BRITISH STANDARD

BS EN
303-7:2006

Heating boilers —

Part 7: Gas-fired central heating boilers equipped with a forced draught burner of nominal heat output not exceeding 1 000 kW

The European Standard EN 303-7:2006 has the status of a British Standard

ICS 91.140.10

BSI
British Standards

National foreword

This British Standard was published by BSI. It is the UK implementation of EN 303-7:2006.

The UK participation in its preparation was entrusted to Technical Committee GSE/29, Gas-fired central heating boilers (domestic and non-domestic) and domestic gas-fired water heaters.

A list of organizations represented on GSE/29 can be obtained on request to its secretary.

EN 303-7:2006 is a candidate "harmonized" European standard and fully takes into account the requirements, given under the EU gas appliances (90/396/EEC) and boiler efficiency (92/42/EEC) Directives, and intended to lead to CE marking. The date of applicability of EN 303-7:2006 as a harmonized European standard, i.e. the date after which this standard may be used for CE marking purposes, is subject to an announcement in the *Official Journal of the European Communities*. The Commission in consultation with Member States has agreed a transition period for the co-existence of harmonized European standards and their corresponding national standard(s). It is intended that this period will comprise a period, usually nine months, after the date of availability of the European Standard, during which any required changes to national regulations are to be made, followed by a further period, usually of 12 months, for the implementation of CE marking. At the end of this co-existence period, the national standard(s) will be withdrawn. In the UK, there are no corresponding national standards. The UK as a member of CEN is obliged to publish EN 303-7:2006 as a British Standard. However, attention is drawn to the fact that during the development of this European standard, the UK consistently voted against its approval as a European standard. The reason for this disapproval and additional information is given in National Annex NA.

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

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

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Heating boilers - Part 7: Gas-fired central heating boilers equipped with a forced draught burner of nominal heat output not exceeding 1 000 kW

Chaudière de chauffage - Partie 7 : Chaudières de chauffage central équipées d'un brûleur à air soufflé utilisant les combustibles gazeux de puissance utile inférieure ou égale à 1 000 kW

Heizkessel - Teil 7 : Zentralheizkessel für gasförmige Brennstoffe mit einer Gebläsebrenner mit einer Nennwärmeleistung kleiner als oder gleich 1 000 kW

This European Standard was approved by CEN on 14 December 2005.

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 Central Secretariat 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 Central Secretariat has the same status as the official versions.

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

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Foreword

This document (EN 303-7:2006) has been prepared by Technical Committee CEN/TC 109 “Central heating boilers using gaseous fuels”, the secretariat of which is held by NEN.

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 April 2007, and conflicting national standards shall be withdrawn at the latest by April 2007.

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, which is an integral part of this document.

WARNING Other requirements and other EU Directives may be applicable to the products falling within the scope of this European Standard.

NOTE When constructional requirements for low temperature boilers will have been introduced in EN 303-1, they will replace those of this European Standard by amendment.

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

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

1 Scope

This European Standard specifies the requirements and test methods for the construction, the safety and the rational energy usage for gas-fired standard and low temperature central heating boilers equipped with a forced draught burner.

These boilers comprise a boiler body and a forced draught gas burner brought together at the producer's assembly facility, the whole being designed and marketed as a complete boiler.

This standard does not apply to the case of the assembly of a boiler body and a forced draught gas burner designed and marketed separately. In this case, EN 303-3 applies.

This European Standard applies to type B_{23} boilers with a nominal heat output not exceeding 1000 kW with a water temperature at normal operation not exceeding 105 °C and with a maximum water-side operating pressure not exceeding 8 bar.

This European Standard does not contain all the necessary requirements for:

— condensing boilers and combination boilers;

— boilers intended to be installed in the open;

— boilers permanently fitted with more than one flue outlet;

— boilers intended to be connected to a common flue having mechanical extraction;

— boilers equipped with several combustion chambers.

This European Standard does not apply to living-space dedicated boilers (see 3.6).

This European Standard only covers type testing.

2 Normative references

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

EN 303-1:1999, *Heating boilers — Part 1: Heating boilers with forced draught burners — Terminology, general requirements, testing and marking*

EN 437, *Test gases — Test pressures — Appliance categories*

EN 676, *Automatic forced draught burners for gaseous fuels*

EN 60335-1:2002, *Household and similar electrical appliances - Safety — Part 1: General requirements (IEC 60335-1:2001, modified)*

EN ISO 3166-1, *Codes for the representation of name of countries and their subdivisions — Part 1: Country codes (ISO 3166-1:1997)*

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

3 Terms and definitions

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

3.1 Gas rates

3.1.1
volumetric rate V (under test conditions); V_r (under reference conditions)
volume of gas consumed by the boiler in unit time during continuous operation

NOTE Volumetric rate is expressed in cubic metres per hour (m^3/h).

3.1.2
mass rate M (under test conditions); M_r (under reference conditions)
mass of gas consumed by the boiler in unit time during continuous operation

NOTE Mass rate is expressed in kilograms per hour (kg/h), or on occasions in grams per hour (g/h).

3.2
heat input Q
product of the volumetric rate or the mass rate, and the net calorific value of the gas, under the same reference conditions

NOTE Heat inputs are expressed in kilowatts (kW).

3.2.1
nominal heat input[1)] Q_n
heat input stated by the manufacturer

3.3 Outputs

3.3.1
useful output P
quantity of heat transmitted to the heat carrier in unit time

NOTE Outputs are expressed in kilowatts (kW)

3.3.2
nominal output P_n
useful output stated by the manufacturer

3.4
useful efficiency η_u
ratio of the useful output to the heat input

NOTE the useful efficiency is expressed in percent (%).

3.5
nominal voltage
voltage or range of voltages stated by the manufacturer, at which the boiler can operate normally

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1) Boilers fitted with a range-rating device operate at a nominal heat input between the maximum and minimum adjustable heat inputs. Modulating boilers operate between the nominal heat input and the minimum controlled heat input. The maximum heat input corresponds to the nominal output of the boiler in accordance with EN 303-1.

3.6
boiler to be installed in the living space
boiler with an effective rated output of less than 37 kW, designed to provide heat to the part of the living space in which it is installed by means of the emission of heat from the casing having an open expansion chamber, supplying hot water using gravity circulation

3.7
boiler
appliance comprising a boiler body and a forced draught burner, designed and brought together at the producer's assembly facility and marketed as a complete boiler

3.8
gases and categories
gases are classified into families, groups and ranges in accordance with EN 437

Boilers are classified into categories in accordance with EN 437.

3.9 Classification in accordance with the mode of evacuation of the combustion products (CEN/TR 1749)

3.9.1
type B
appliance intended to be connected to a flue that evacuates the products of combustion to the outside of the room containing the appliance. The combustion air is drawn directly from the room

3.9.2
type B_2
type B appliance without draught diverter

3.9.3
type B_{23}
type B_2 appliance incorporating a fan upstream of the combustion chamber/heat exchanger

3.10
forced draught burner
burner in which the combustion air is introduced by means of a fan

3.11
automatic forced draught burner
forced draught burner that is fitted with automatic ignition, flame monitoring and burner control devices. Ignition, flame monitoring and the on/off switching of the burner occur automatically. The heat input of the burner can be adjusted during operation either automatically or manually

3.12
total pre-mixed burner
burner in which at least all the air theoretically required for complete combustion of the gas is mixed with the gas upstream of the mixture outlet ports

3.13
nozzle mixed burner
burner in which part, or all, of the air theoretically required for combustion of the gas is mixed with the gas at, or downstream of, the air and gas ports

3.14
start gas rate
gas rate ignited by the ignition device during the start-up of the burner

3.15
combustion chamber
part of the boiler in which the combustion of the mixture of the gas and air takes place

3.16
gas line
part of the burner which is made up of the valves and controls and safety devices in which gas is conveyed between the inlet connection and the burner head

3.17
range-rating device
component on the burner intended to be used for adjusting the heat input, within a range of heat inputs stated by the manufacturer, to suit the actual heat requirements of the installation

This adjustment may be progressive or in discrete steps.

3.18
automatic shut-off valve
device that automatically opens, closes or varies the gas rate on a signal from the control circuit and/or the safety circuit

3.19
ignition device
any means (flame, electrical ignition or other means) used to ignite the gas at the ignition burner or at the main burner

3.20
purge
forced introduction of air into the combustion chamber and flue passages, in order to displace any remaining gas/air mixture and/or products of combustion

3.21
flame stability
capacity of flame to remain on the burner head or in the flame reception zone intended by the design

3.22
flame lift
total or partial lifting of the base of the flame away from the burner head or the flame holding zone provided by the design

3.23
light back
unintended movement of the flame front to a point upstream of its normal stable operating position

3.24
control thermostat
device enabling the water temperature to be kept automatically, within a given range, at a predetermined value

3.25
adjustable control thermostat
control thermostat that permits the operator to obtain setting temperatures between a minimum and a maximum value

3.26
safety temperature limiter
device that causes safety shutdown and non-volatile lockout so as to prevent the water temperature exceeding a pre-set limit

3.27
flue damper
device having a closure member which virtually blocks the flue gas passage when the main burner is off

3.28
air damper
device having a closure member which virtually blocks the air supply passage when the main burner is off

3.29
ignition safety time (t_{SA})
time that elapses between the order to open and the order to close the gas supply to the burner in the event of no flame being detected

3.30
extinction safety time (t_{SE})
time that elapses between extinction of the supervised flame and the order to shut off the gas supply to the burner

3.31
first safety time
period between the ignition burner gas valve, the start gas valve or main gas valve(s), as applicable, being energized and the pilot gas valve, start gas valve or main gas valve(s), as applicable, being de-energized if the flame detector device signals the absence of a flame

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

3.32
second safety time
where there is a first safety time applicable to either an ignition burner or start gas flame only, the second safety time is the period between the main gas valves being energized and the main gas valves being de-energized if the flame detector device signals the absence of a flame

3.33
total closing time
period that starts with the signal that the flame has been extinguished and ends with the shut-off valves being closed

3.34
automatic recycling
after loss of flame during operation, the gas supply is interrupted and the full start procedure is re-initiated automatically

3.35
non-volatile lock-out
safety shut-down condition of the system, such that a restart can only be accomplished by a manual reset of the system and by no other means

3.36
condensate
liquid formed from the combustion products during the condensation process

3.37
standard boiler
boiler for which the average water temperature can be restricted by design

3.38
low-temperature boiler
boiler which can work continuously with a water supply temperature of 35 °C to 40 °C, possibly producing condensation in certain circumstances

3.39
excess coefficient or air ration, *λ*
ratio of the real air volume (in m^3) to the stœchiometric air volume (in m^3)

4 Constructional and operational requirements

4.1 General principles

The boiler body shall comply with the relevant requirements of EN 303-1.

The construction and the equipment of the forced draught gas burner shall be in accordance with EN 676.

The operational requirements of the forced draught burner shall be checked on the boiler.

The corresponding requirements and tests are described in this standard.

In the case where the forced draught burner complies with EN 676, only the tests defined in Annex F are necessary.

For low-temperature boilers, all parts of the heat exchanger(s) and other parts of the boiler 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 a boiler that is installed, used and maintained in accordance with the manufacturer's instructions.

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

4.2 Operational requirements

The following requirements are checked on the boiler in accordance with the test conditions of 5.1 unless otherwise specified

4.2.1 General operational requirements

A controlling device shall not override the operation of any safety device.

4.2.2 External tightness of the gas circuit

When tested as specified in 5.2 the gas carrying parts of the burner, up to the last downstream shut-off device, shall be sound.

4.2.3 Heat input range

Under the test conditions of 5.3 at the normal test pressure, the maximum and minimum heat inputs declared by the manufacturer shall be obtained to within ± 5 %.

4.2.4 Gas pressure governor

The gas regulators shall be conform to the relevant clause of EN 676.

The gas supply for operation and start up shall be controlled by a governor to ensure that the pressure at the burner head remains stable. Under the test conditions of 5.4, the heat input shall not vary by more than ± 5 % from the specified value, if the supply pressure changes in the limits of the minimum and maximum pressure.

4.2.5 Safety of operation

4.2.5.1 Limiting temperature of control and safety devices

Under the test conditions of 5.5.1, the ambient temperature of the control and safety devices shall not exceed the maximum value stated by the devices manufacturer, and their operation shall remain satisfactory.

4.2.5.2 Limiting temperature of control knobs and parts to be touched

Under the test conditions of 5.5.2 the surface temperatures of control knobs and of all parts intended to be touched shall not exceed the ambient temperature by more than:

— 35 K for metals;

— 45 K for porcelain;

— 60 K for plastics.

4.2.5.3 Limiting temperature of the side walls, the front and the top

Under the test conditions of 5.5.3:

— the temperature of the side walls, front and top of the boiler shall not exceed the ambient temperature by more than 80 K.

  Nevertheless, the parts of the case within 5 cm of the sight glass and within 15 cm of the boiler combustion products evacuation duct are exempt from this requirement;

— the average temperature of the boiler doors and of the cleaning doors shall not exceed the ambient temperature by more than 100 K.

4.2.5.4 Limiting temperature of the floor and the test panels

Under the test conditions of 5.5.4, the temperature of the floor on which the boiler is placed and that of the test panels placed at the side of and behind the boiler shall at no point exceed 80 °C when measured.

Where the temperature is between 50 °C and 80 °C, the manufacturer's technical manual shall include information regarding the installation of protection between the boiler and the floor or walls, where these latter consist of flammable materials

4.2.5.5 Start-up

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

a) any interlock integral with the boiler (e.g. flue damper) is indicating its correct position;

b) the flame detector has been checked to be functioning correctly for flame simulation. This check may also be carried out during the pre-purge or after a controlled shut-down;

c) any valve proving system has completed its check successfully. This check may also be carried out during the pre-purge or after a controlled shut-down;

d) the air flow proving device has been proved to be functioning correctly.

Under the conditions of 5.5.5, no excessive pressure fluctuation or flame pulsation shall take place in the boiler.

4.2.5.6 Ignition and flame stability

a) Under the test conditions of 5.5.6, ignition shall be effected correctly, rapidly and without any pulsation. The flames shall be stable and shall not create any disturbing noise. A slight tendency to lift at the moment of ignition is permissible, but the flames shall be stable thereafter.

