BRITISH STANDARD

BS EN 13836:2006

# Gas fired central heating boilers — Type B boilers of nominal heat input exceeding 300 kW, but not exceeding 1 000 kW

The European Standard EN 13836:2006 has the status of a British Standard

ICS 91.140.65



BSI British Standards

# National foreword

This British Standard was published by BSI. It is the UK implementation of EN 13836:2006.

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.

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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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN 13836

August 2006

ICS 91.140.65

English Version

# Gas fired central heating boilers - Type B boilers of nominal heat input exceeding 300 kW, but not exceeding 1 000 kW

Chaudières de chauffage central utilisant les combustibles gazeux - Chaudières de type B dont le débit calorifique nominal est supérieur à 300 kW mais inférieur ou égal à 1 000 kW

Heizkessel für gasförmige Brennstoffe - Heizkessel des Typs B mit einer Nennwärmebelastung größer als 300 kW aber gleich oder kleiner als 1 000 kW

This European Standard was approved by CEN on 20 April 2006.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

**Management Centre: rue de Stassart, 36 B-1050 Brussels**



Ref. No. EN 13836:2006: E

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# Foreword

This European Standard (EN 13836:2006) 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of an identical text or by endorsement, at the latest by February 2007, and conflicting national standards shall be withdrawn at the latest by February 2007.

It was established to deal with aspects related to:

— safety;

— rational use of energy;

— fitness for purpose.

Other types of boilers are dealt with in separate standards.

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

For relationship with EU Directives 90/396/EEC “Approximation of the laws of Member States concerning gas appliances” and 92/42/EEC “Efficiency requirements for new hot water boilers fired with liquid or gaseous fuels” see informative Annex ZA, which is an integral part of this European Standard.

This standard covers only type testing.

Boilers within the scope of this European Standard are typically installed in a room separated from living rooms and provided with appropriate ventilation directly to the outside. They need not be fitted with a combustion products discharge safety device but appropriate warnings on the packaging and in the instructions should clearly indicate the limit on the use of this type of boiler.

It is impractical to use the full range of test gases to EN 437 for type testing since their availability, for inputs over 300 kW, may present problems for test houses and manufacturers. Informative Annex L gives guidance on the use of gases for tests in order to ensure conformity with EU Directive 90/396/EEC “Approximation of the laws of Member States concerning gas appliances.”

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 concerning, in particular, the construction, safety, fitness for purpose, and rational use of energy, as well as the classification and marking of gas-fired central heating boilers that are fitted with atmospheric burners, fan assisted atmospheric burners or fully premixed burners, and are hereafter referred to as “boilers”.

This European Standard applies to boilers of type B, as listed in 4.2:

— that use one or more combustible gases of the three gas families at the pressures stated in Tables 16 and 17;

— that have a nominal heat input (on the basis of net calorific value) exceeding 300 kW, but not exceeding 1 000 kW, including modular boilers;

— where the temperature of the heat transfer fluid does not exceed 105 °C during normal operation;

— where the maximum operating pressure in the water circuit does not exceed 6 bar;

— that can give rise to condensation under certain circumstances;

— of the standard and low-temperature types.

This European Standard applies to boilers designed for sealed water systems or for open water systems.

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

— intended to be installed in the open or in living rooms;

— permanently fitted with more than one flue outlet;

— where the combustion circuit is sealed with respect to the room where the boiler is installed;

— of the condensing type;

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

— fitted with a forced draught burner in accordance with EN 676 (see EN 303-7);

— producing hot water for domestic purposes.

This standard only covers type testing.

Matters related to quality assurance systems, tests during production, and certificates of conformity of auxiliary devices are not dealt with in this European Standard.

## 2 Normative references

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

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

EN 125, *Flame supervision devices for gas burning appliances — Thermo-electric flame supervision devices*

EN 126, *Multifunctional controls for gas burning appliances*

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

EN 257, *Mechanical thermostats for gas burning appliances*

EN 297, *Gas-fired central heating boilers — Type $B_{11}$ and $B_{11BS}$ boilers fitted with atmospheric burners of nominal heat input not exceeding 70 kW*

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

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

EN 656, *Gas-fired central heating boilers — Type B boilers of nominal heat input exceeding 70 kW but not exceeding 300 kW*

EN 1057*, Copper and copper alloys — Seamless, round copper tubes for water and gas in sanitary and heating applications*

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

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

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

EN 1561, *Founding — Grey cast irons*

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

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

EN 10029, *Hot rolled steel plates 3 mm thick or above — Tolerances on dimensions, shape and mass*

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

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

EN 50165, *Electrical equipment of non-electric appliances for household and similar purposes — Safety requirements*

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

EN 60529, *Degrees of protection provided by enclosures (IP code) (IEC 60259:1989)*

EN 60730-2-9, *Automatic electrical controls for household and similar use — Part 2-9: Particular requirements for temperature sensing controls (IEC 60730-2-9:2000, modified)*

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

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

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

# 3 Terms and definitions

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

## 3.1 Combustible gases

**3.1.1**
**calorific value**
quantity of heat produced by the complete combustion, at a constant pressure equal to 1 013,25 mbar, of unit volume or mass of gas, the constituents of the combustible mixture being taken at reference conditions and the products of combustion being brought back to the same conditions.

A distinction is made between:

— gross calorific value: the water produced by combustion is assumed to be condensed

Symbol: $H_s$

and

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

Symbol: $H_i$

NOTE The calorific value is expressed:
— either in megajoules per cubic metre ($MJ/m^3$) of dry gas under the reference conditions,
— or in megajoules per kilogram (MJ/kg) of dry gas.

