	**mg/MJ**
O_2 = 0 %	1 ppm = 1 mg/m³ =	1,764 0,859	0,490 0,239	1,797 0,875	0,499 0,243
O_2 = 3 %	1 ppm = 1 mg/m³ =	2,059 1,002	0,572 0,278	2,098 1,021	0,583 0,284

Table B.3 — Conversion of the emission value of NO_x for third family gases

1 ppm = 2,054 mg/m³		**G 30**		**G 31**	
(1 ppm = 1 cm³/m³)		**mg/kWh**	**mg/MJ**	**mg/kWh**	**mg/MJ**
O_2 = 0 %	1 ppm = 1 mg/m³ =	1,792 0,872	0,498 0,242	1,778 0,866	0,494 0,240
O_2 = 3 %	1 ppm = 1 mg/m³ =	2,091 1,018	0,581 0,283	2,075 1,010	0,576 0,281

Annex C
(informative)

Example of calculation of weighting factors NO_x

Example of calculation of the weighting factors for an air source appliance with several rates.

Rates of the appliance: 100 %, 50 % and 30 %.

Table C.1 — Weighting factors NO_x

Q_{pi}	70 %	60 %	40 %	20 %
F_{pi}	0,15	0,25	0,30	0,30
100 %		50 %	30 %	

Apportioning of $Q_{pi} = 20\ \%$

Q_{min} is 30 %, which is larger than 20 %, so the F_{pi} of 20 % is added to the F_{pi} of 30 %;

$$F_{pi}(30\%) = 0{,}3$$

Apportioning of $Q_{pi} = 40\ \%$

$Q_{pi} = 40\ \%$ has to be apportioned between $Q_{pi} = 30\%$ (low rate) and $Q_{pi} = 50\%$ (high rate);

— high rate: $$F_{pi}(50\%) = F_{pi}(40\%) \cdot \frac{Q(40\%) - Q(30\%)}{Q(50\%) - Q(30\%)} \cdot \frac{Q(50\%)}{Q(40\%)} \quad \Leftrightarrow$$

$$F_{pi}(50\%) = 0{,}3 \times \frac{40 - 30}{50 - 30} \cdot \frac{50}{40} = 0{,}1875$$

— low rate: $F_{pi}(30\%) = F_{pi}(40\%) - F_{pi}(50\%) = 0{,}3 - 0{,}1875 = 0{,}1125$

Apportioning of $Q_{pi} = 60\ \%$

$Q_{pi} = 60\ \%$ has to be apportioned between $Q_{pi} = 50\ \%$ (low rate) and $Q_{pi} = 100\ \%$ (high rate)

— high rate: $$F_{pi}(100\%) = F_{pi}(60\%) \cdot \frac{Q(60\%) - Q(50\%)}{Q(100\%) - Q(50\%)} \cdot \frac{Q(100\%)}{Q(60\%)} \quad \Leftrightarrow$$

$$F_{pi}(100\%) = 0{,}25 \cdot \frac{60 - 50}{100 - 50} \cdot \frac{100}{60} = 0{,}0833$$

— low rate: $F_{pi}(50\%) = F_{pi}(60\%) - F_{pi}(100\%) = 0{,}25 - 0{,}0833 = 0{,}1667$

Apportioning of $Q_{\mathrm{pi}} = 70\%$

$Q_{\mathrm{pi}} = 70\ \%$ has to be apportioned between $Q_{\mathrm{pi}} = 50\ \%$ (low rate) and $Q_{\mathrm{pi}} = 100\ \%$ (high rate)

— high rate: $F_{\mathrm{pi}}(100\%) = F_{\mathrm{pi}}(70\%) \cdot \frac{Q(70\%) - Q(50\%)}{Q(100\%) - Q(50\%)} \times \frac{Q(100\%)}{Q(70\%)} \quad \Leftrightarrow$

$$F_{\mathrm{pi}}\ (100\,\%) = 0{,}15 \cdot \frac{70 - 50}{100 - 50} \cdot \frac{100}{70} = 0{,}0857$$

— low rate: $F_{\mathrm{pi}}(50\%) = F_{\mathrm{pi}}(70\%) - F_{\mathrm{pi}}(100\%) = 0{,}15 - 0{,}0857 = 0{,}0643$