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

b) The ignition of the boiler at reduced pressure before the action of the low pressure gas switch or the flame supervision device shall not lead to a dangerous situation for the user or damage to the boiler.

4.2.5.7 Resistance of the burner to over-heating

Under the test conditions of 5.5.7 the various parts of the burner shall not suffer any deterioration other than the superficial alterations inherent in combustion.

4.2.5.8 Pre-purge

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

The duration of the pre-purge shall be either:

a) at least 20 s at the full combustion air rate corresponding to the maximum nominal heat input or

b) where the air rate is reduced, a time period increased by an amount inversely proportional to the reduced air rate.

EXAMPLE 100% air rate – at least 20 s pre-purge time;

50% air rate – at least 40 s pre-purge time;

33% air rate (minimum permitted) – at least 60 s pre-purge time.

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

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

a) the boiler shall proceed to safety shut-down, or

b) the purge shall be continued upon restoration of the required air rate provided that the air flow does not fall below 33 % of the required air rate and that the total purge time at the required air rate is not reduced.

After a controlled shut-down a restart of the following boilers may be achieved without a pre-purge:

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

b) boilers of heat input greater than 70 kW fitted with two class A safety shut-off valves in series plus a valve proving system.

A pre-purge shall be carried out at any restart after every safety shut-down.

4.2.6 Control and safety equipments

4.2.6.1 Start-up heat input

Boilers with a nominal heat input up to and including 120 kW may be ignited directly.

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

$t_{SA} \times Q_s \leq 100$ or $t_{SA} \times Q_S \leq 150$ where appropriate (see Table 1);

where:

t_{SA} is the ignition safety time in seconds (s);

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

The tests shall be carried out under the conditions of 5.6.1.

4.2.6.2 Start-up

The start-up gas valves shall not be energised before the ignition spark (or other means of ignition) is energized.

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

The start gas flame proving period shall establish that the flame is stable on its own. In the case of a flame failure, the requirements of 4.2.6.5 apply.

Where the gas line is designed such that the gas supply to the ignition burner is taken from between the two main burner gas valves, it is checked under the test conditions of 5.5.6 that it is not possible for a hazardous situation to arise in the event of defective closure of the gas valve immediately upstream of the main burner when the ignition burner is lit.

Where the start gas rate is controlled by a start gas rate position contained within the downstream main safety shut-off valve any means of adjustment of the start gas rate shall be capable of being pre-set and sealed.

The tests shall be carried out under the conditions of 5.5.6.

4.2.6.3 Main burner ignition

4.2.6.3.1 Establishment by means of a start gas flame

If the start gas flame has been ignited at a separate ignition burner and proved the second safety time shall be not more than the safety time mentioned in Table 1 at the end of which time sensing of the main flame shall begin. If the main flame is not detected at the end of this period, the requirements of 4.2.6.5 apply.

The tests shall be carried out under the conditions of 5.5.6.

4.2.6.3.2 Direct establishment of the main gas flame

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

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

The tests shall be carried out under the conditions of 5.5.6.

4.2.6.4 Safety times

4.2.6.4.1 Ignition safety time

The ignition safety time shall be determined from the equation given in 4.2.6.1 as a function of the start gas rate, but in no case shall the safety time exceed 5 s.

The ignition of the main and ignition burners, the maximum start gas rate and the corresponding safety time shall be as specified in Table 1 according to the maximum heat input of the burner. Figures 8 to 11 illustrate the ignition systems referred to in this clause.

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

— direct ignition of the main burner at full rate Q_n; (see Table 1, column 2, Figure 8);

— direct ignition of the main burner at reduced rate; (see Table 1, column 3, Figure 9);

— direct ignition of the main burner at reduced rate with independent start gas supply; (see Table 1, column 4, Figure 10);

— ignition of the main burner by means of an independent ignition burner; (see Table 1, column 5, Figure 11).

Higher start gas rates than those specified in Table 1 may be achieved at the end of the safety time provided that it is proved that the total amount of energy released in the combustion chamber during the safety time is not greater than the energy release calculated by multiplying the values of maximum start gas heat input and safety time given by Table 1.

When the electrical supply voltage U_N is varied between 85 % of the minimum nominal voltage and 110 % of the maximum nominal voltage declared by the manufacturer, the safety times declared by the manufacturer shall not be exceeded.

The safety times given in Table 1 are absolute maxima.

The tests shall be carried out under the conditions of 5.6.2.1.

Table 1 — Maximum start gas heat inputs (Q_s) and ignition safety times (t_{SA})

1	2		3		4		5			
Main burner	Direct main burner ignition at nominal rate		Direct main burner ignition at reduced rate		Direct main burner ignition at reduced rate with independent start gas supply		Main burner ignition with independent ignition burner			
							Ignition burner ignition		Main burner ignition	
Rate Q_n kW	Rate Q_s kW	Safety time s	Rate Q_s kW	Safety time s	Rate Q_s kW	Safety time s	Rate Q_s kW	First Safety Time s	Rate Q_s kW	Second safety time s
≤ 70	Q_n	5	Q_n	5	Q_n	5	≤ 0,1Q_n	5	Q_n	5
> 70 ≤120	Q_n	3	Q_n	3	Q_n	3	≤ 0,1Q_n	5	Q_n	3
> 120	not permitted		120 kW or t_{SA} x $Q_s \leq 100$ (max. t_{SA} = 3 s)				≤ 0,1Q_n	3	120 kW or t_{SA} x $Q_s \leq 150$ (max.t_{SA} = 5 s)	

Q_n = maximum burner heat input in kilowatts

Q_s = maximum start gas heat input expressed as a percentage of Q_n

t_{SA} = safety time in seconds

4.2.6.4.2 Extinction safety time

In the test conditions of 5.6.2.2, the extinction safety time shall not exceed 1 s.

4.2.6.4.3 Total closing time

In the test conditions of 5.6.2.3, the total closing time shall not exceed 2 s. The two valves shall close simultaneously, but where a valve proving system is used there may be a delay for the second valve of up to 2 s.

4.2.6.5 Failure to ignite

For boilers with a heat input up to and including 120 kW, failure to ignite shall lead to either

a) a single attempt at recycling, followed by non-volatile lock-out if this attempt fails, or

b) non-volatile lock-out.

For boilers with heat input greater than 120 kW failure to ignite shall lead to non-volatile lock-out.

The test shall be carried out under the conditions of 5.6.2.4.

4.2.6.6 Flame failure during the running condition

Upon flame failure during the running condition, the flame sensing system shall cause non-volatile lock-out except in the case of boilers of heat input up to and including 120 kW with direct ignition of the main flame, in which case a recycling attempt may take place.

If the recycling attempt is unsuccessful, non-volatile lock-out shall occur.

The test shall be carried out under the conditions of 5.6.2.5.

4.2.6.7 Boiler shut-down

The operation of a safety device other than a low gas pressure sensing device shall cause non-volatile lockout in a time less than or equal to the total closing time.

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

4.2.6.8 Operation of control thermostats and safety temperature limiters

Under the conditions of 5.6.3:

— it is checked that the control thermostat interrupts the operation at the value stated by the manufacturer with a tolerance of ± 10 K and not exceeding 105 °C;

— it is checked that the safety temperature limiter interrupts the operation at the value stated by the manufacturer, which shall be less than 110 °C, or 120° C if the manufacturer states in his instructions that the boiler shall only be used to equip heating installations designed for failure temperatures of at least 120° C.

The other safety devices shall not operate during the test.

4.2.7 Combustion

Under the conditions of 5.7, the concentration of CO and NO_x in the products of combustion on an air free basis shall not exceed the values specified in 4.2.7.1 and 4.2.7.2.

4.2.7.1 Carbon monoxide (CO)

a) The CO concentration of the dry, air-free combustion products shall not exceed 0,1 % when the boiler operates under the nominal voltage with the reference gas of the family or the group for which it is designed, or with a gas actually distributed for boilers of heat input higher than 300 kW.

b) The CO concentration of the dry, air-free combustion products shall not exceed 0,2 % when the boiler operates at 85 % of the nominal voltage with the reference gas of the family or the group for which it is designed, or with a gas actually distributed for boilers of heat input higher than 300 kW.

c) The CO concentration of the dry, air-free combustion products shall not exceed 0,2 % when the boiler operates under the nominal voltage with the incomplete combustion gas of the family or the group for which it is designed, or with an overload of 9 % in comparison with the nominal heat input.

d) The boiler shall be designed such that if the voltage input becomes lower than 85 % of the nominal value, either the boiler continues to operate safely with a CO concentration in the products of combustion below 1% by volume or it shall go to a safety shut down.

4.2.7.2 Nitrogen oxides (NO_x)

4.2.7.2.1 General

The concentration of NO_x in the products of combustion is expressed in the following reference conditions (see Annex E)

— Temperature: 20 °C;

— Relative humidity: 70 %

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

a) 170 mg/kWh when the boiler is tested at the supply voltage declared by the manufacturer with reference gas G 20 for second family gases for groups H and E;

b) 170 mg/kWh when the boiler is tested at the supply voltage declared by the manufacturer with reference gas G 25 for second family gases for group L;

c) 230 mg/kWh when the burner is tested at the supply voltage declared by the manufacturer with reference gas G 30 for the third family.

4.2.7.2.2 NO_x classes

The manufacturer selects the NO_X class of the boiler from Table 2. Under the test conditions of 5.7, the NO_X concentration in the dry, air free products of combustion shall not exceed the limit value of this class.

Table 2 — NO_x classes

NO_X classes	Limit NO_X concentration (mg/kWh)
1	170
2	120
3	80

The limit values are given for second family gases. For third family gases, the limit values of these classes are multiplied by a factor of 1,30. For boilers intended to use propane only, the limit values of these classes are multiplied by a factor of 1,20.

4.2.7.2.3 Weighting

For multistage and modulating boilers the NO_x concentration is equal to the arithmetic average of the values of NO_x measured at the different stages or at the maximum and minimum heat input of the modulating boiler.

None of the individual measured values shall exceed the value of the class immediately above the class in which the average value calculated belongs. Moreover none of the measured values shall exceed the value of the class 1 as specified in 4.2.7.2.2 for the gas concerned.

4.2.8 Useful efficiencies

4.2.8.1 Useful efficiency at the maximum nominal heat input

Under the conditions of 5.8.1, the useful efficiency, expressed in percent, shall be at least equal to the values derived from Table 3:

Table 3 — Useful efficiency requirement at maximum nominal heat input

Ranges of nominal heat output	Efficiency requirement expressed at maximum nominal heat input %
4 kW ≤ P_n ≤ 400 kW	≥ $84 + 2 \log_{10} P_n$ for standard boilers ≥ $87{,}5 + 1{,}5 \log_{10} P_n$ for low temperature boilers
400 kW < P_n ≤ 1 000 kW	≥ 89,2 for standard boilers ≥ 91,4 for low temperature boilers
1) P_n is the maximum nominal output, expressed in kilowatts (kW).	

4.2.8.2 Useful efficiency at part load

Under the conditions of 5.8.2, the useful efficiency for a load corresponding to 30 % of the maximum nominal heat input, expressed in percent, shall be at least equal to the values derived from Table 4:

Table 4 — Useful efficiency requirement at part load

Ranges of nominal output	Efficiency requirement expressed at part load %
4 kW ≤ P_n ≤ 400 kW	≥ 80 + 3 $\log_{10} P_n$ for standard boilers ≥ 87,5 + 1,5 $\log_{10} P_n$ for low temperature boilers
400 kW < P_n ≤ 1 000 kW	≥ 87,8 for standard boilers ≥ 91,4 for low temperature boilers
1) P_n is the maximum nominal output, expressed in kilowatts (kW).	

4.2.9 Condensation

For standard boilers which are designed not to give rise to condensation, there shall be no indication of condensation at the operating temperatures provided by the controls.

Low temperature boilers are considered to be designed to give rise to condensation. This condensation shall not impair operation of low temperature boiler.

The tests shall be carried out under the conditions of 5.9.

4.2.10 Condensate discharge for low temperature boilers

For low-temperature boilers, a means of condensate discharge shall be provided if the condensate:

— impairs safety or correct operation;

— results in spillage from the appliance;

— causes deterioration of materials.

A pipe or pipes shall be used to discharge condensate when this is necessary. The internal diameter of the outside connection of the condensate discharge system shall be at least 13 mm.

The disposal system, forming part of the boiler or supplied with the boiler, shall be such that:

— it can be easily inspected and cleaned in accordance with the manufacturer's instructions;

— it cannot transmit combustion products into the room where the boiler is installed; this requirement is satisfied if the disposal system incorporates a water trap;

— a water trap has a seal of at least 25 mm at the maximum pressure in the combustion chamber at the maximum flue length specified by the manufacturer.

4.2.11 Resistance of the materials to pressure

For low-temperature boilers, corrosion resistant coatings shall show no sign of damage after the tests of resistance of the materials to pressure.

NOTE The test conditions of the pressure test are described in Clause 5 of EN 303-1:1999.

5 Test methods

5.1 General principles

The following test conditions are applied unless otherwise specified in particular paragraphs.

5.1.1 Test performance

The boiler supplied by the reference gas of the category (or another gas distributed in the network for boilers of a heat input higher than 300 kW) is adjusted in accordance to the indications given by the manufacturer. Unless otherwise specified, the tests are performed at the maximum nominal heat input.

5.1.2 General conditions for the tests

5.1.2.1 Test room

The boiler is installed in a well ventilated, draught-free room, which has an ambient temperature of about 20 °C; the boiler is protected from direct solar radiation.

The ambient temperature is measured at a height of 1,50 m above the floor and at a minimum distance of 3 m from the boiler, with a temperature sensor protected against radiation from the test installation.

5.1.2.2 Installation

For all the tests, the boiler is installed, used and put into operation under the conditions specified in the manufacturer's instructions.

The combustion products are sampled by devices shown in Figures 6 or 7, as appropriate.

5.1.2.3 Water circuit

The boiler is connected to the insulated test rig shown schematically in Figures 1, 2 or 3, or to other equipment giving equivalent results; it is purged of air in accordance with the information stated in the manufacturer's instructions.