**3.1.2**
**gas pressure**
static pressure of the moving gas, relative to the atmospheric pressure, measured at right angles to the direction of flow of the gas

Symbol: $p$

Unit: millibar (mbar)

**3.1.3**
**limit gases**
test gases representative of the extreme variations in the characteristics of the gases for which appliances have been designed

**3.1.4**
**limit pressures**
pressures representative of the extreme variations in the appliance supply conditions.

Symbols: maximum pressure: $p_{max}$

minimum pressure: $p_{min}$

**3.1.5**
**normal pressure**
pressure under which the appliances operate in nominal conditions when they are supplied with the corresponding reference gas.

Symbol: $p_n$

**3.1.6**
**pressure couple**
combination of two distinct gas distribution pressures applied by reason of the significant difference existing between the Wobbe indices within a single family or group in which:

— higher pressure corresponds only to gases of low Wobbe index;

— lower pressure corresponds to gases of high Wobbe index

**3.1.7**
**reference gases**
test gases with which appliances operate under nominal conditions, when they are supplied at the corresponding normal pressure

**3.1.8**
**reference conditions**
correspond to 15 °C, 1 013,25 mbar, unless otherwise specified

**3.1.9**
**relative density**
ratio of the masses of equal volumes of dry gas and dry air under the same conditions of temperature and pressure: 15 °C or 0 °C and 1 013,25 mbar.

Symbol: $d$

**3.1.10**
**test gases**
gases intended for the verification of the operational characteristics of appliances using combustible gases. They consist of the reference and the limit gases

**3.1.11**
**test pressures**
gas pressures used to verify the operational characteristics of appliances using combustible gases. They consist of normal and limit pressures

**3.1.12**
**Wobbe index**
ratio of the calorific value of a gas per unit volume and the square root of its relative density under the same reference conditions. The Wobbe index is said to be gross or net according to whether the calorific value used is the gross or net calorific value.

Symbol: gross Wobbe index: $W_s$

net Wobbe index: $W_i$

The Wobbe indices are expressed:

— either in megajoules per cubic metre (MJ/m$^3$) of dry gas under the reference conditions;

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

## 3.2 Constituent parts of the boiler

### 3.2.1 Gas supply

**3.2.1.1**
**gas circuit**
assembly of parts of the boiler that carry or contain the combustible gas between the boiler gas inlet connection and the burner(s)

**3.2.1.2**
**gas inlet connection**
part of the boiler intended to be connected to the gas supply

**3.2.1.3**
**gas rate adjuster**
component allowing the gas rate of the burner to be brought to a predetermined value according to the supply conditions.

The action of operating this component is called “adjustment of the gas rate”

**3.2.1.4**
**injector**
component that admits gas into the burner

**3.2.1.5**
**primary aeration adjuster**
device enabling the primary aeration of a burner to be set to the desired value according to the supply conditions

**3.2.1.6**
**putting an adjuster or a control out of service**
action intended to put an adjuster or control (rate, pressure etc.) out of service

**3.2.1.7**
**range rating device**
component on the boiler intended to be used by the installer to adjust the heat input of the boiler, within the range of maximum and minimum heat inputs stated by the manufacturer, to suit the actual heat requirements of the installation

**3.2.1.8**
**restrictor**
device with one or more orifices, which is placed in the gas circuit so as to create a pressure drop and thus bring the gas pressure at the burner to a predetermined value for a given supply pressure and given rate

**3.2.1.9**
**sealing an adjuster or a control**
arrangements made to make evident any attempt to change its adjustment (e.g. breakage of a device or of a sealing material).

A control or adjuster which is sealed is considered to be non-existent

### 3.2.1.10 Burners

**3.2.1.10.1**
**alternating ignition burner**
ignition burner which is extinguished as soon as ignition of the main burner is effected. It re-ignites at the main burner flame just before the latter goes out

**3.2.1.10.2**
**automatic ignition device**
automatic device which ignites the ignition burner or the main burner directly

**3.2.1.10.3**
**ignition burner**
burner intended to ignite a main burner

**3.2.1.10.4**
**ignition device**
means (flame, electrical ignition device or other device) used to ignite the gas at the ignition burner or at the main burner

**3.2.1.10.5**
**intermittent ignition burner**
ignition burner that is ignited before and extinguished at the same time as the main burner

**3.2.1.10.6**
**interrupted ignition burner**
ignition burner which operates only during the ignition sequence

**3.2.1.10.7**
**main burner**
burner that is intended to assure the thermal function of the boiler and is generally called “the burner”

**3.2.1.10.8**
**manual ignition device**
device by means of which the burner is ignited following manual intervention

**3.2.1.10.9**
**permanent ignition burner**
ignition burner that operates continuously throughout the whole period that the boiler is in use

**3.2.1.10.10**
**premixed burner**
burner in which the gas and a quantity of air at least equal to that theoretically necessary for complete combustion are mixed before the flame ports

### 3.2.2 Combustion circuit

**3.2.2.1**
**combustion chamber**
enclosure inside which combustion of the air-gas mixture takes place

**3.2.2.2**
**combustion products circuit**
circuit including the combustion chamber, the heat exchanger and the circuit permitting evacuation of the combustion products to the flue, up to and including the flue outlet

**3.2.2.3**
**damper**
device placed in the air inlet duct or the flue products outlet duct to control the volume flow

**3.2.2.4**
**draught diverter**
device, placed in the combustion products circuit of the boiler, that is intended to maintain the quality of combustion within certain limits and to keep the combustion stable under certain conditions of updraught and downdraught

**3.2.2.5**
**flue outlet**
part of the boiler through which the combustion products are evacuated to the flue system

**3.2.2.6**
**flue stabilizer**
opening in the combustion products circuit which serves to stabilize the flow of combustion products.