Total apportioning

Table C.2 — Apportion rates

Rate:	20 %	40 %	60 %	70 %	Total
30 %	0,30 +	0,1125			= 0,4125
50 %		0,1875 +	0,1667 +	0,0643	= 0,4185
100 %			0,0833 +	0,0857	= 0,1690
Total	0,30 +	0,30 +	0,25 +	0,15	= 1

The ponderation formula is:

For heat input:

$$\mathrm{NO}_{\mathrm{x,\,pond}} = \left(0{,}4125 \cdot \mathrm{NO}_{\mathrm{x,\,mes(30\%)}} + 0{,}4185 \cdot \mathrm{NO}_{\mathrm{x,\,mes(50\%)}} + 0{,}169 \cdot \mathrm{NO}_{\mathrm{x,\,mes(100\%)}}\right)$$

For heat output:

$$\mathrm{NO}_{\mathrm{x,\,pond}} = \left(0{,}4125 \cdot \mathrm{NO}_{\mathrm{x,\,mes(30\%)}} + 0{,}4185 \cdot \mathrm{NO}_{\mathrm{x,\,mes(50\%)}} + 0{,}169 \cdot \mathrm{NO}_{\mathrm{x,\,mes(100\%)}}\right) / GUE_{H}$$

Where GUE_{h} is the gas utilization efficiency calculated according to EN 12309-4:2014, 4.2.6.1, at working point conditions of A7W45 for air source appliance (medium temperature EN 12309-3:2014, Table 5).

Annex D
(informative)

Ratio of calorific value Gross to Net and Net to Gross for Gas Families 1, 2 and 3

For the ratio of calorific value Gross to Net and Net to Gross for Gas Families 1, 2 and 3 see Table D.1

Table D.1 – Table of ratio of calorific value Gross to Net and Net to Gross for Gas Families 1, 2 and 3

Gas Family	Ref Gas	Net CV MJ/m^3	Gross C MJ/m^3	Ratio gross/net	Ratio net/gross
First	G 110	13,95	15,87	1,138	0,879
Second H + E	G 20	34,02	37,78	1,111	0,900
Second L	G 25	29,25	32,49	1,111	0,900
Third Propane	G 31	116,09	125,81	1,084	0,923
Third Butane	G 30	88,00	95,65	1,087	0,920

NOTE Data from EN 437:2003+A1:2009.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2009/142/EC relating to appliances burning gaseous fuels (codified version)

This European Standard has been prepared under a mandate given to CEN by the European Commission to provide a means of conforming to Essential Requirements of the New Approach Directive 2009/142/EC relating to appliances burning gaseous fuels" (codified version).

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Directive 2009/142/EC relating to appliances burning gaseous fuels (codified version)

Clause(s)/sub-clause(s) of this EN	Essential Requirements (ERs) of Directive 2009/142/EC	Qualifying remarks/Notes
Clause 5	1.1 Safe design and construction	
8.2 8.2 8.1 8.1 8.3	1.2 Marking and instructions Installation instructions User's instruction Warnings on the appliance Warnings on the packaging Official languages	
8.2 8.1.2 8.1.2 8.2 8.2	1.2.1 Information in the installation instructions Gas type Supply pressure Combustion air rate Discharge of combustion products	
8.2.2	1.2.2 Contents of the user's instructions	
8.1.4	1.2.3 Warnings on the appliance and on the packaging	
8.2	1.3 Fittings	

Clause(s)/sub-clause(s) of this EN	Essential Requirements (ERs) of Directive 2009/142/EC	Qualifying remarks/Notes
5.1.2	**2 Materials** 2.1 Characteristics 2.2 Guarantee	
5.1.2 5.1.2	**3 Design and construction** 3.1 General 3.1.1 Resistance to constraints	
5.15 / 6.12	3.1.2 Condensation	
6.1	3.1.4 Air/Water penetration	
	3.1.3 Risk of explosion	
5.1.13	3.1.5 Normal fluctuation of auxiliary energy	
5.1.13	3.1.6 Abnormal fluctuation of auxiliary energy	
5.1.12	3.1.7 Hazards of electrical origin	
5.1.15 / 6.8	3.1.8 Pressurized parts	
5.2.7.3 5.2.8 5.10.2 6.2 / 5.1.5 5.1.7 / 5.1.8 5.2.7 5.2 / 5.10	3.1.9 Failure of the safety devices — flame supervision device — automatic burner control system — overheat protection — gas circuit — air proving — automatic shut-off valves — regulators	
7.1.3.2	3.1.10 Safety, adjustment	
5.1.6	3.2 Unburnt gas release 3.2.1 Risk of gas leakage	
5.3 5.6 5.6	3.2.2 Risk of gas accumulation in the appliance — Ignition — Re-ignition — Flame extinction	
6.1.2	3.2.3 Risk of gas accumulation in rooms	
6.4.1 6.4.1	3.3 Ignition — Ignition and re-ignition — Cross-lighting	
6.4.2	3.4.1 Flame stability Unacceptable concentrations harmful to health	