If the boiler is fitted with an adjustable water temperature thermostat, the tests are carried out with a water flow temperature of (80 ± 2) °C.

However, where these conditions cannot be obtained (due to the design of the boiler or non adjustable thermostat), the tests are carried out with the maximum possible water temperatures.

Valves I and II from Figures 1 or 2 are used to obtain a temperature difference between the flow and return of (20 ± 1) K or the value stated by the manufacturer if the design of the boiler control system does not allow correct operation at a 20 K temperature difference.

5.1.2.4 Thermal equilibrium

Unless otherwise specified in the test conditions, the tests are carried out with the boiler at thermal equilibrium, i.e. when the water flow and return temperatures of the boiler have stabilized to ± 2 K.

5.1.2.5 Electrical supply

The boiler is supplied at the nominal voltage, except where otherwise stated.

5.1.2.6 Uncertainty of measurements

Except where otherwise stated in the particular clauses, measurements are carried out within the maximum uncertainties indicated below:

1)	atmospheric pressure	± 5 mbar;
2)	combustion chamber and test flue pressure	± 5 % full scale or 0,05 mbar;
3)	gas pressure	± 2 % full scale;
4)	water-side pressure loss	± 5 %;
5)	water rate	± 1 %;
6)	gas rate	± 1 %;
7)	time	± 0,2 s up to 1 h; 0,1 % beyond 1 h;
8)	auxiliary electrical energy	± 2 %;
9)	temperatures:	
	— ambient	± 1 K ;

—	water	± 2 K ;
—	combustion products	± 5 K ;
—	gas	± 0,5 K ;
—	surface	± 5 K ;
10)	CO, CO_2 and O_2, for the calculation of flue losses	± 6 % full scale;
11)	gas calorific value	± 1 % ;
12)	gas density	± 0,5 % ;
13)	mass	± 0,05 %.

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

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

5.1.2.7 Adjustment of the heat input

The heat input Q, in kilowatts (kW), obtained during a test is given by one of the two following expressions:

— If the volumetric rate is measured:

$$Q = 0{,}278 \times V_r \times H_i \ ;$$

— if the mass rate is measured:

$$Q = 0{,}278 \times M_r \times H_i \ ;$$

where:

H_i is the net calorific value of the gas used for the test (dry, 15 °C, 1 013,25 mbar), in megajoules per cubic metre (MJ/m^3) on the volume basis, or in megajoules per kilogram (MJ/kg) on the mass basis, as appropriate;

V_r is the volumetric rate measured in cubic metres per hour (m^3/h) of dry gas under reference conditions (15 °C, 1 013,25 mbar), where:

$$V_r = V \cdot \frac{p_a + p_g - p_s}{1013{,}25} \frac{288{,}15}{273{,}15 + t_g}$$

where:

p_s is the saturated vapour pressure of water at t_g, in millibars (mbar); for the meaning of the other symbols see clause 6.

M_r is the mass rate measured in kilograms per hour (kg/h) of dry gas.

5.1.2.8 Adjustment of the excess air

Unless otherwise specified in the test conditions, the excess air ratio λ is adjusted in accordance with the instructions supplied by the manufacturer.

5.2 External tightness of the gas line

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

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

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

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

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

When using a test method measuring a leakage rate, do not allow the leakage rate to exceed 0,14 dm^3/h.

5.3 Heat input rates

The boiler is supplied with each of the reference gases for the boiler category at the normal pressure (or another gas distributed in the network for boilers of a heat input higher than 300 kW). The heat input of the burner is measured at the maximum heat input of the boiler, then at the minimum heat input of the boiler. For boilers with a fixed output do not change the adjustment. Any adjusters are set to the position stated by the manufacturer. The volumetric rate V obtained under these conditions (p_a, p_g, t_g, d) is corrected as if the test had been carried out under the reference test conditions (1 013,25 mbar, 15 °C, dry gas) and the corrected heat input is calculated using one of the following formulae:

— If the volumetric rate V is measured:

$$Q_c = H_i \cdot \frac{10^3}{3\,600} \cdot V \sqrt{\frac{1\,013{,}25 + p_g}{1\,013{,}25} \cdot \frac{p_a + p_g}{1\,013{,}25} \cdot \frac{288{,}15}{273{,}15 + t_g} \cdot \frac{d}{d_r}}$$

hence:

$$Q_c = \frac{H_i \cdot V}{214{,}9} \sqrt{\frac{(1\,013{,}25 + p_g)(p_a + p_g)}{(273{,}15 + t_g)} \cdot \frac{d}{d_r}}$$

— If the mass rate M is measured:

$$Q_c = H_i \; \frac{10^3}{3\,600} \; M \sqrt{\frac{1\,013{,}25 + p_g}{p_a + p_g} \; \frac{273{,}15 + t_g}{288{,}15} \; \frac{d_r}{d}}$$

hence:

$$Q_c = \frac{H_i \; M}{61{,}1} \sqrt{\frac{(1\,013{,}25 + p_g)(273{,}15 + t_g)}{(p_a + p_g)} \; \frac{d_r}{d}}$$

where :

Q_c is the corrected heat input (1013,25 mbars, 15 °C, dry gas) based on the net calorific value, in kilowatts (kW);

V is the 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 mass rate of wet gas, in kilograms per hour (kg/h);

H_i as appropriate, is the net calorific value of the dry reference gas at 15 °C, 1 013,25 mbar, in megajoules per cubic metre (MJ/m^3) on the volume basis; or the net calorific value of dry reference gas, in megajoules per kilogram (MJ/kg) on the mass basis;

t_g is the gas temperature at the meter, in degrees Celsius (°C);

d is the relative density of the test gas [2)] ;

d_r is the relative density of the reference gas;

p_g is the gas pressure at the meter in millibars (mbar);

p_a is the atmospheric pressure at the time of the test, in millibars (mbar).

It is checked that the heat inputs, corrected as stated above, comply with the requirement of 4.2.3.

5.4 Gas pressure governor

The governor is adjusted, if necessary, to give the nominal heat input with the reference gas (or with a distributed gas where appropriate) at the normal pressure corresponding to this gas. Keeping the initial adjustment, the supply pressures are varied between p_{min} and p_{max}. It is checked that the requirements of 4.2.4 are satisfied.

The normal pressures, the minimum pressure p_{min} and the maximum pressure p_{max} are given by EN 437.

5.5 Safety of operation

5.5.1 Limiting temperature of control and safety devices

The boiler is installed and supplied with the appropriate reference gas (or with the distributed gas as appropriate) at the nominal maximum heat input. The temperatures of the control and safety devices are measured after 30 minutes operation. It is checked that the requirements of 4.2.5.1 are satisfied.

[2)] 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 :

$$d_h = \frac{d(p_a + p_g - p_s) + 0{,}622\, p_s}{p_a + p_g}$$

where :

p_s is the saturated vapour pressure of water at t_g, in millibars (mbar).

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

5.5.2 Limiting temperature of control knobs and parts to be touched

The boiler is installed as described in 5.1, with the control thermostat set to the position giving the highest temperature.

The temperatures of the control knobs and parts to be touched are measured by means of temperature sensors with the sensing element applied against the external surface of these parts of the boiler.

The temperatures are measured when thermal equilibrium is reached.

It is checked that the requirements of 4.2.5.2 are satisfied.

5.5.3 Limiting temperature of the side walls, the front and the top

The boiler is installed as described in 5.1, with the control thermostat set to the position giving the highest temperature.

The temperatures of the hottest places on the side walls, front and top are measured by means of temperature sensors with the sensing element applied against the external surface of these parts of the boiler.

The temperatures are measured when thermal equilibrium is reached.

It is checked that the requirements of 4.2.5.3 are satisfied.

5.5.4 Limiting temperature of the floor and the test panels

5.5.4.1 Floor

In determining the floor temperatures, the boiler should be installed on a test floor complying, for example, with Figure 4. The surface temperatures of the test floor are measured in at least five places.

It is recommended that the surface temperatures of the test floor are measured with the aid of thermocouples, as illustrated in Figure 5, or with the aid of surface temperature sensors.

It is checked that the requirements of 4.2.5.4 are satisfied.

5.5.4.2 Test panels

For boilers which the manufacturer states may be installed near a wall or walls, the distances between the side and back walls of the boiler and the wooden test panels are those stated by the manufacturer; however in no case is this distance to exceed 200 mm.

For boilers which the manufacturer states may be installed under a shelf or in a similar installation position, an appropriate panel is placed above the boiler at the minimum distance given in the installation instructions.

When the manufacturer gives no details on the installation of the boiler close to a wall or walls, or under a shelf, the test is carried out with appropriate panels placed against the boiler.

The wooden panels shall be (25 ± 1) mm thick and painted matt black; their dimensions shall be at least 50 mm greater than the corresponding dimensions of the boiler.

Temperature sensors are incorporated into the panels at the centre of 100 mm squares and penetrate the panels from the outside so that the hot junctions are situated 3 mm from the surface facing the boiler.

After the boiler has been left to operate, the temperatures of the test panels are measured when these are stable to within ± 2 K.

It is checked that the requirements of 4.2.5.4 are satisfied.

5.5.5 Start up

The boiler is installed according to the manufacturer's instructions and in accordance with 5.1.

The boiler is supplied with the reference gas corresponding to the family or to the group for which the boiler is designed (or with the distributed gas, where appropriate) and the value of the excess air ratio λ is adjusted in accordance with the value given by the manufacturer.

The electrical supply of the boiler is adjusted to 85 % of the minimum value of the range of voltage specified by the manufacturer.

Three start up tests are carried out, the first one with the boiler cold.

For the second and the third start-up tests, the boiler is switched off and immediately switched on again within less than 5 sec.

It is checked that the requirements of 4.2.5.5 are satisfied.

5.5.6 Ignition and flame stability

5.5.6.1 Tests with the reference gas

The boiler is installed in accordance with 5.1 and supplied with each reference gas for the burner category (or with the distributed gas, where appropriate) at the normal pressure so as to obtain the nominal heat input. The boiler is switched on. Under these conditions the requirements of 4.2.5.6 a), 4.2.6.2, 4.2.6.3.1 and 4.2.6.5 are verified.

The requirement on the flame stability is checked visually.

Ignition is attempted with progressively reduced inlet pressures until the limit of operation of the flame supervision device or low pressure gas switch. It is checked that the corresponding requirement of 4.2.5.6 b) is satisfied.

With the heat input adjusted to the minimum nominal value, the excess air ratio λ is adjusted to 1,5 or greater or the air damper is fully opened, as appropriate. The requirements of 4.2.5.6 a) are verified.

If the gas supply to the ignition burner is taken between the two automatic valves of the main burner, the automatic valve immediately upstream of the main burner is kept fully open artificially. The boiler is supplied with a reference gas or a distributed gas at normal pressure. The requirements of 4.2.6.2 are checked.

5.5.6.2 Tests with limit gas

For all boilers the heat input with the reference gas is increased by 9 % or the reference gas is replaced by the corresponding incomplete combustion gas. The requirements of 4.2.5.6 a) are verified.

For boilers equipped with a total pre-mixed burner, the reference gas is replaced by light back gas. The boiler is switched on. The requirements of 4.2.5.6 a) are verified.

For boilers of heat input not exceeding 150 kW equipped with total pre-mixed burners, the reference gas is replaced by the lift limit gas without readjustment of the maximal and minimal heat input. The boiler is switched on. The requirements of 4.2.5.6 a) are verified.

5.5.7 Resistance of the burner to overheating

5.5.7.1 Boilers equipped with nozzle mixed burners

The burner is supplied with reference gas (or with the distributed gas, where appropriate) at 1,09 times its nominal maximum heat input and the pressure in the combustion chamber adjusted to the maximum value corresponding to the nominal maximum heat input specified by the manufacturer.

The burner is operated for 10 min after which it is checked that the requirements of 4.2.5.7 are satisfied.

5.5.7.2 Boilers equipped with total pre-mixed burners

The burner is adjusted in accordance with 5.1. Without re-adjustment the burner is then supplied with the appropriate light back gas and operated for 10 min. At the end of this time it is checked that the requirements of 4.2.5.7 are satisfied.

5.5.8 Pre-purge

The boiler is operated from the beginning of the burner control programme. The duration of the pre-purge is measured. It is checked that the requirements of 4.2.5.8 are satisfied.

5.6 Control and safety equipments

5.6.1 Start-up heat input

The boiler is operated with the electrical supply at its nominal voltage. The maximum start-up heat input is measured. Under these conditions it is checked that the requirements specified in 4.2.6.1 are satisfied.

5.6.2 Safety times

The tests are carried out with the reference gas or gases of the respective gas family or group (or with a distributed gas where appropriate).

5.6.2.1 Ignition safety time

The boiler is switched off and the flame detector device is put out of action.

Or the low pressure gas switch, if any, is put out of operation. The gas supply is shut off.

The signal is given to admit gas to the ignition burner, if any, and to the main burner. The time that elapses between this signal and the moment when the safety device gives the order to shut off the gas valve is measured.

It is checked that the requirements of 4.2.6.4.1 are satisfied.

5.6.2.2 Extinction safety time

With the boiler in operation, a flame failure is simulated by putting the flame sensor out of action. The time that elapses between this operation and the moment at which the safety device gives the order to shut off the gas valve is measured.

It is checked that the requirements of 4.2.6.4.2 are satisfied.

5.6.2.3 Total closing time

With the boiler in operation, a flame failure is simulated by putting the flame sensor out of action. The time between this action and the moment at which the valve is actually closed is measured.

It is checked that the requirements of 4.2.6.4.3 are satisfied.

5.6.2.4 Failure to ignite

The gas supply is shut off. The boiler is switched on. The requirements of 4.2.6.5 are checked.

5.6.2.5 Flame failure during the running condition

The boiler is switched on. The gas supply is shut off. The requirements of 4.2.6.6 are checked.

5.6.3 Checking the operation of control thermostats and safety temperature limiters

The waterside conditions of the boiler are as required to produce the maximum nominal output. The output from the test rig shall be equal to (40 ± 5) % of the nominal heat input.

The circulation pump is in continuous operation. Set the control thermostat at its maximum value. The operation of the control thermostat is checked.

The same test is repeated after short-circuiting the control thermostat.