It is fitted with a device which monitors the evacuation of combustion products in order to maintain the quality of combustion within certain limits and to keep the combustion stable under certain conditions of updraught and downdraught

### 3.2.3 Adjusting, control and safety devices

**3.2.3.1**
**adjustable control thermostat**
control thermostat that permits the operator to adjust setting temperatures between a minimum and a maximum value

**3.2.3.2**
**adjustable pressure regulator**
pressure regulator fitted with a means of adjusting the adjuster of the downstream pressure.

This means is considered as an “adjusting device”

**3.2.3.3**
**automatic burner control system**
system that comprises a programming unit and all the elements of a flame detector. All the functions of an automatic burner control system may be assembled in one or more housings

**3.2.3.4**
**automatic shut-off valve**
valve which opens when energized and closes automatically when de-energized

**3.2.3.5**
**breather hole**
orifice that allows atmospheric pressure to be maintained in a compartment of variable volume

**3.2.3.6**
**closure member**
movable part of the valve or the thermoelectric device that opens, varies or shuts off the gas way

**3.2.3.7**
**control knob**
component intended to be moved by hand in order to act on a boiler control (tap, thermostat etc.)

**3.2.3.8**
**control thermostat**
device enabling the water temperature to be kept automatically, within a given range, at a predetermined value

**3.2.3.9**
**diaphragm**
flexible component that operates a valve or a switch by means of forces resulting from a pressure difference

**3.2.3.10**
**device monitoring the air supply or combustion products evacuation**
device intended to cause safety shutdown in the event of abnormal conditions of air admission or of combustion products evacuation for boilers with a flue stabilizer

**3.2.3.11**
**external soundness**
soundness, with respect to the atmosphere, of an enclosure containing gas

**3.2.3.12**
**flame detector**
device which detects and signals the presence of a flame. It can consist of a flame sensor, an amplifier and a relay for signal transmission.

NOTE These parts, with the possible exception of the actual flame sensor, may be assembled in a single housing for use in conjunction with a programming unit

**3.2.3.13**
**flame signal**
signal given by the flame detector, normally when its sensor senses a flame

**3.2.3.14**
**flame simulation**
condition which occurs when a flame signal is given by the flame detector although in reality there is no flame

**3.2.3.15**
**flame supervision device**
device that, in response to a signal from the flame detector, keeps the gas supply open and shuts it off in the absence of the supervised flame

**3.2.3.16**
**gas/air ratio control**
device that automatically adapts the combustion air rate to the gas rate or vice versa

**3.2.3.17**
**high pressure cut-off device**
device that shuts off the gas supply when the upstream pressure or the burner supply pressure rises above a predetermined value

**3.2.3.18**
**internal soundness**
soundness of a closure member in the closed position and isolating an enclosure containing gas from another enclosure or from the outlet of the valve

**3.2.3.19**
**low pressure cut-off device**
device that shuts off the gas supply when the upstream pressure falls below a predetermined value

**3.2.3.20**
**multi-functional control**
device having at least two functions, one of which is a shut-off function, integrated in one housing, whereby the functional elements cannot operate if separated

**3.2.3.21**
**pressure regulator**
device which maintains the downstream pressure constant to within fixed limits independent of variations, within a given range, of the upstream pressure and the gas rate

**3.2.3.22**
**programme**
sequence of control operations determined by the programming unit involving switching on, supervising and switching off the burner

**3.2.3.23**
**programming unit**
device that reacts to impulses from control and safety systems, gives control commands, controls the start-up programme, supervises the burner operation and causes controlled shutdown, safety shutdown and lockout if necessary.

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

**3.2.3.24**
**safety temperature limiter**
device that causes safety shutdown and non-volatile lockout so as to prevent the water temperature exceeding a preset limit

**3.2.3.25**
**sealing force**
force acting on the valve seat when the closure member is in the closed position, independent of any force provided by gas pressure

**3.2.3.26**
**start signal**
signal causing the boiler to leave its start position and the predetermined programme of the programming unit to commence

**3.2.3.27**
**temperature sensing element; sensor**
component that detects the temperature of the environment to be supervised or controlled

**3.2.3.28**
**volume regulator**
device which maintains a rate between fixed limits, independent of upstream and downstream pressures, within a range of given values

**3.2.3.29**
**water rate monitoring device**
device that shuts off the gas supply to the main burner when the water rate through the boiler is less than a predetermined value and automatically reopens the gas supply when the water rate reaches this value

## 3.3 Operation of the boiler

### 3.3.1 Gas rates

**3.3.1.1**
**heat input**
quantity of energy used in unit time corresponding to the volumetric or mass flow rates, the calorific value used being either the net or gross calorific value.

Symbol: $Q$

Unit: kilowatt (kW)

**3.3.1.2**
**ignition rate**
average heat input during the ignition safety time.

Symbol: $Q_{ign}$

Unit: kilowatt (kW)

**3.3.1.3**
**mass flow rate**
mass of gas consumed by the appliance in unit time during continuous operation.

Symbol: $M$ (under test conditions);

$M_r$ (under reference conditions)

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

**3.3.1.4**
**nominal heat input** [1)]
value of the heat input declared by the manufacturer.

Symbol: $Q_n$

Unit: kilowatt (kW)

**3.3.1.5**
**volumetric rate**
volume of gas consumed by the appliance in unit time during continuous operation.

Symbol: $V$ (under test conditions);

$V_r$ (under reference conditions)

Unit: cubic metres per hour ($m^3/h$)

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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.

### 3.3.2 Outputs

**3.3.2.1**
**nominal output**
useful output stated by the manufacturer.

Symbol: $P_n$

Unit: kilowatt (kW)

**3.3.2.2**
**useful output**
quantity of heat transmitted to the heat carrier in unit time.

Symbol: $P$

Unit: kilowatt (kW)

**3.3.3**
**useful efficiency**
ratio of the useful output to the heat input.

Symbol: $\eta_u$

Unit: percent (%)

### 3.3.4 Gas combustion

**3.3.4.1**
**combustion**
combustion is said to be “complete” if there are no more than traces of combustible constituents (hydrogen, hydrocarbons, carbon monoxide, carbon etc.) in the combustion products.