Clause(s)/sub-clause(s) of this EN	Essential Requirements (ERs) of Directive 2009/142/EC	Qualifying remarks/Notes
5.1.6.2	3.4.2 No accidental release of combustion products	
6.1.2	3.4.3 Release of combustion products into the room or appliances connected to a flue under abnormal draught conditions	
6.3.3 6.3.1 6.3.2	3.6 Temperature 3.6.1 Floor and adjacent walls 3.6.2 Knobs 3.6.3 Temperatures of external surfaces	
Clause 8	CE marking Appliance or its data plate — CE marking — manufacturer's name or identification symbol — trade name — electrical supply — appliance category — installation information	

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this European Standard.

Annex ZB
(informative)

Relationship between this European Standard and the requirements of Commission Regulation (EC) No 813/2013

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to requirements of Commission Regulation (EC) N° 813/2013 of 6 September 2013 implementing Directive 2005/32/EC[5)] / 2009/125/EC of the European Parliament and of the Council with regard to Ecodesign requirements for space heaters and combination heaters.

Once this standard is cited in the Official Journal of the European Union under that Commission Regulation, compliance with the clauses of this standard given in Table ZB.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding requirements of that and associated EFTA regulations.

Table ZB.1 — Correspondence between this European Standard and Commission Regulation (EC) No 813/2013

Clauses and subclauses of this EN	Requirements of Commission Regulation (EC) No 813/2013	Qualifying remarks/Notes
7.3.12	Annex II.4	NO_x measurement

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

5) The Directive was replaced by the Directive 2009/125/EC.

Annex ZC
(informative)

Relationship between this European Standard and the requirements of Commission Regulation (EC) N° 811/2013

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to requirements of Commission Regulation (EC) N° 811/2013 of 6 September 2013 implementing Directive 2005/32/EC[6)] / 2009/125/EC of the European Parliament and of the Council with regard to energy labelling of space heaters, combination heaters, packages of space heater, temperature control and solar device and packages of combination heater, temperature control and solar device.

Once this standard is cited in the Official Journal of the European Union under that Commission Regulation, compliance with the clauses of this standard given in Table ZC.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding requirements of that and associated EFTA regulations.

Table ZC.1 — Correspondence between this European Standard and Commission Regulation (EC) N° 811/2013

Clauses and subclauses of this EN	Requirements of Commission Regulation (EC) No 811/2013	Qualifying remarks/Notes
Not applicable	Article 3, 1(a), Annex II, 1	Energy efficiency classes
Not applicable	Article 3, 1(a), Annex II, 2	Water heating energy classes
Not applicable	Article 3, 1(a), Annex III and IV	Sound power level
Not applicable	Article 3, 1(a), Annex III, 1.1 and Annex III, 3	Tests conditions for measuring the rated heat output to be inserted in the Energy label for space heater
Not applicable	Article 3, 1(b), Annex IV, 1 and Annex IV, 5	Tests conditions for measuring the data to be inserted in the product fiche for space heater
Not applicable	Article 3, 1(c), Annex V, 1	Technical documentation for space heater
Not applicable	Article 3, 2(a), Annex III, 2.1 and Annex III, 4	Energy label for combination heater
Not applicable	Article 3, 2(b), Annex IV, 2 and Annex IV, 6	Product fiche for combination space heater
Not applicable	Article 3, 2(c), Annex V, 2	Technical documentation for combination heater

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

6) The Directive was replaced by the Directive 2009/125/EC.

Bibliography

[1] EN 378-1:2008+A2:2012, *Refrigerating systems and heat pumps - Safety and environmental requirements - Part 1: Basic requirements, definitions, classification and selection criteria*

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