It is checked that the requirements of 4.2.6.8 are satisfied.

5.7 Combustion

5.7.1 Combustion at the maximum nominal heat input

With the appropriate reference gas (or with the distributed gas, where appropriate) at normal supply pressure

— the heat input is adjusted to the maximum nominal value;

— the electrical supply voltage is adjusted to the nominal value;

— the excess air ratio λ is adjusted to the declared value.

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

The CO and NO_X concentrations are given in the dry, air-free combustion products in accordance with Annex E.

It is checked that the requirements of 4.2.7.1 a) and 4.2.7.2 are satisfied.

The supply voltage is reduced to 85 % of the nominal voltage. It is checked that the requirements of 4.2.7.1 b) are met.

When the supply voltage drops below 85 % of the nominal voltage, it is checked that the requirements of 4.2.7.1 d) are met.

The heat input with the reference gas is increased by 9 % or the reference gas is replaced by the corresponding incomplete combustion gas.

It is checked that the requirements of 4.2.7.1 c) are met.

5.7.2 Combustion at the minimum nominal heat input

With the appropriate reference gas (or with the distributed gas, where appropriate) at normal supply pressure:

— the heat input is adjusted to the minimum nominal value;

— the electrical supply voltage is adjusted to the nominal value;

— the excess air ratio λ is adjusted to the declared value.

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

The CO and NO_X concentrations are given in the dry, air-free combustion products in accordance with Annex E.

It is checked that the requirements of 4.2.7.1 a) and 4.2.7.2 are satisfied.

The heat input with the reference gas is increased by 9 % or the reference gas is replaced by the corresponding incomplete combustion gas.

It is checked that the requirements of 4.2.7.1 c) are met.

5.7.3 Combustion at the minimum controlled heat input (multi stage or modulating burners)

These tests are conducted for all multistage or modulating boilers.

The boiler operates at the first stage or at its lowest heat input as appropriate.

It is checked that the requirements of 4.2.7.1 a) and 4.2.7.2 are satisfied.

The test is then repeated at the mid-point of the heat input range.

5.8 Useful efficiencies

5.8.1 Useful efficiency at the maximum nominal heat input

The boiler is connected to the test flue with the largest diameter stated by the manufacturer in his instructions.

The flow temperature is adjusted up to (80 ± 2) °C and the temperature difference between the flow and return of the boiler is in accordance with 5.1.2.3.

The measurement of the efficiency may begin once the boiler, with the control thermostat put out of action, is at thermal equilibrium and the return and flow temperatures are constant.

The hot water is passed into a vessel placed on scales (suitably tared before beginning the test) and at the same time measurement of the gas rate is started (meter reading).

Readings of the water return and flow temperatures are taken periodically so as to obtain a sufficiently accurate average.

Mass m_1 of water is collected for a period of 10 min. However where the heat input of the boiler demands that large volumes of water be collected, the test may be carried out for a shorter period of time.

If the water mass cannot be measured, it is permitted to measure the water flow rate during a given period and to calculate the equivalent water mass. However, the accuracy for the measurement of the flow rate shall be sufficient to calculate the efficiency within the required tolerances.

A waiting time of 10 min, or a shorter period if necessary, is required in order to evaluate the evaporation corresponding to the test period. Mass m_2 is obtained.

$m_1 - m_2 = m_3$ is the quantity to be taken into account in order to increase m_1 by the value corresponding to the evaporation, whence corrected water mass $m = m_1 + m_3$.

The quantity of heat transferred by the boiler to the water collected in the vessel is proportional to the corrected mass m and to the difference between the temperatures, t_1 at the cold water inlet and t_2 at the boiler outlet.

The useful efficiency is calculated from the formula:

$$\eta_u = \frac{4{,}186 \cdot m \cdot (t_2 - t_1) + D_p}{10^3 \cdot V_{r(10)} \cdot H_i} \cdot 100$$

where:

η_u is the useful efficiency in percent ;

m is the corrected quantity of water, in kilograms (kg);

$V_{r(10)}$ is the gas consumption measured during the 10 minutes of the test, corrected to 15°C, 1013,25 mbar, in cubic metres (m^3);

H_i is the net calorific value of the gas used, in megajoules per cubic metre (MJ/m^3), (at 15 °C and 1013,25 mbar, dry);

D_p is the heat loss from the test rig corresponding to the mean water flow temperature, expressed in kilojoules (kJ), taking into account the heat contribution from the circulation pump (a practical calibration method for determining D_p is described in Annex B).

The measurement uncertainties are chosen in a way which ensures a total uncertainty in the efficiency measurement of ± 2 %.

The useful efficiency is determined at the maximum nominal heat input.

It is verified that the requirements of 4.2.8.1 are satisfied.

5.8.2 Useful efficiency at part load

5.8.2.1 General

To determine the useful efficiency at a load corresponding to 30 % of the maximum nominal heat input, the manufacturer has the choice of either the direct method or the indirect method.

It is checked that the requirements of 4.2.8.2 are satisfied.

5.8.2.2 Direct method

The boiler is installed as stated in 5.1.2.2 and supplied with one of the reference gases (or with the distributed gas, where appropriate) as for the determination of the useful efficiency at maximum nominal heat input.

Throughout the test, the water volumetric rate is maintained constant within ± 1 %, taking into account temperature variations, and the pump operates continuously.

5.8.2.2.1 Operating mode n° 1

The boiler is fitted to the test rig illustrated in Figure 1 or 2 (or any other test rig giving at least comparable results and equivalent measurement accuracies).

The boiler water return temperature is held constant, with a maximum variation in this temperature of ± 1 K during the measurement period at the appropriate temperatures:

— (47 ± 1) °C for standard boilers, and

— (37 ± 1) °C for low temperature boilers.

If the boiler control does not permit operation at a water return temperature that is low enough, the test is carried out at the lowest water return temperature compatible with the boiler control.

A time switch is fitted to the room thermostat to obtain a working cycle of 10 minutes.

The shutdown time (t_3) and operating times (t_1, t_2, t_{21} and t_{22}) are calculated as indicated in 5.8.2.3.2.

The temperatures are measured continuously directly on the flow and return of the boiler.

The boiler is considered to be in thermal equilibrium when the efficiency measurement of three consecutive cycles, combining any two, does not vary by more than 0,5 %. In this case, the result is equal to the average value of at least three consecutive measurement cycles. For any other case, the average value is calculated from at least ten consecutive cycles.

The respective figures gas and water consumption over complete cycles are determined.

The efficiency is determined using the formula in 5.8.1.

A deviation of ± 2 %, with respect to the 30 % of the nominal heat input is permitted. For deviations up to ± 4 % it is necessary to carry out two measurements, one above and one below 30 % of the nominal heat input. The efficiency corresponding to 30 % is determined by linear interpolation.

5.8.2.2.2 Operating mode n° 2

The boiler is fitted to the test rig illustrated in Figure 1 or 2 (or any other test rig giving at least comparable results and equivalent measurement accuracies).

The boiler water flow and return temperatures and the operating and off cycles are given by the boiler control. The temperatures are measured continuously as close as possible to the flow and at the return of the boiler when (30 ± 2) % of the maximum nominal input is drawn through the heat exchanger.

The average water temperature shall be no less than the temperatures given below:

— 50 °C for standard boilers, and

— 40 °C for low temperature boilers.

If the boiler control does not permit operation at a water return temperature that is low enough, the test is carried out at the lowest water return temperature compatible with the boiler control.

The boiler is considered to be in thermal equilibrium when the efficiency measurement of three consecutive cycles, combining any two, does not vary by more than 0,5 %. In this case, the result is equal to the average value of at least three consecutive measurement cycles. For any other case, the average value shall be calculated from at least ten consecutive cycles.

The respective figures gas and water consumption over complete cycles are measured.

The efficiency is determined using the formula in 5.8.1.

A deviation of ± 2 %, with respect to the 30 % of the nominal heat input is permitted. For deviations up to ± 4 % it is necessary to carry out two measurements, one above and one below 30 % of the nominal heat input. The efficiency corresponding to 30 % is determined by linear interpolation.

5.8.2.3 Indirect method

5.8.2.3.1 Measurements

5.8.2.3.1.1 Useful efficiency at the nominal heat input at 50 °C

The test of 5.8.1, at the nominal heat input, is repeated with the following flow and return temperatures as given by Table 5.

Table 5 — Flow and return temperatures at nominal heat input

	Flow temperature (°C)	Return temperature (°C)	Mean temperature (°C)
Standard boiler	60 ± 2	40 ± 1	50 ± 1
Low temperature boiler	50 ± 2	30 ± 1	40 ± 1

The measured value η_1 is noted.

5.8.2.3.1.2 Useful efficiency at the minimum controlled rate

If the boiler is fitted with a control system incorporating a main burner reduced rate, a test is carried out at the minimum heat input allowed by the control at the following flow and return temperatures as given by Table 6.

Table 6 — Flow end return temperatures at minimum controlled rate

	Flow temperature (°C)	Return temperature (°C)	Mean temperature (°C)
Standard boiler	55 ± 2	45 ± 1	50 ± 1
Low temperature boiler	45 ± 2	35 ± 1	40 ± 1

The measured value is designated η_2.

If the boiler is fitted with a control system incorporating two main burner reduced rates, in which one has a heat input greater than 30 % of the nominal heat input and the other has a heat input less than 30 % of the nominal heat input, the efficiencies corresponding to the two inputs are determined.

The measured values are designated by:

— η_{21} for the larger heat input;

— η_{22} for the smaller heat input.

5.8.2.3.1.3 Standby losses

The test installation is described in Figure 12.

The circuits joining the different parts of the installation are insulated and as short as possible. The inherent losses of the test installation and the thermal contribution of the pump for the different flow rates are determined at the beginning to be able to take account of them (see Annex C).

The boiler is fitted with the largest diameter test flue as stated by the manufacturer in the technical instructions.

The boiler water temperature is brought to a mean temperature of (30 ± 5) K above ambient temperature for standard boilers or (20 ± 5) K for low temperature boilers. The gas supply is then shut off, the additional pump (11) and the boiler pump, if any, are stopped, and the exchanger circuit (12) is shut off.

With the water circulating continuously by means of the pump (5) of the test rig, the thermal contribution of the electric boiler is adjusted so as to obtain, in the steady state condition, a difference of (30 ± 5) K between the mean water temperature and the ambient temperature for standard boilers or (20 ± 5) K for low temperature boilers.

Throughout the test, the variation in room temperature shall not exceed 2 K per hour.

Then:

— P_m the electrical power consumed by the auxiliary electric boiler, corrected for the losses of the test rig and the thermal contribution of the pump (5), in kilowatts (kW);

— T the mean water temperature equal to the mean of the temperature indicated by the two probes (2) at the return and the flow of the boiler on test, in degrees Celsius (°C);

— T_A the ambient temperature during the test, in degrees Celsius (°C);

are noted.

The standby losses P_s, expressed for an ambient temperature of 20 °C, are given, in kilowatts (kW), by:

$P_s = P_m \left[\frac{30}{T - T_A}\right]^{1,25}$, for standard boilers, for a mean water temperature of 50 °C, and

$P_s = P_m \left[\frac{20}{T - T_A}\right]^{1,25}$, for low temperature boilers, for a mean water temperature of 40 °C

5.8.2.3.2 Calculation

The useful efficiency for a load of 30 % of the maximum nominal heat input at an average water temperature of 50 °C for standard boilers and of 40 °C for low temperature boilers, is calculated for a control cycle.

The symbols of Table 7 are used.

Table 7 — Symbols and quantities needed to calculate the useful efficiency at part load

Operational phases of the main burner	Heat input kW	Operational time s	Measured values at 50 °C
			efficiency %
Full rate	Q_1	t_1	η_1
Reduced rate	Q_2	t_2	η_2
Reduced rate > 0,3 Q_1	Q_{21}	t_{21}	η_{21}
Reduced rate < 0,3 Q_1	Q_{22}	t_{22}	η_{22}
Controlled off	Q_3	t_3	Standby losses P_s (kW)

The efficiency is calculated from the ratio of the useful energy to the energy supplied by the gas during a 10 minute cycle.

Depending on the means of control, the following operating cycles can be identified, which correspond to the formulae in Table 8:

a) permanent operation with $Q_2 = 0{,}3\ Q_1$ (fixed reduced rate or modulating);

b) full rate/controlled off (one fixed rate);

c) reduced rate/controlled off operation (one or several reduced rates or modulation where the minimum heat input $Q_2 > 0{,}3\ Q_1$) (or cycle 6 if, by design, the ignition is carried out at full rate);

d) full rate/reduced rate operation (one or several reduced rates where the minimum heat input $Q_2 < 0{,}3\ Q_1$);

e) operation with two reduced rates (where $Q_{21} > 0{,}3\ Q_1$ and $Q_{22} < 0{,}3\ Q_1$);

f) full rate/reduced rate/controlled off operation (by design, ignition is carried out at Q_1 for a time t_1, with one or several reduced rates or modulation such that the cycle comprises a controlled shut down ($t_3 > 0$); otherwise cycle 4 above applies).

The efficiency is calculated as indicated in Table 8.