Conversely, combustion is said to be “incomplete” if at least one combustible constituent is present in significant proportions in the combustion products.

The amount of carbon monoxide, CO, in the dry, air-free combustion products is used as the criterion to distinguish between “hygienic” and “non-hygienic” combustion.

This European Standard specifies maximum CO limits according to the circumstances of use or of test. In each case, the combustion is regarded as hygienic if the CO concentration is below or equal to the permitted limit but non-hygienic if it is above the limit

**3.3.4.2**
**condensate**
liquid formed from the combustion products during the condensation process

**3.3.4.3**
**flame lift**
phenomenon characterized by the total or partial lifting of the base of the flame away from the burner port or the flame holding zone

**3.3.4.4**
**flame stability**
characteristic of flames which remain on the burner ports or in the flame retention zone

**3.3.4.5**
**light-back**
phenomenon characterized by the entry of a flame into the body of the burner

**3.3.4.6**
**light-back at the injector**
phenomenon characterized by ignition of the gas at the injector, either as a result of light back into the burner or of the propagation of a flame outside the burner

**3.3.4.7**
**sooting**
phenomenon appearing during incomplete combustion and characterized by deposits of soot on the surfaces or parts in contact with the combustion products or with the flame

**3.3.4.8**
**yellow tipping**
phenomenon characterized by the yellowing of the tip of the blue cone of an aerated flame

### 3.3.5 Times

**3.3.5.1**
**extinction delay time ($T_{IE}$)**
for a thermoelectric flame supervision device, the time that elapses between the disappearance of the flame and the interruption of the gas supply

**3.3.5.2**
**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

**3.3.5.3**
**ignition opening time ($T_{IA}$)**
for a thermoelectric flame supervision device, the time that elapses between ignition of the supervised flame and the moment when the closure element is held open by the flame signal

**3.3.5.4**
**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

**3.3.5.5**
**maximum ignition safety time ($T_{SA,max}$)**
ignition safety time measured under the least favourable conditions of ambient temperature and variation in supply voltage

**3.3.6**
**spark restoration**
automatic process by which, following flame failure, the ignition device is switched on again without total interruption of the gas supply

**3.3.7**
**automatic recycling**
automatic process by which, after loss of flame, the gas supply is interrupted and the full start procedure is re-initiated automatically

**3.3.8**
**controlled shutdown**
process by which the control device (on the boiler or external to it) causes the gas supply to the burner to be stopped immediately the boiler returns to its start position

**3.3.9**
**safety shutdown**
process which is initiated immediately in response to the signal from a limiting device or sensor and which causes the burner to shut down; the boiler returns to its start position

**3.3.10 Locking out**

**3.3.10.1**
**lockout**
total interruption of the gas supply

**3.3.10.2**
**non-volatile lockout**
shutdown condition such that a start can only be accomplished by a manual reset

**3.3.10.3**
**volatile lockout**
shutdown condition such that a start can also be accomplished by restoration of the electrical supply after its loss

**3.3.11**
**de-energized to trip principle**
principle according to which neither auxiliary energy nor external action is required to activate a safety device

**3.3.12**
**nominal voltage**
voltage or range of voltages stated by the manufacturer at which the boiler can operate normally

**3.3.13**
**purge**
mechanical introduction of air into the combustion circuit in order to displace any gas/air mixture which could remain there.

A distinction is made between:

— pre-purge: the purge that takes place between the start-up command and the ignition device being energized;

— post-purge: the purge that takes place following burner shutdown

# 4 Classification of boilers

## 4.1 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.

The applicable categories for each country are given in Annex A.

## 4.2 Classification according to the mode of evacuation of the combustion products

### 4.2.1 General

Boilers are classified into several types according to the mode of evacuation of the combustion products and admission of the combustion air, as described in CEN/TR 1749 [2)].

### 4.2.2 Type B

#### 4.2.2.1 General

A boiler intended to be connected to a flue which evacuates the products of combustion to the outside of the room containing the boiler. The combustion air is drawn directly from the room.

#### 4.2.2.2 Type $B_1$

Type B boiler incorporating a draught diverter.

#### 4.2.2.3 Type $B_{11}$

Natural draught type $B_1$ boiler.

#### 4.2.2.4 Type $B_{12}$

Type $B_1$ boiler designed for a natural draught flue incorporating a fan downstream of the combustion chamber/heat exchanger and upstream of the draught diverter.

#### 4.2.2.5 Type $B_{13}$

Type $B_1$ boiler designed for a natural draught flue incorporating a fan upstream of the combustion chamber/heat exchanger.

#### 4.2.2.6 Type $B_{14}$

Type $B_1$ boiler having an integral fan downstream of both the combustion chamber/heat exchanger and the draught diverter.

#### 4.2.2.7 Type $B_2$

Type B boiler without a draught diverter.

#### 4.2.2.8 Type $B_{22}$

Type $B_2$ boiler incorporating a fan downstream of the combustion chamber/heat exchanger.

#### 4.2.2.9 Type $B_{23}$

Type $B_2$ boiler incorporating a fan upstream of the combustion chamber/heat exchanger.

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2) "European scheme for the classification of gas appliances according to the method of evacuation of the products of combustion (types)"

## 4.3 Classification according to operating conditions[3)]

### 4.3.1 Standard boiler

Boiler for which the average water temperature can be restricted by design.

### 4.3.2 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.

NOTE This is the wording of the definition in the BED, except the last part which reads 'including condensing boilers using liquid fuel'.

### 4.3.3 Gas condensing boiler [4)]

Boiler designed to condense permanently a large part of the water vapour contained in the combustion products.