Table 8 — Calculation of the useful part load efficiency

Conditions of operation		Heat input	Cycle time (s)	Meas.	Useful efficiency (%)
1	30 % reduced rate	$Q_2 = 0{,}3 \cdot Q_n$	$t_2 = 600$	η_2	$\eta_u = \eta_2$
2	Full rate	$Q_1 = Q_n$ [1)]	$t_1 = \frac{180\ Q_1 - 600\ Q_3}{Q_1 - Q_3}$	η_1	$\eta_u = \frac{\frac{\eta_1}{100}\ Q_1 t_1 + 0{,}8\ Q_3 t_3 - P_s t_3}{Q_1 t_1 + Q_3 t_3} \times 100$
	Controlled off	Q_3 = permanent ignition burner	$t_3 = 600 - t_1$	P_s	
3	Reduced rate	$Q_{21} > 0{,}3 \cdot Q_n$	$t_{21} = \frac{180\ Q_{21} - 600\ Q_3}{Q_{21} - Q_3}$	η_{21}	$\eta_u = \frac{\frac{\eta_{21}}{100}\ Q_{21} t_{21} + 0{,}8\ Q_3 t_3 - P_s t_3}{Q_{21} t_{21} + Q_3 t_3} \times 100$
	Controlled off	Q_3 = permanent ignition burner	$t_3 = 600 - t_{21}$	P_s	
4	Full rate	$Q_1 = Q_n$ [1)]	$t_1 = \frac{180\ Q_1 - 600\ Q_{22}}{Q_1 - Q_{22}}$	η_1	$\eta_u = \frac{\frac{\eta_1}{100}\ Q_1 t_1 + (\frac{\eta_{22}}{100})\ Q_{22} t_{22}}{Q_1 t_1 + Q_{22} t_{22}} \times 100$
	Reduced rate	$Q_{22} < 0{,}3 \cdot Q_n$	$t_{22} = 600 - t_1$	η_{22}	
5	Reduced rate 1	$Q_{21} > 0{,}3 \cdot Q_n$	$t_{21} = \frac{180\ Q_{21} - 600\ Q_{22}}{Q_{21} - Q_{22}}$	η_{21}	$\eta_u = \frac{\frac{\eta_{21}}{100}\ Q_{21} t_{21} + \frac{\eta_{22}}{100}\ Q_{22} t_{22}}{Q_{21} t_{21} + Q_{22} t_{22}} \times 100$
	Reduced rate 2	$Q_{22} < 0{,}3 \cdot Q_n$	$t_{22} = 600 - t_{21}$	η_{22}	
6	Full rate	$Q_1 = Q_n$ [1)]	t_1 = measured value (see annex Q)	η_1	$\eta_u = \frac{\frac{\eta_1}{100} Q_1 t_1 + \frac{\eta_2}{100} Q_2 t_2 + 0{,}8\ Q_3 t_3 - P_s t_3}{Q_1 t_1 + Q_2 t_2 + Q_3 t_3} \times 100$
	Reduced rate	Q_2	$t_2 = \frac{(180 - t_1) Q_1 - (600 - t_1) Q_3}{Q_2 - Q_3}$	η_2	
	Controlled off	Q_3 = permanent ignition burner	$t_3 = 600 - (t_1 + t_2)$	P_s	

[1)] Q_n is replaced by the arithmetic mean Q_a of the maximum and minimum heat input for range-rated boilers.

5.9 Condensation

The boiler is operated at the lowest temperature declared in the manufacturer instruction's for one hour.

The requirements of 4.2.9 are checked.

6 Marking and instructions

6.1 Marking

6.1.1 Data plate

Each boiler 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, carrying at least the following information:

a) the name of the manufacturer[3)] or his identification symbol;

b) the serial number or year of manufacture;

c) the trade name of the boiler;

d) the direct and indirect country(ies) of destination. In accordance with EN ISO 3166-1, the names of countries shall be represented by the following codes:

Austria	AT	Greece	GR
Belgium	BE	Ireland	IE
Switzerland	CH	Iceland	IS
Czech Republic	CZ	Italy	IT
Germany	DE	Luxembourg	LU
Denmark	DK	Netherlands	NL
Spain	ES	Norway	NO
Finland	FI	Portugal	PT
France	FR	Sweden	SE
United Kingdom	GB		

e) the category(ies) of boiler in relation to the direct countries of destination;.

f) 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";

g) the nominal useful output or, for range rated boilers, the maximum and minimum useful outputs in kilowatts, given by the symbol "*P*", followed by the equals sign, the numerical value(s) and the unit "kW";

3) Manufacturer means the organization or company which assumes responsibility for the product

h) the nominal heat input or for range rated boilers, the maximum and minimum heat inputs, in kilowatts, given by the symbol "*Q*", followed by the equals sign, the numerical value(s) and the unit "kW";

i) the maximum water pressure at which the boiler can be used, in bar, given by the symbol "PMS", followed by the equals sign, the numerical value and the unit "bar";

j) the electrical supply;

- the nature given by the symbol "~" or "=",
- the nominal voltage of the electrical supply in volts given by the numerical value followed by the unit "V",
- the power consumption in watts given by the numerical value followed by the unit "W";

k) the NO_x class of the boiler followed in brackets by the maximum value of emission of this class in mg/kWh.

The indelibility of markings is checked by a test carried out in accordance with 7.14 of EN 60335-1:2002.

6.1.2 Supplementary marking

On an additional plate, the appliance shall carry visible and indelible information relating to its state of adjustment:

a) the direct country(ies) of destination in accordance with the symbols in 6.1.1;

b) the gas group or range, the indication of gas type, the gas supply pressure and/or the pressure couple in accordance with EN 437 (e.g. 2L - G 20 - 20 mbar).

This information may be carried on the data plate.

6.1.3 Packaging

The packaging shall carry the category(ies), the appliance type and information given on the additional data plate (see 6.1.2) as well as warnings in accordance with 6.1.4.

6.1.4 Warnings on the boiler and on the packaging

Warnings carried on the boiler shall be visible to the user.

a) the boiler may only be installed in a room which complies with the appropriate ventilation requirements;

b) read the installation instructions before installing the boiler;

c) read the user's instructions before lighting the boiler.

6.1.5 Other information

No other information shall be carried on the boiler 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 direct country(ies) of destination.

6.2 Instructions

6.2.1 Technical instructions

Each boiler shall be accompanied by instructions giving requirements for the installation, the adjustment and servicing of the boiler according to the rules in force in the country where the boiler will be installed. In all cases, the documents shall be given in the language of the country and must carry the date of publication.

These instructions shall at least include the following information:

a) the information on the data plate, with the exception of the serial number and the year of manufacture;

b) the maximum water temperature in °C (≤ 105 °C);

c) the minimum return temperature in °C;

d) a warning for boilers with a normal operation temperature exceeding 90 °C;

e) that the boiler shall only be used to equip heating installations designed for safety temperatures of at least 110 °C or 120° C, as appropriate;

f) the servicing necessary and the recommended service interval;

g) the recommended method for cleaning the boiler;

h) reference to certain standards and/or particular regulations if these prove to be necessary for the correct installation and use of the boiler;

i) an electrical wiring diagram with terminals (including those for external control);

j) an indication of the controls which may be used;

k) the precautions to be taken to limit the level of operating noise of the installation;

l) the obligation to earth boilers incorporating electrical equipment;

m) for sealed systems, instructions concerning the installation of a pressurized expansion vessel when the boiler designed for this kind of system is not originally fitted with such a device;

n) if necessary, indication that the boiler can only be installed with a central heating system with an open expansion vessel;

o) necessary information concerning the gas supply connection, the supply pressure, the pressure supervision and the adjustment pressure;

p) for boilers capable of operating on several gases, information on the operations required to convert from one gas to another and indication that the adjustments and modifications shall only be carried out by a competent person and that the adjuster shall be sealed after the adjustment;

q) the minimum distances to be maintained from easily inflammable materials;

r) if necessary, information that walls sensitive to heat, for example wood, shall be protected by suitable insulation, and the clearance to be observed between the walls near the boiler and the hot parts on the outside of the boiler;

s) a table giving for the different categories and the different gases the volume or mass rates in m^3/h or kg/h, expressed at the mean conditions of use (15 °C, 1 013,25 mbar, dry gas) or the gas pressure at the burner as a function of the pressure in the combustion chamber;

t) a general description of the boiler, with an illustration of the principal parts (sub-assemblies) which can be removed and replaced;

u) information on:

1) either the characteristic curve of the water pressure head available at the boiler outlet connection if the boiler has an integral pump;

2) or the pressure loss as a function of water rate, in graphical or tabular form, for a boiler supplied without a pump;

v) for the chimney calculation, an indication of the combustion products mean temperature and mass rate in grams per second;

w) the measures to be taken into account when the national requirements for the avoidance of condensation in chimneys are not fulfilled;

x) if relevant, the indication that the boiler is intended to be installed solely on a gas installation with a governed meter;

y) information on the air supply and ventilation requirements of the room where the boiler is installed.

6.2.2 User's instructions

These instructions, which must accompany the boiler at the time of the delivery, are intended for the user.

They shall:

a) point out that a competent person should be called on to install, and adjust the boiler where appropriate;

b) specify the operations to start up and stop the boiler;

c) explain the operations necessary for normal operation, cleaning of the boiler and point out that the boiler should be checked and maintained periodically by a qualified person;

d) explain any precautions to be taken if necessary against frost;

e) warn against incorrect use;

f) draw the users attention to the air supply and ventilation requirements of the room where the boiler is installed;

g) if necessary, draw the user's attention to the risks of burning if in direct contact with the viewing window or its immediate surroundings.

6.2.3 Chemical composition of the condensate for low temperature boilers

The manufacturer shall communicate the possible chemical composition of the condensate (pH, heavy metals, etc.), if the composition is required by national regulations.

6.2.4 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 competent person.

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) state that broken seals shall be re-made and/or any adjusters shall be sealed;

d) state that for appliances operating with a pressure couple, any governor 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 boiler shall be supplied with the parts and the conversion instructions. It shall be possible to state on this label the supplementary marking specified in 6.1.2, indicating:

a) the gas group or range;

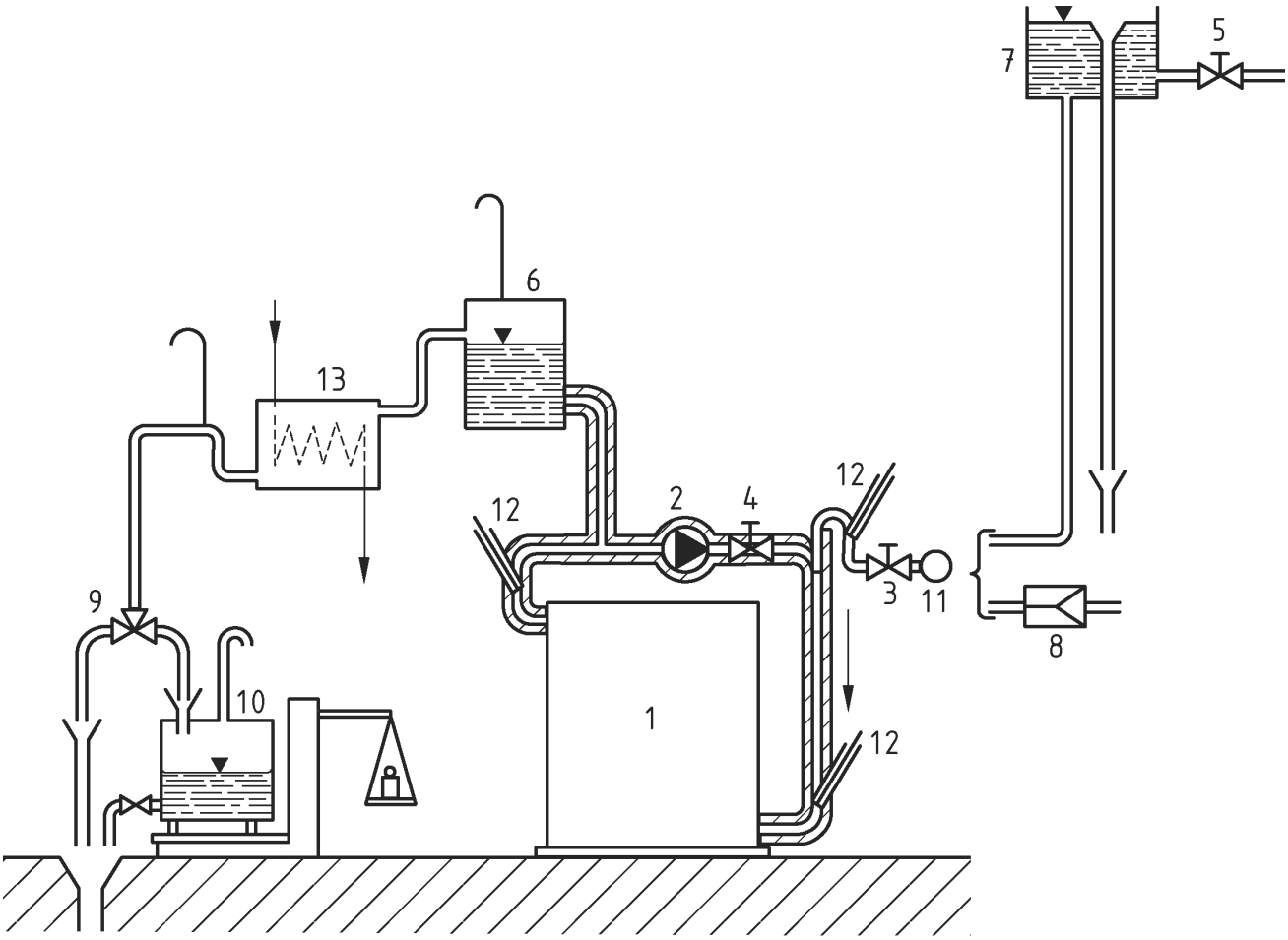
b) the gas type;

c) the gas supply pressure and/or the pressure couple;

d) the adjusted heat input, where appropriate.