## 4.4 Modular boiler

Boiler consisting of an assembly of two or more generally identical modules, each of which consists of a heat exchanger, burner, control and safety devices.

The assembly has a single flue outlet and a common gas connection, a common electricity supply connection and common flow and return water temperature connections. Each module is capable of independent operation

# 5 Constructional requirements

## 5.1 General

Unless otherwise indicated, constructional requirements are checked by examination of the boiler and its technical documentation.

## 5.2 Conversion to different gases

The following operations are permitted when converting from a gas of one group or family to a gas of another group or family:

— adjustment of the gas rate to the main burner and the ignition burner;

— change of injectors or restrictor;

— change of ignition burner or its components;

— change of system which modulates the gas rate;

— putting out of service and sealing of an adjuster and/or a regulator.

---

3) These definitions are in accordance with 92/42/EEC, however in this standard, definition 4.3.2 is limited to gas.

4) Specific requirements and test methods for condensing boilers with heat inputs exceeding 300 kW subject of the draft standard EN 15417. To be discussed because EN 15417 covers boilers of 70 to 1000 Kw..

These operations shall be possible without having to interfere with the connections of the boiler to its pipe work (gas, water, flue system).

## 5.3 Materials and method of construction

### 5.3.1 General

The quality and thickness of the materials used in the construction of the boilers, and the method of assembling the various parts, shall be such that the constructional and operational characteristics are not significantly altered during a reasonable life and under normal conditions of installation and use.

In particular, materials shall be appropriate for their intended purpose and shall withstand the mechanical, chemical and thermal conditions to which they will foreseeably be subjected.

Materials downstream of the heat exchanger shall be corrosion resistant or be effectively protected against corrosion.

Materials containing asbestos are forbidden.

Hard solder containing cadmium in its formulation shall not be used.

If there is a risk of condensation in the combustion products circuit, 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.

### 5.3.2 Materials and thicknesses of walls or tubes under water pressure

#### 5.3.2.1 General

The materials and the thicknesses of walls under pressure shall comply with 5.3.2.2, 5.3.2.3 and 5.3.2.4. If other materials and/or thicknesses are used, the manufacturer shall provide appropriate justification for their suitability of use.

#### 5.3.2.2 Materials

Materials for parts under pressure shall be appropriate for their duty and envisaged use.

The following materials satisfy these criteria:

— steels that have the properties and composition detailed inTable1;

— cast irons that have the mechanical properties detailed in Table 2;

— non-ferrous materials detailed in Table 3 and Table 4.

**Table 1 — Mechanical properties and chemical compositions of carbon and stainless steels**

| **Materials** | **Steel type** | **Mechanical properties** | | | | **Chemical compositions** % by mass | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Tensile strength** | **Yield point** | **Breaking elongation** | **Breaking elongation** | C | P | S | Si | Mn | Cr | Mo | Ni | Ti | Nb/Ta |
| | | $R_m$ | $R_{oH}/R_p$ 0,2 | $A_{long}$ | $A_{transv}$ | | | | | | | | | | |
| | | | | at $L_o$ =5 $d_o$ | at $L_o$ = 5 $d_o$ | | | | | | | | | | |
| | | N/mm$^2$ | N/mm$^2$ | % | % | | | | | | | | | | |
| Pipes, sheets | carbon | ≤ 520 | ≤ 0,7 [a] | ≥ 20 | - | ≤ 0,25 | ≤ 0,05 | ≤ 0,05 | -- | -- | -- | -- | -- | -- | -- |
| | ferritic | ≤ 600 | ≥ 250 | ≥ 20 | ≥ 15 | ≤ 0,08 | ≤ 0,045 | ≤ 0,030 | ≤ 1,0 | ≤ 1,0 | 15,5 to 18 | ≤ 1,5 | -- | ≤ 7 × % C | ≤ 12 × % C |
| | austenitic | ≤ 800 | ≥ 180 | ≥ 30 | ≥ 30 | ≤ 0,08 | ≤ 0,045 | ≤ 0,030 | ≤ 1,0 | ≤ 2,0 | 16,5 to 20 | 2,0 to 3,0 | 9 to 15 | ≤ 5 × % C | ≤ 8 × % C |

[a] Ratio yield point - tensile strength. An adequate high temperature yield point for the highest possible temperature of the components shall be guaranteed.

**Table 2 — Minimum requirements for cast iron**

| **Flake graphite cast iron (EN 1561)** | |
|---|---|
| Tensile strength $R_m$ | > 150 N/mm² |
| Brinell hardness | 160 HB to 220 HB 2,5/187,5 |
| **Spheroidal graphite cast iron (annealed ferritic):** | |
| Tensile strength $R_m$ | > 400 N/mm² |
| Notch impact strength | > 23 J/cm² |

**Table 3 — Aluminium and aluminium alloy parts**

| | **Tensile strength** | **Temperature range** |
|---|---|---|
| | $R_m$ | °C |
| | N/mm² | |
| Al 99,5 | ≥ 75 | ≤ 300 |
| Al Mg2 Mn 0,8 | ≥ 275 | ≤ 250 |

**Table 4 — Copper or copper alloy parts**

| | **Tensile strength** $R_m$ | **Temperature range** |
|---|---|---|
| | N/mm² | °C |
| SF - Cu | ≥ 200 | ≤ 250 |
| Cu Ni 30 Fe | ≥ 310 | ≤ 350 |

#### 5.3.2.3 Thicknesses

The minimum wall thicknesses are given in Table 5 and Table 6. For rolled steel the tolerances shall be as given in EN 10029.