6.3 Presentation

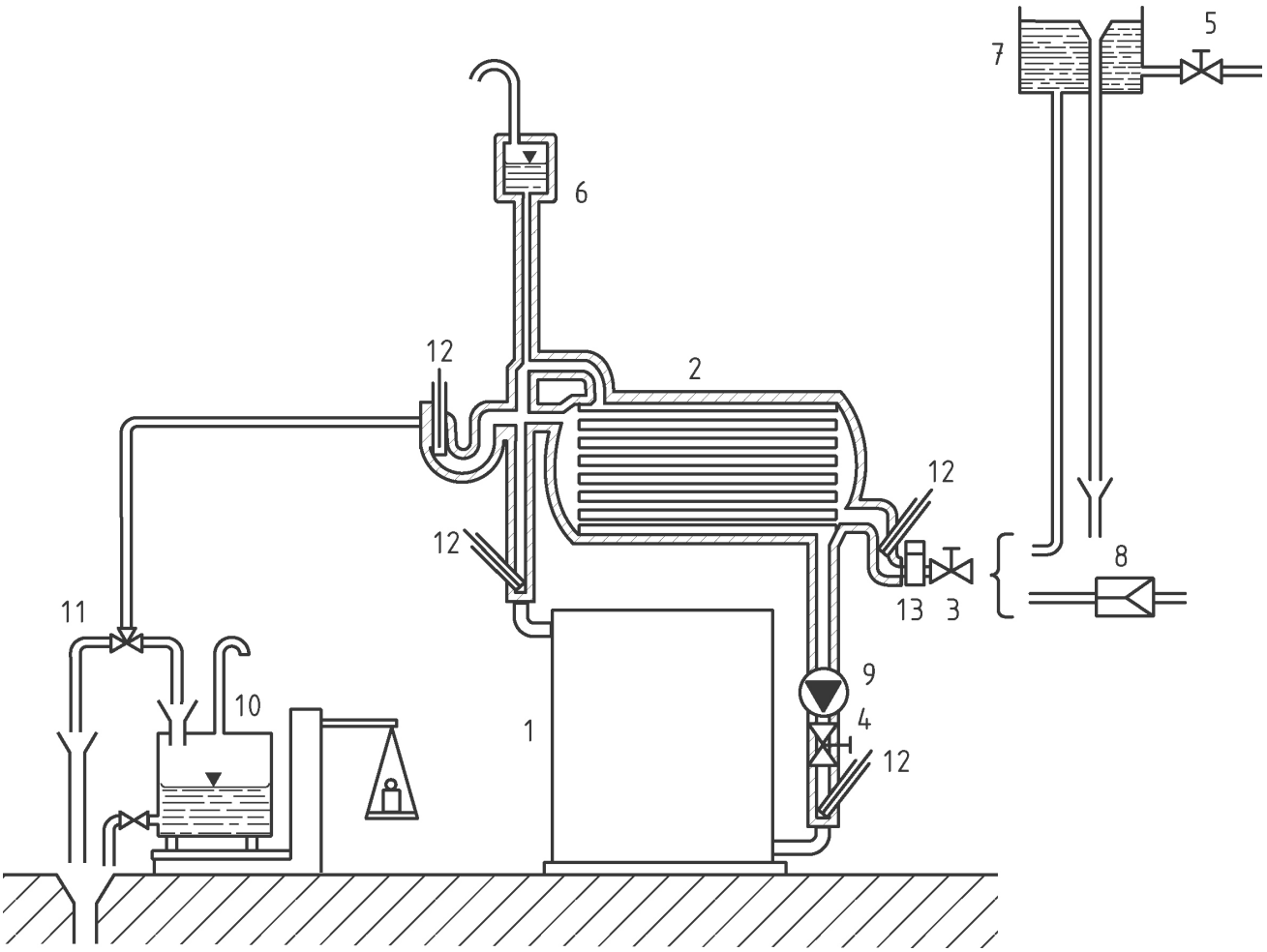
All the information of 6.1 and 6.2 is given in the language(s) and according to the practice of the country(ies) in which the boiler is intended to be installed.



Key

1 Boiler under test
2 Circulating pump
3 Control valve I
4 Control valve II
5 Control valve III
6 Compensating tank
7 Constant head tank or
8 Connection to constant pressure distribution pipe
9 Three-way tap
10 Weighing vessel
11 Water meter
12 Temperature measurements
13 Cooler

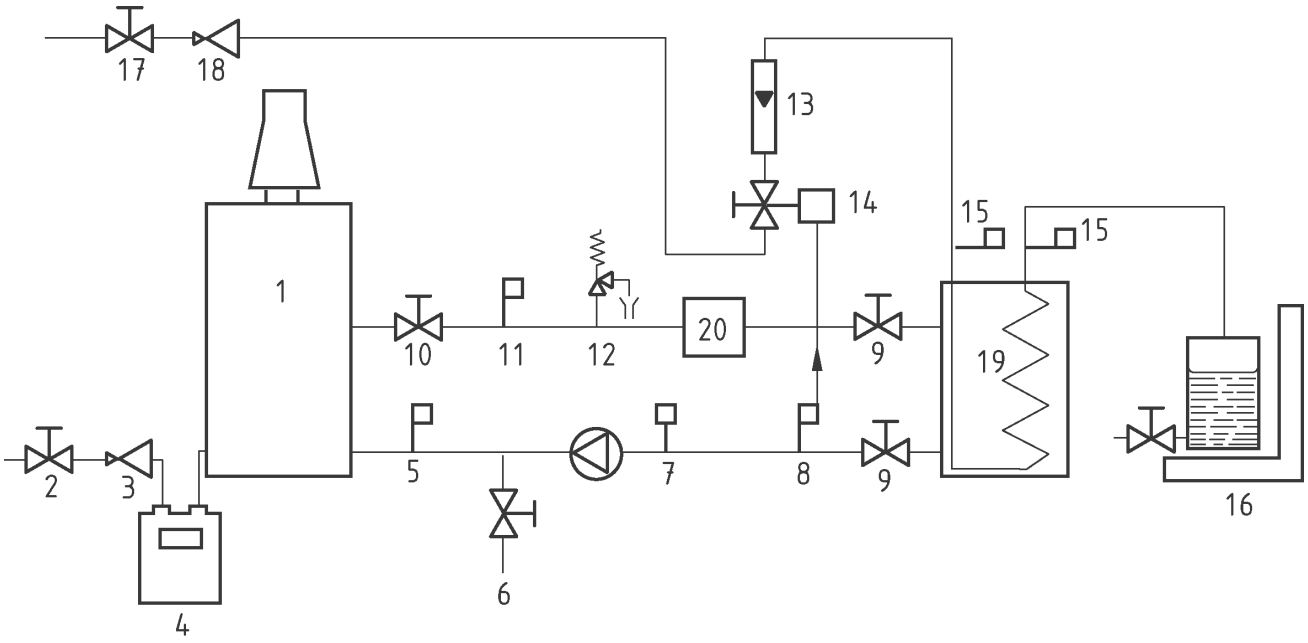
Figure 1 — Test rig with direct re-circulation (see 5.8.2.2.1, 5.8.2.2.2 and Annex B)



Key

1 Boiler
2 Heat exchanger
3 Control valve I
4 Control valve II
5 Control valve III
6 Expansion vessel (not in the circulating system)
7 Constant head tank or
8 Connection to constant pressure distribution pipe
9 Circulating pump
10 Weighing vessel
11 Three-way tap
12 Temperature measurements
13 Water meter

Figure 2 — Test rig with heat exchanger (see 5.8.2.2.1, 5.8.2.2.2 and Annex B)

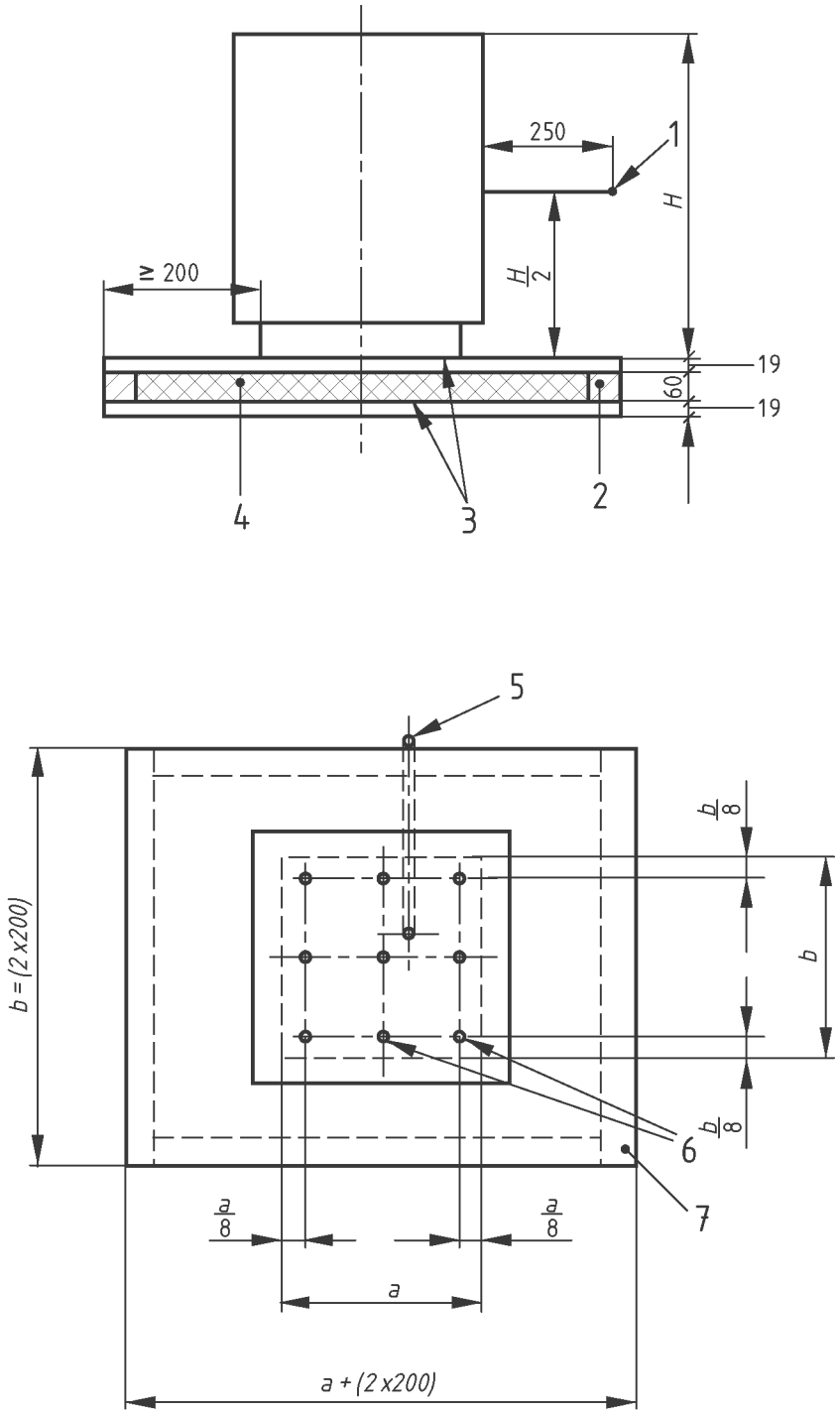


Key

1	Boiler under test
2/17	Shut-off valve
3/18	Gas governor
4	Gas meter
5/8/11/15	Thermometer
6	Drain tap
14	Control valve
9/10	Shut-off valve
12	Control and relief valve
13	Rotameter
16	Balance
19	Heat Exchanger
20	Heat buffer

Figure 3 — Test rig for determination of efficiency (see 5.8.2.2.1)

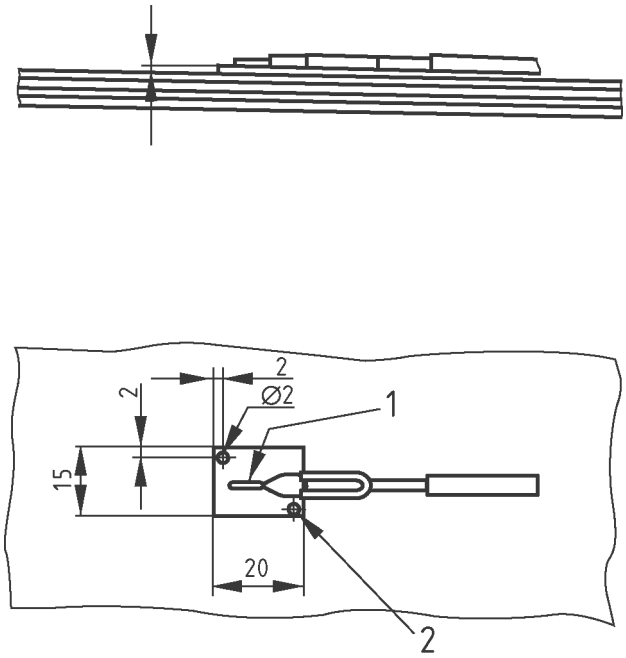
Dimensions in millimetres



Key

1 Air temperature measurement point
2 Squared timber frame
3 Norway spruce with groove and tongue
4 Glass fibre
5 Hollow tube for measurement cable
6 Measurement points
7 Test floor for measuring floor temperature

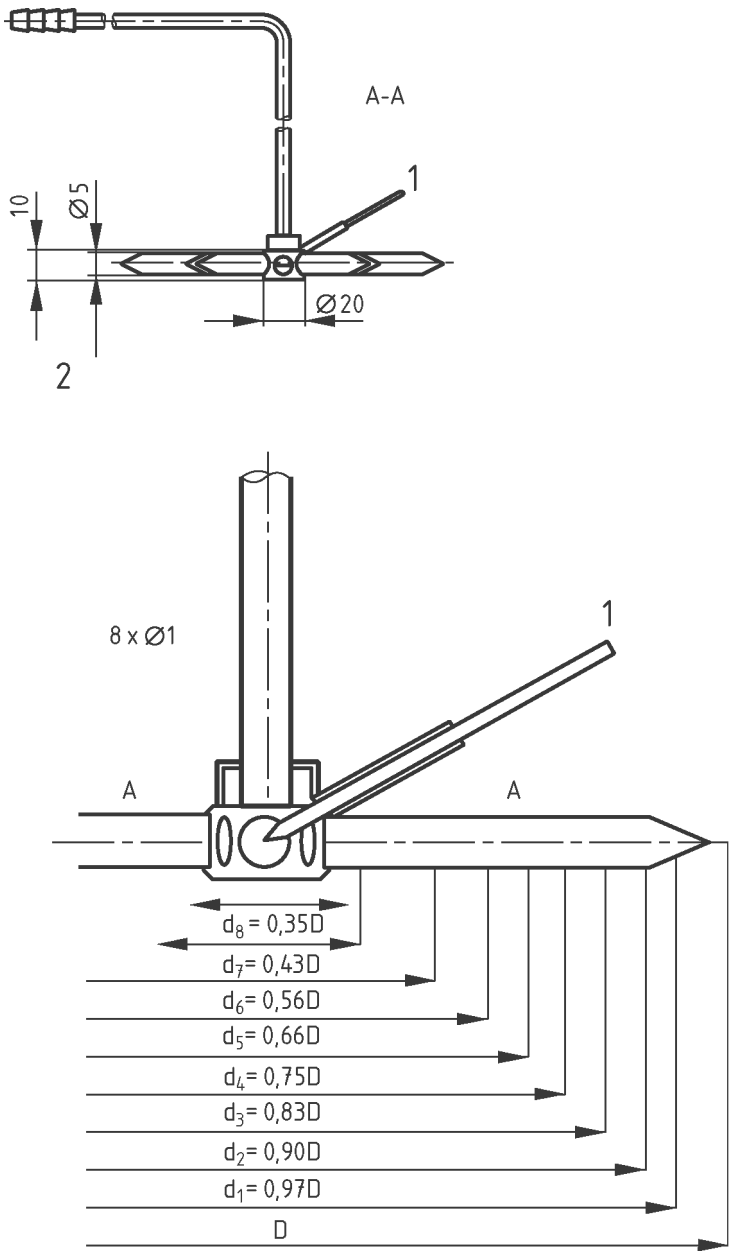
Figure 4 — Test configuration for determining floor temperature (see 5.5.4)



Key
1 Thermocouple brazed to copper plate
2 Hole for fitting copper plate

Figure 5 — Thermocouple configuration for measuring surface temperatures on test floor (see 5.5.4)

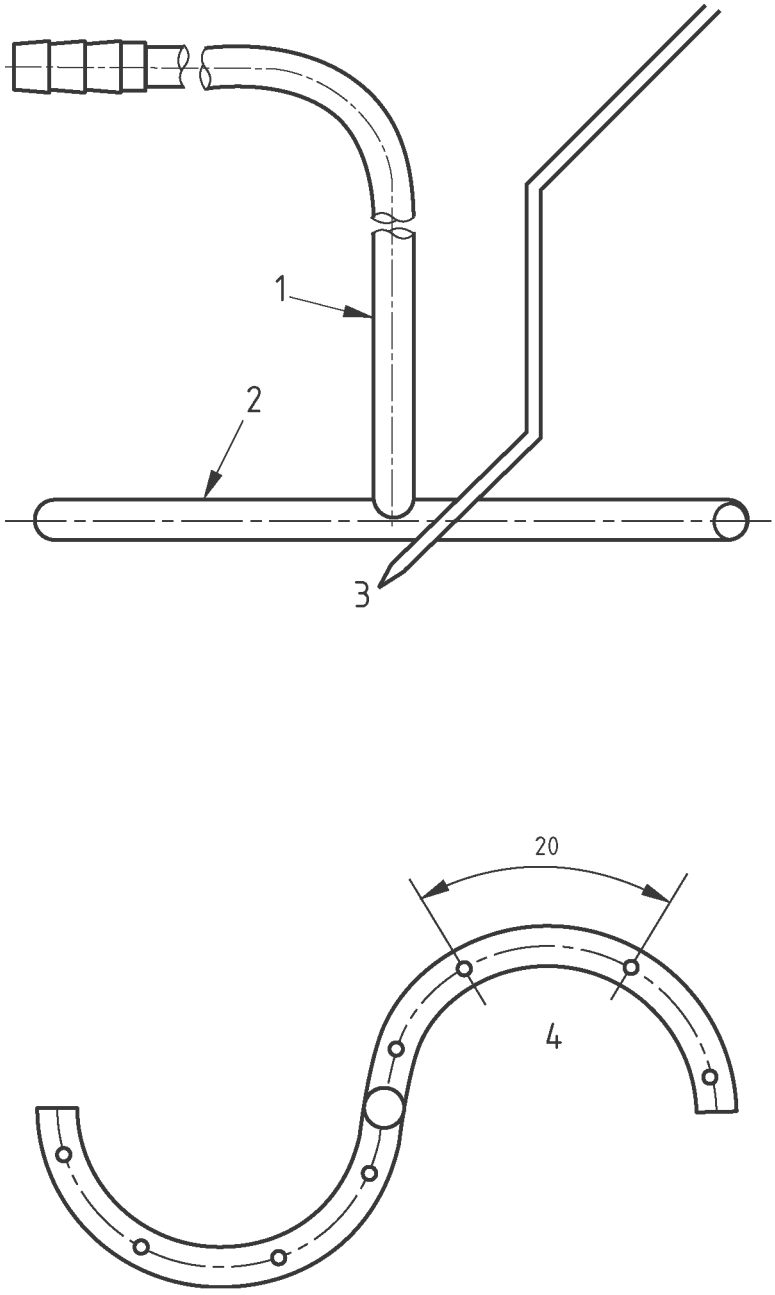
Dimensions in millimetres



Key
1 Openings in each branch: 8 x Ø 1
2 Thermocouple

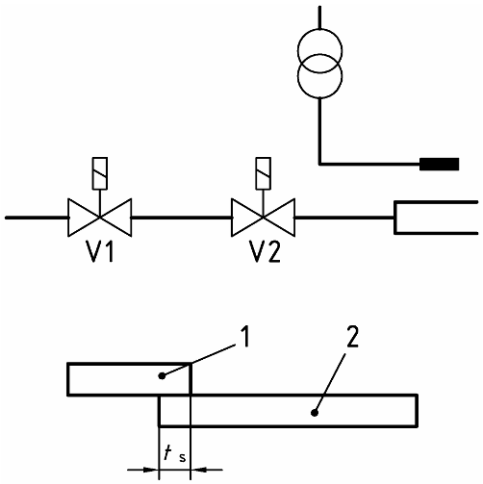
Figure 6 — Sampling probe for flue diameters greater than DN 100

Dimensions in millimetres



Key
1 Tube Ø 6
2 Tube Ø 4/3
3 Thermocouple
4 Openings: 8 x Ø 1

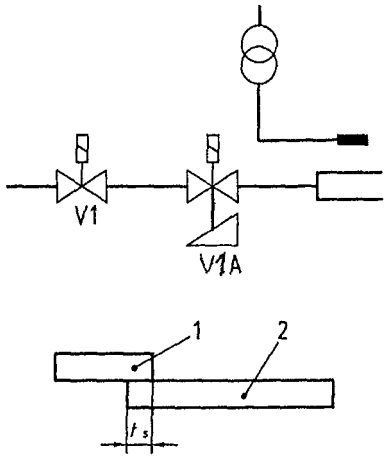
Figure 7 — Sampling probe for flue diameters not greater than DN 100



Key

V1, V2	Main gas safety shut-off valves
t_s	Safety time
1	Ignition
2	Main burner

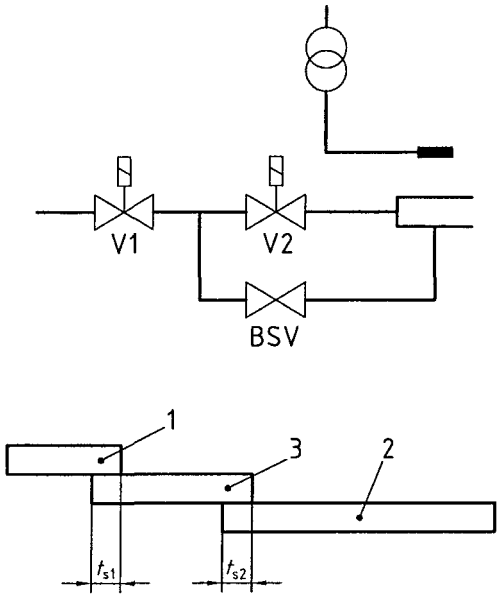
Figure 8 — Direct main burner ignition at full rate



Key

V1	Main gas safety shut-off valve
V1A	Main gas slow opening safety shut-off valve
t_s	Safety time
1	Ignition
2	Main burner

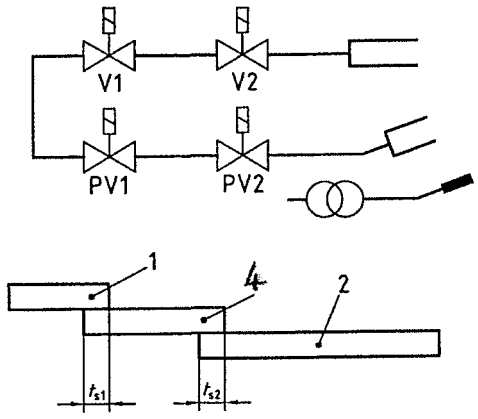
Figure 9 — Direct main burner ignition at reduced rate



Key

V1, V2	Main gas safety shut-off valves
BSV	Start gas supply safety shut-off valve
t_{s1}	First safety time
t_{s2}	Second safety time
1	Ignition
2	Main burner
3	Start gas

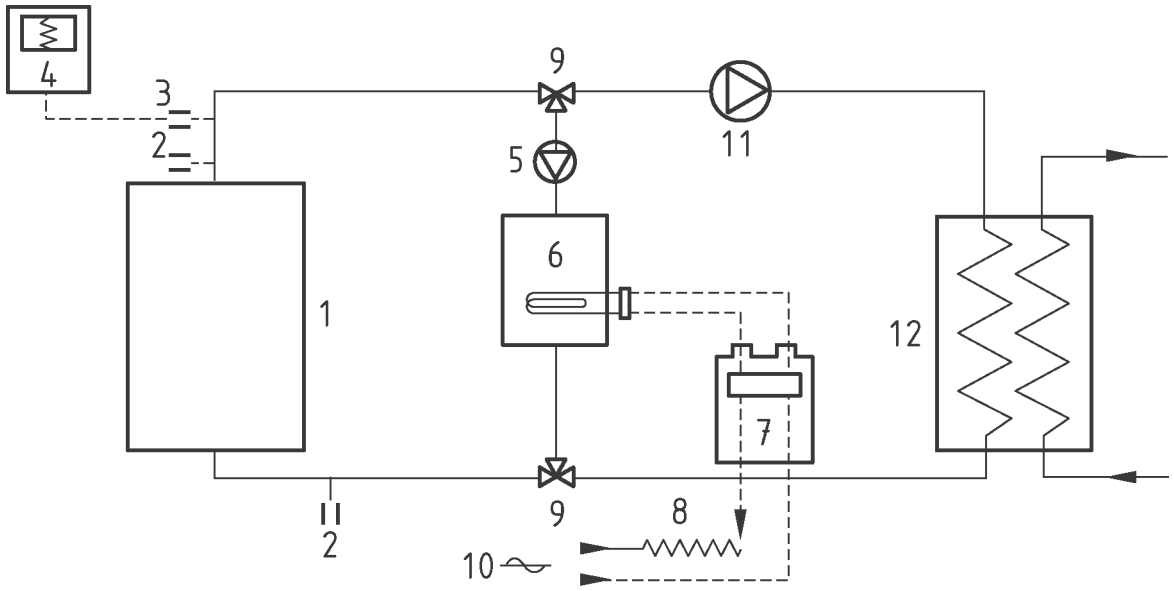
Figure 10 — Direct main burner ignition at reduced rate with independent start gas supply



Key

V1, V2	Main gas safety shut-off valves
PV1, PV2	Ignition burner safety shut-off valve
t_{S1}	First safety time
t_{S2}	Second safety time
1	Ignition
2	Main burner
4	Ignition burner

Figure 11 — Main burner ignition with independent ignition burner



Key

1 Boiler under test
2 Temperature probes
3 Low inertia thermocouple
4 Recorder
5 Pump with a rate such that the temperature difference between the two probes is between 2 °C and 4 °C at the maximum test temperature
6 Auxiliary electric boiler
7 Device for measuring the electric power
8 Voltage regulator
9 1/4 turn valves
10 Electrical supply
11 Additional pump (if necessary)
12 Cooling system on principle of exchange or mixing

Figure 12 — Test installation to determine the heat emissions of the boiler when the burner is off (see 5.8.2.3.1.3)

Annex A
(informative)

Diameters of combustion products evacuation ducts marketed in the various countries

The following table shows the diameters of combustion products evacuation ducts marketed in the various countries:

Table A.1 — Diameters of combustion products evacuation ducts marketed (in mm)

Country code	Diameter	Diameters of combustion products flues
AT	internal	60 - 70 - 80 - 90 - 100 - 110 - 120 - 130 - 140 - 150 - 160 - 170 - 180 - 200 - no standards for larger diameters
BE		no standards
CH	external	70 - 80 - 90 - 100 - 110 - 120 - 130 - 150 - 180 - 200 - 250 - 300 - 350 - 400
DE	internal	60 - 70 - 80 - 90 - 110 - 120 - 130 - 150 - 180 - 200 - 250 - 300 - 350
DK	nominal	50 - 60 - 70 - 80 - 90 - 100 - 110 - 120 - 130 - 150 - 180 - 200 - 250 - no standards for larger diameters
ES	internal	80 - 90 - 100 - 110 - 120 - 125 - 130 - 140 - 150 - 165 - 175 - 180 - 200 - 250 - 300 - 350 - 400 - 450 - 500
FI		90 - 100 - 110 - 130 - 150 - 180 - 200
FR	external	66 - 83 - 97 - 111 - 125 - 139 - 153 - 167 - 180 - no standards for larger diameters
GB	internal	75 - 101 - 126 - 152 metal pipes 92 - 117 - 146 - 171 fibre cement pipes no standards for larger diameters
GR		
IE	internal	75 - 101 - 126 - 152 metal pipes 84 - 109 - 136 - 162 fibre cement pipes
IS		
IT	internal	60 - 80 - 100 - 110 - 120 - 130 - 140 - 150 - 180 - 200 - 230 - 300 - 350 - 400 - 450 - 500
LU		
NL	internal	50 - 60 - 70 - 80 - 90 - 100 - 110 - 130 - 150 - 180 - 200 - no standards for larger diameters
NO		no standards
PT	external	83 - 97 - 111 - 125 - 139 - 153 - 167 - 180
SE		

Annex B
(informative)

Practical method of calibrating the test rig to enable determination of heat loss D_p

Substitute for the boiler (1) (Figure 1 or 2) a well insulated water container of small volume (about 250 ml) containing an electric immersion heater. Fill the circulation system and start the pump running at its normal setting. The immersion heater is connected to the mains supply via a continuously variable transformer and a Watt-hour meter. Adjust the transformer so that the temperature of the circulation water reaches equilibrium (this may take four hours or more). Note the ambient temperature and measure the heat input. A series of tests at different temperatures will give the test rig heat losses over various temperature rises above ambient.