**Table 5 — Minimum thicknesses for rolled parts**

| | Carbon steels, aluminium | Protected steels, stainless steels, copper |
|---|---|---|
| | mm | mm |
| Walls of the combustion chamber in contact with fire and water and flat walls of convection heating surfaces | 6 | 4 |
| Walls in contact only with water and rigidly formed (e.g. corrugated) convection heating surfaces outside the combustion chamber | 5 | 2 |
| Pipes used in the convection part of the heat exchanger | 2,9 | 1 |

**Table 6 — Nominal thicknesses of boiler sections of cast materials**

| Flake graphite cast iron, aluminium | Spheroidal graphite (annealed ferritic) cast iron, copper |
|---|---|
| 5,5 mm | 5,0 mm |

The thicknesses of cast walls given in the production drawings shall not be less than the nominal minimum thicknesses given in Table 6 for parts of cast iron or of cast materials which are subjected to pressure. The actual minimum thickness of the boiler sections and of parts under pressure shall be greater than 0,8 times those given in the drawings.

#### 5.3.2.4 Welded seams and welding fillers

Materials shall be suitable for welding. The materials in accordance with Table 1 are suitable for welding and do not require additional heat treatment after welding.

Welded seams shall show no cracks or bonding faults and shall be defect free over the whole cross-section for butt welds.

One sided fillet welds and half Y-welds which have not been welded through shall be kept substantially free from bending stresses. Smoke tubes, inserted stays and similar components need not be counter-welded. Double fillet welds are only permissible when sufficiently cooled. Projections into the flue gas side in areas of high thermal stresses shall be avoided.

Corner welds, edge welds and similar welded connections which are subjected to high bending stresses during production and operation are to be avoided.

For welded in longitudinal stay bars or stay tubes the shearing cross-section of the fillet weld should be 1,25 times the required stay bar or stay tube cross-sectional area.

See Table 7 for details on the welding seams mentioned. Welding fillers shall be suitable for the material being used.

The terms given in Table 7 are in accordance with EN 22553; the reference numbers of welding processes are in accordance with ISO 857-1 and EN ISO 4063, as appropriate.

**Table 7 — Weld joints and welding processes**

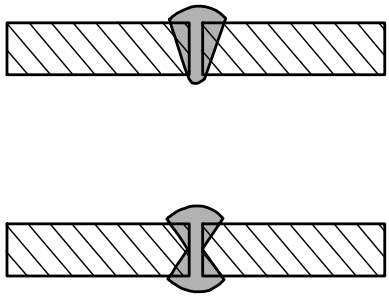
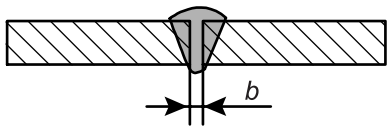
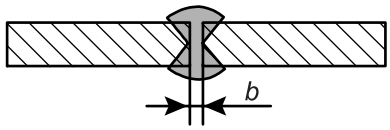
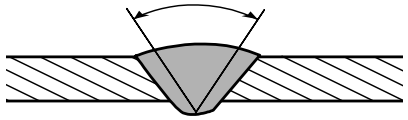
| No | Weld joint type | Material thickness | Welding process [a] | Remarks |
|---|---|---|---|---|
| | | *t* | | |
| | | mm | | |
| 1.1 | Square butt weld  | ≤ 6 | 135 | Permissible up to *t* = 8 mm on use of deep penetration electrodes or welding on both sides |
| | | (8) | 12 | |
| | | | 131 | |
| | | | (111) | |
| 1.2 | Square butt weld   | ≥ 6<br>≤ 12 | 12 | Root gap *b* = 2 mm to 4 mm with stiffener, powder holder necessary |
| 1.3 | Square butt weld (double)   | > 8 | 135 | Root gap *b* = 2 mm to 4 mm |
| | | ≤12 | 12 | Deep penetration electrodes shall be used for manual electro welding |
| | | | (111) | |
| 1.4 | Single-V butt weld  | ≤ 12 | (111) | Seam preparation<br>V-seam 60° |

**Table 7 — Weld joints and welding processes**

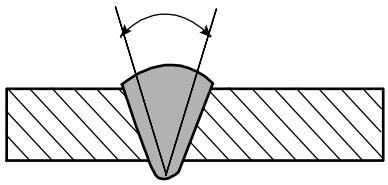
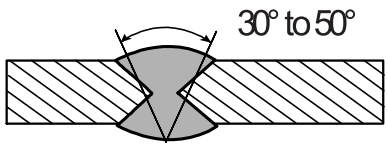
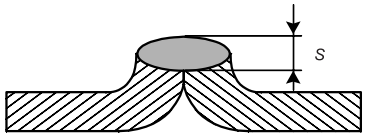
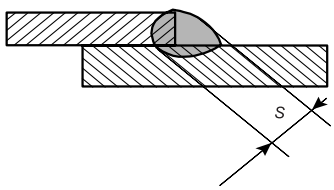
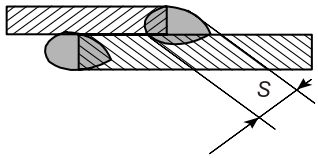
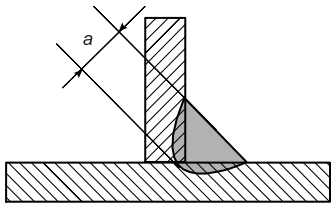
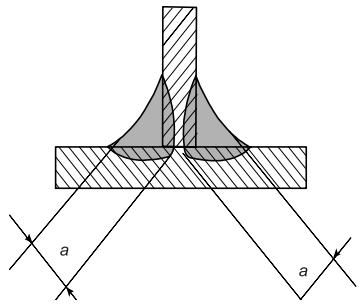
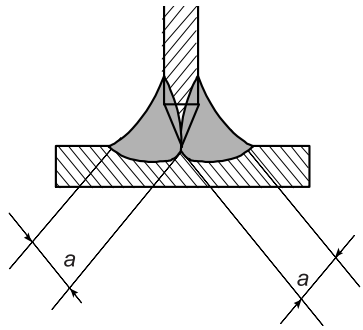
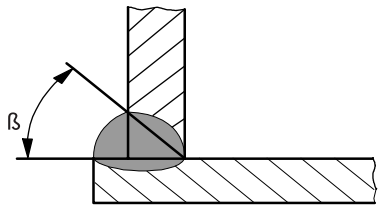
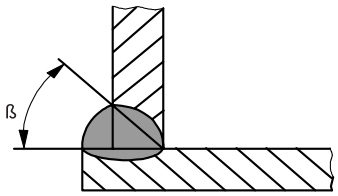
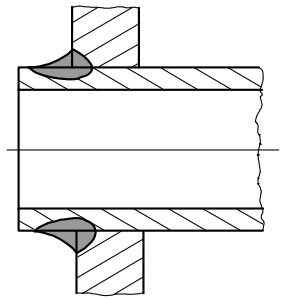
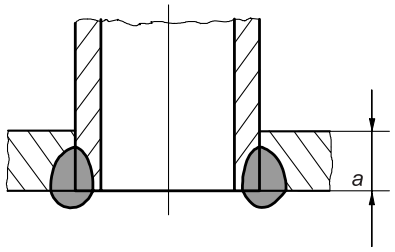
| No | Weld joint type | Material thickness | Welding process [a] | Remarks |
|---|---|---|---|---|
| | | *t* | | |
| | | mm | | |
| 1.5 | Single-V butt weld  | ≤ 12 | 135<br>12 | Seam preparation V-seam 30° to 50° depending on thickness of material |
| 1.6 | Double-V butt weld   | > 12 | 135 | Seam preparation double V-seam 30° to 50° depending on material thickness |
| | | | 12 | |
| 1.7 | Butt weld between plates with raised edges   | ≤ 6 | 135 | Only permissible in exceptional cases for parts welded in |
| | | | 141 | Moreover, the welds have to be kept largely free from bending stresses |
| | | | 131 | Not suitable for directly fired wall parts |
| | | | (111) | $s = 0{,}8\ t$ |
| 1.8 | Overlap welding   | ≥ 6 | 135 | Welds of this type are to be kept largely free from bending stresses |
| | | | 12 | Not suitable for directly fired wall parts |
| | | | | $s = t$ |
| 1.9 | Overlap welding (cont) | ≤ 6 | 135 | Not suitable for directly fired wall parts |

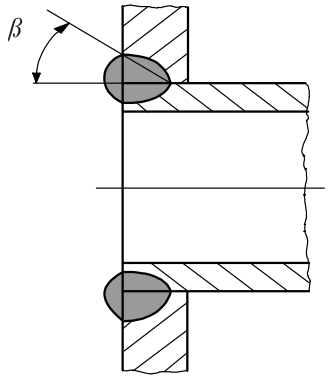
**Table 7 — Weld joints and welding processes**

| No | Weld joint type | Material thickness | Welding process [a] | Remarks |
|---|---|---|---|---|
| | | *t* | | |
| | | mm | | |
| |  | | 12<br>(111) | *s* = *t* |
| 2 | Fillet weld<br>  | ≤ 6 | 135 | Welds of this type are to be kept largely free from bending stresses |
| | | | 12 | *a* = *t* |
| | | | (111) | |

| | | | | |
|---|---|---|---|---|
| 2.1 | Double fillet weld<br>  <br> | ≤12 | 135 | *a* = *t* |
| | | | 12 | |
| | | | (111) | |
| | | > 12 | 135 | *a* = 2/3 *t* |
| | | | 12 | |
| | | | (111) | |

| | | | | |
|---|---|---|---|---|
| 2.2 | Double-bevel butt weld<br>  <br> | ≤12 | 135 | *a* = *t* |
| | | | 12 | |
| | | | (111) | |
| | | >12 | 135 | *a* = 2/3 *t* |
| | | | 12 | |
| | | | (111) | |

| | | | | |
|---|---|---|---|---|
| 2.3 | Single bevel butt weld<br>  | ≤12 | 135 | for (111) ß = 60° |
| | | | 12 | for 135, 12 ß = 45° to 50° |
| | | | (111) | |
| | | > 12 | 135 | |
| | | | 12 | |
| 2.4 | Single-bevel butt weld<br>  | ≤ 12 | 135 | for (111) ß = 60° |
| | | | 12 | for 135, 12 ß = 45° to 50° |
| | | | (111) | |
| 2.5 |  | ≤ 12 | 135 | Tube ends shall not project beyond fillet weld if it is subjected to heat radiation |
| | | | (111) | |
| 2.6 |  | ≤ 6 | 135 | Welding in of tube under high thermal stress $a \geq t$ |
| | | | (111) | |

| | | | | |
|---|---|---|---|---|
| 2.7 |  | | 135 | Welding in of tube under high thermal stress |
| | | | (111) | For (111) ß = 60°<br>For 135 ß = 45° to 50° |

a Reference numbers of welding processes in accordance with ISO 857-1 or EN ISO 4063:

| Reference number | Process |
|---|---|
| 12 | Submerged arc welding |
| 111 | Metal-arc welding with covered electrode |
| 131 | Metal-arc inert gas welding; MIG welding |
| 135 | Metal-arc-active gas welding; MAG welding |
| 141 | Tungsten inert gas arc welding TIG welding |

### 5.3.3 Thermal insulation

Any thermal insulation shall withstand a temperature of at least 120 °C without deformation and shall retain its insulating properties under the influences of heat and ageing.

The insulation shall withstand the normally expected thermal and mechanical stresses.

The insulation shall be of non-combustible materials. However, inflammable materials are permitted provided that:

— the insulation is applied to surfaces in contact with water, or

— the temperature of the surface to which it is applied does not exceed 85 °C in normal operation, or

— the insulation is protected by a non-combustible case having an appropriate wall thickness.