When the actual test is carried out, the ambient temperature is noted and the heat loss D_p corresponding to the temperature difference between the ambient and mean test rig temperatures can be determined.

Annex C
(informative)

Determination of the heat losses from the test rig of the indirect method and the contributions of the circulating pump of the test rig (see 5.8.2.3.1.3)

The boiler is removed from the test rig in Figure 12 and the flow and return pipes are connected directly.

The additional pump (11) is stopped and the valves (9) on the exchanger are shut.

The pump (5) is started and operates continuously at the intended water rate.

The values (T - T_A) are measured in the steady state under the following three conditions:

a) without electrical contribution from the boiler (6);

b) with an electrical contribution from the boiler (6), so as to obtain a value of

(T - T_A) = (40 ± 5) K ;

c) with an electrical contribution from the boiler (6), so as to obtain a value of

(T - T_A) = (60 ± 5) K ;

where:

T is the mean temperature value, indicated by the two probes (2) at the return and the flow of the boiler on test (1);

T_A is the ambient temperature.

These three measured values are plotted to determine the curve of the electrical contribution, expressed in watts (W), as a function of the value of (T - T_A), expressed in Kelvins (K).

It can be considered to be a straight line.

The equation of this straight line gives, for the water rate considered, the heat losses and contributions from the circulating pump of the test circuit as a function of (T - T_A).

Annex D
(informative)

Determination of the operating time at full rate prior to modulation

The boiler is installed as indicated in Figure 12. The water circuit comprises an insulated circuit incorporating a reservoir.

The installation holds at least 6 litres of water per kilowatt of nominal output.

The gas circuit is fitted with a gas rate meter or a manometer measuring the pressure upstream of the injector.

The initial water temperature being (47 ± 1) °C for standard boilers and (37 ± 1) °C for low temperature boilers, the boiler is operated and the time t_1 in seconds is measured, which elapses between ignition of the burner and the moment when, due to the action of the controls :

— either the heat input reaches the value equal to:

$0{,}37\ Q_{nom} + 0{,}63\ Q_{red}$

— or, the pressure at the injector reaches the value equal to:

$$\left(0{,}37\sqrt{p_{nom}} + 0{,}63\sqrt{p_{red}}\right)^2$$

where:

Q_{nom} is the heat input corresponding to the full rate, in kilowatts (kW);

Q_{red} is the heat input corresponding to the reduced rate, in kilowatts (kW);

p_{nom} is the pressure corresponding to the full rate, in millibars (mbar);

p_{red} is the pressure corresponding to the reduced rate, in millibars (mbar).

Annex E
(normative)

Determination of the combustion characteristics – Carbon monoxide and nitrogen oxides

For range rated boilers, the tests are carried out at the maximum and minimum rated heat inputs. For modulating boilers, 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 boiler has reached thermal equilibrium.

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

$$CO = (CO)_M \frac{(CO_2)_N}{(CO_2)_M}$$

where:

CO	is the carbon monoxide concentration of the dry, air-free combustion products in percent;
$(CO_2)_N$	is the maximum carbon dioxide concentration of the dry, air-free combustion products in percent;
$(CO)_M$ and $(CO_2)_M$	are the measured concentrations in the samples taken during the combustion test, both expressed in percent.

The concentrations of $(CO_2)_N$, in percent, for the test gases are given below:

Table E.1 — $(CO_2)_N$ concentration of the combustion products

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 110	G 120	G 130	G 140	G 141	G 150	G 231	G 271
$(CO_2)_N$	7,6	8,35	13,7	7,8	7,9	11,7	11,5	11,2

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

$$CO = (CO)_M \frac{21}{21 - (O_2)_M}$$

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 %.

The NO_x measurements are carried out when the boiler is at thermal equilibrium, conforming with details given in CR 1404.

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 from these reference conditions, it will be necessary to correct the NO_x values as specified below.

$$NO_{x,0} = NO_{x,m} + \frac{0,02\ NO_{x,m} - 0,34}{1 - 0,02\,(h_m - 10)}\,(h_m - 10) + 0,85\,(20 - T_m) \quad 1$$

Where:

$NO_{x,0}$ is the value of NO_x corrected to the reference conditions expressed in milligramme per kilowatt-hour (mg/kwh);

$NO_{x,m}$ is the value of NO_x measured at h_m and T_m expressed in milligramme per kilowatt-hour (mg/kwh) in the range 50 mg/kWh to 300 mg/kWh;

h_m is humidity during the measurement of $NO_{x,m}$ in g/kg in the range 5 g/kg to 15 g/kg;

T_m is the ambient temperature during the measurement of value of $NO_{x,m}$ in the range 15 °C to 25 °C.

Annex F
(normative)

Case of a forced draught burner complying with EN 676

Only the following tests are necessary.

— 5.3 Heat input rates;

— 5.5.1 Limiting temperature of adjusting, control and safety devices;

— 5.5.3 Limiting temperature of the side walls, the front and the top;

— 5.5.4 Limiting temperature of the floor and the test panels;

— 5.6.3 Checking the operation of control thermostats and safety temperature limiters;

— 5.7.1 Combustion at the maximum nominal heat input;

— 5.7.2 Combustion at the minimum nominal heat input;

— 5.7.3 Combustion at the minimum controlled heat input;

— 5.8 Useful efficiencies;

— 5.9 Condensation.

Annex G
(informative)

Main symbols and abbreviations used

Table G.1

Designation	Symbol
Net calorific value	H_i
Density	d
Normal pressure Minimum pressure Maximum pressure	p_n p_{min} p_{max}
Maximum water pressure	PMS
Volumetric gas rate under test conditions Volumetric gas rate under reference conditions	V V_r
Mass rate under test conditions Mass rate under reference conditions	M M_r
Heat input Nominal heat input	Q Q_n
Useful output Nominal output	P P_n
Useful efficiency	η_u
Ignition safety time Maximum ignition safety time Extinction safety time	T_{SA} $T_{SA,max}$ T_{SE}

Annex H
(informative)

A-deviations

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

This European Standard falls under Directive 90/396/EEC on the approximation of the laws of Member States concerning gas appliances.

NOTE Where standards fall under EC Directives, it is the view of the Commission of the European Communities (OJ No C 59, 1982-03-09) that the effect of the decision of the Court of Justice in Case 815/79 Cremonini/Vrankovich (European Court Reports 1980, p. 3583) is that compliance with A-deviations is no longer mandatory and that the free movement of products complying with such a standard should not be restricted within the EC except under the safeguard procedure provided for in the relevant Directive.

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

Switzerland
The Swiss law (Luftreinhalte-Verordnung, LRV) of 1985-12-16 (state on 1993-01-01) is applicable instead of the requirements of 5.7 and 5.8 regarding energy efficiency (chimney losses, standby losses) and emissions of CO and NO_x.

Annex ZA
(informative)

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

This European standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of EU Directives 90/396/EC "Gas appliances" and "92/42/EC "Boiler efficiency".

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

The following clauses of this standard are likely to support requirements of Directives 90/396/EC "Gas appliances" and "92/42/EC "Boiler efficiency".

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

Table ZA.1 — Table identifying conformity with the relevant clauses of the Gas Appliances Directive 90/396/EC

Essential Requirement	Object	Clauses and/or subclauses in European Standards which comply wholly or in part with the essential requirement
	ANNEX I	
1	**General conditions**	
1.1	Safe design and construction	1, 4, 5
1.2	Instructions installer Instructions users Warnings notice on appliance and packaging Official language	6.2.1 6.2.2 6.1.3, 6.1.4 6.2.1, 6.2.5
1.2.1	Instructions installer contains Type of gas Gas supply pressure Flow of fresh air : - for combustion supply, - danger unburned gas (essential requirement **3.2.3**). Dispersal combustion products	6.2.1
1.2.2	Instructions user contains - all instructions - restrictions on use	6.2.2
1.2.3	Warning notices with : - type of gas, - gas supply pressure, - restrictions.	6.1.3, 6.1.4
1.3	Fittings, instructions	Non applicable

Table ZA.1 — Table identifying conformity with the relevant clauses of the Gas Appliances Directive 90/396/EC *(concluded)*

Essential Requirement	Object	Clauses and/or subclauses in European Standards which comply wholly or in part with the essential requirement
2	**Materials**	
2.1	Appropriate to their purpose	4.1, 4.2
2.2	Properties of the materials	4.2
3	**Design and construction**	
3.1	**General**	4
3.1.1	Safety of construction	4.1, 4.2
3.1.2	Condensation	4.1, 4.2.9, 5.9
3.1.3	Risk explosion external fire	4.1
3.1.4	Penetration water/air in gas circuit	Non applicable
3.1.5	Normal fluctuation auxiliary energy	4.1, 4.2.5.5, 4.2.6.4, 4.2.7
3.1.6	Abnormal fluctuation or failure of auxiliary energy	4.1, 4.2.7.1 d)
3.1.7	Hazards of electrical energy	4.1
3.1.8	Parts under pressure	4.1
3.1.9	Failure of devices gas circuit	4.1
3.1.10	Overruling safety devices	4.1
3.1.11	Adjustment protection	4.1
3.1.12	Clear marking of devices	4.1
3.2	**Unburned gas release**	
3.2.1	Risk of gas leakage	4.1
3.2.2	Risk of gas accumulation during ignition, during re-ignition, after extinction	4.1
3.2.3	Safety device fitted Room with sufficient ventilation	4.1 Non applicable
3.3	**Ignition**, re-ignition and cross-lighting	4.1, 4.2.5.6, 4.2.6
3.4	**Combustion**	
3.4.1	Flame stability Unacceptable concentrations harmful to health	4.2.5.6 4.1, 4.2.7
3.4.2	No accidental release of combustion products	4.1
3.4.3	No release in dangerous quantity	4.1
3.4.4	CO concentration	4.2.7
3.5	**Rational use of energy**	4.2.8, 5.8
3.6	**Temperatures**	
3.6.1	Floor and adjacent wall	4.2.5.3, 4.2.5.4
3.6.2	Knobs and levels	4.2.5.2
3.6.3	External parts	4.2.5.2
3.7	**Foodstuffs and water used for sanitary purpose**	Non applicable
	ANNEX II - Certification	
	ANNEX III - Data plate Name of the manufacturer or identification symbol, Trade name of the appliance, Type of electrical supply used, Appliance category.	6.1.1

Table ZA.2 — Table identifying conformity with the relevant clauses of the Efficiency Directive 92/42/EC

Relevant articles of the Directive	Object	Clauses and/or subclauses in the European Standard which comply wholly or in part with the article
1	Field of application	1
2	Definitions	3
3	Exclusions	1
4.3	Efficiency of living space dedicated boilers	1
5.1	Efficiency requirements	4.2.8
5.2	Verification methods	5.8

Bibliography

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

EN 303-3, *Heating boilers — Part 3: Gas-fired central heating boilers — Assembly comprising a boiler body and a forced draught burner*

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

National Annex NA (informative)
Additional information for UK users

NA.1 General

During the discussion of EN 303-7:2006 by BSI Technical GSE/29, which mirrors the work of CEN Committee, TC 109, the UK committee expressed the opinion that existing standards and draft standards, possibly with minor amendments, could have covered the product within its scope. (The scope of EN 303-7:2006 covers gas-fired standard and low temperature central heating boilers comprising a boiler body and a forced draught gas burner brought together at a producer's assembly facility and marketed as a complete boiler.)

Boilers within the scope of EN 303-7:2006 are only of type B_{23} in accordance with CEN CR 1749. The other standards, EN 297 including amendment A4, EN 656 and EN 13836, hereinafter referred to as "the other standards" also have type B_{23} boilers within their scopes.

In the opinion of the BSI Committee, some of the requirements in EN 303-7:2006 conflict with the requirements of the other standards.

In the opinion of the BSI Committee GSE/29, this should be borne in mind when using this standard.

NA.2 The testing method and classification for nitrogen oxides

The testing method and classification for nitrogen oxides differ. It is a requirement of all these standards that the nitrogen oxides class is shown on the data plate. The purpose of this is to compare the environmental performance of one product against another. Although Class 1, Class 2 and Class 3 are used in all of these standards, the classes are not comparable, e.g. Class 1 in accordance with EN 303-7:2006 cannot be compared with Class 1 from the other group of standards.

NA.3 Level of carbon monoxide under fault conditions

In the other standards, the accepted maximum level of carbon monoxide under fault conditions before at least "safety shutdown" occurs is 0.2 % [by volume, dry, air-free (DAF)]. This is regarded as the acceptable limit for safe emissions. EN 303-7 allows 1 % under one condition.

NA.4 Combustion test at the allowable tolerance on heat input

The combustion test at the limit of gas quality is carried out in the other standards taking account of the maximum allowable tolerance (5 %) on heat input. The 5 % tolerance is not taken into account in EN 303-7:2006. This could result in higher than advisable levels of carbon monoxide emissions in some circumstances. For example a boiler could be operating with a heat input 5 % higher than the nominal heat input. This meets the requirements of the standard and can be regarded as a "normal" condition. The combustion test in EN 303-7:2006 is carried out at nominal heat input, without the +5 %. If the measured value of carbon monoxide is at the "limit" allowed by the standard (0.1 % DAF using reference gas, and 0.2 % DAF using the combustion limit gas) then it is likely these carbon monoxide "limit" values would be exceeded when tested at the +5 % tolerance on heat input.

NA.5 Gas soundness check

The other standards require gas soundness to be checked up to the burner injector. The gas soundness test in EN 303-7:2006 is only required to be carried out up to the last "closure member" i.e. the last gas valve. This means that at least one joint could remain untested for gas leakage.

NA.6 Non-volatile lockout water temperature

In the other standards the "safety temperature limiter" is required to cause non-volatile lockout before the water temperature reaches 110 °C. This is in order to ensure that the essential requirements of the Pressure Equipment Directive (97/23/EEC) are complied with. EN 303-7:2006 allows the water temperature to reach 120 °C before non-volatile lockout. The essential requirements of the Pressure Equipment Directive might not be complied with, unless additional measures are taken.

NA.7 Temperature of accessible components above ambient

EN 303-7:2006 allows the temperature of accessible components to reach an average of 100 K above ambient. The other standards require the maximum temperature to be 80 K above ambient.

blank

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