If flame can come into contact with the insulation or if the insulation is applied close to the combustion products outlet, the insulation shall be non-combustible or protected by a non-combustible case having an appropriate wall thickness.

## 5.4 Design

### 5.4.1 General

The boiler shall be designed such that when it is installed and used according to the manufacturer's instructions, it shall be possible to vent the air from the boiler waterways, if it is not self-venting.

For standard boilers that 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.

If condensation is produced at start-up, this shall not:

— affect the operational safety;

— drop outside the appliance.

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

### 5.4.2 Modular boilers

Each module shall be fitted with its own control system and automatic valves, including flame safeguard equipment, control thermostat and safety temperature limiter. The requirements in relation to control and safety devices depend on the nominal heat input ($Q_n$) of the module (e.g. when $Q_n \leq 70$ kW, the requirements shall be those of EN 297 and when $Q_n > 70$ kW but less than 300 kW, the requirements shall be those of EN 656, where relevant).

Where it is possible to close off the water flow to individual modules, it shall not be possible to operate the isolated module(s) unless provision is made for the modules to be installed in a manner similar to individual boilers.

## 5.5 Use and servicing

The operator shall be able to gain access to and operate all control knobs, buttons etc. necessary for normal use of the boiler without having to remove any part of the case. However, part of the case may be removable provided that:

— this part can be handled easily and safely by the operator;

— this part can be removed without the use of tools;

— incorrect replacement is difficult (e.g. by the provision of stops).

All markings intended for the operator shall be easily visible and shall be made in a clear and indelible manner.

Parts, which are required to be inspected or removed for servicing, shall be easily accessible, possibly after removal of the case.

Removable parts shall be designed or marked so that they are difficult to re-assemble incorrectly.

In accordance with the manufacturer's instructions, it shall be possible to clean the burner, combustion chamber and parts in contact with combustion products easily by mechanical means or to remove them easily for cleaning: this shall not involve disconnection of the boiler from the gas or water pipes, or the use of other than commercially available tools. The gas circuit shall be designed so as to permit separate disconnection of the burner or of the whole burner and control assembly.

## 5.6 Connections to the gas and water pipes

### 5.6.1 General

The boiler connections shall be easily accessible. They shall be clearly identified in the installation instructions and possibly on the boiler. The clearance around the connections, after removing the case if necessary, shall be adequate to allow easy use of the tools required to make the connection. It shall be possible to make all the connections without special tools.

### 5.6.2 Connections to the gas pipe

It shall be possible to connect the boiler by rigid metallic means to the gas supply pipe.

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

If flanges are used, they shall comply with EN 1092-1, EN 1092-2 or EN 1092-3, as appropriate, and the manufacturer shall provide the counter-flanges and sealing gaskets.

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

### 5.6.3 Connections to the central heating circuit

Threaded connections shall comply with EN ISO 228-1 or ISO 7-1.

If copper connections are used, the connecting end of the tube shall comply with EN 1057.

If other than metallic materials are used, the manufacturer shall provide the appropriate justification for their suitability of use.

## 5.7 Soundness

### 5.7.1 Soundness of the gas circuit

The gas circuit shall consist of metallic parts.

Holes for screws, studs, etc., intended for the assembly of parts shall not open into gas ways. The wall thickness between drillings and gas ways shall be at least 1 mm. This does not apply to orifices for measurement purposes. It shall not be possible for water to penetrate into the gas circuit.

The soundness of parts and assemblies making up the gas circuit and likely to be dismantled for routine maintenance in situ shall be achieved by means of mechanical joints, e.g. metal to metal joints, gaskets or toroidal seals, i.e. excluding the use of all sealing materials such as tape, paste or liquid. However, the sealing materials mentioned above may be used for permanent assemblies. These sealing materials shall remain effective under normal conditions of boiler use.

Where parts of the gas circuit are assembled without threads, soundness of the assembly shall not be achieved by means of soft solder or by means of adhesive.

### 5.7.2 Soundness of the combustion circuit

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

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

The soundness of parts likely to be removed during routine servicing shall be achieved by mechanical means, excluding pastes, liquids and tapes. The replacement of seals in accordance with the manufacturer's instructions is permitted.

## 5.8 Supply of combustion air and the evacuation of the combustion products

### 5.8.1 Control dampers in the air or combustion products circuit

Moveable components of the damper shall interlock and shall have no relative motion with respect to one another.

Any limit switch shall be designed and arranged so that incorrect signals about the open position of the damper are eliminated.

The damper system shall be provided with a means of proving that the position of any interlocks is correct prior to the damper being operated. This requirement is deemed to be met by limit switches which are protected against the effects of short circuits by suitable protective devices. These devices shall operate before the short circuit current exceeds 50 % of the rated current of the switches.

At the start-up and at every operating state, it shall be ensured that the damper is or has been moved to a position in which the air flow rate and heat input are in the specified ratios.

If the ratio of heat input to air flow rate is not as specified or if there is a fault in the switching system:

— either the damper shall be moved to a position which increases the excess air;

— or there shall be a safety shutdown of the gas supply to the main burner.

### 5.8.2 Fan

Direct access to the rotating parts of a fan shall be prevented. Parts of a fan in contact with combustion products shall be effectively protected against corrosion unless they are made of corrosion resistant material; they shall withstand the temperature of the combustion products.

### 5.8.3 Air proving

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

Before each fan start it is checked that there is no simulation of air flow; this requirement is deemed to be met if the boiler is fitted with a gas/air ratio control.

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

— supervision of the combustion air pressure or the combustion products pressure;

— supervision of the combustion air rate or the combustion products rate;

— automatic gas/air ratio control;

— indirect supervision (e.g. fan speed supervision) when there is an air proving device which proves the air rate at least once at each start up and provided that there is a shutdown at least once every 24 h.

### 5.8.4 Gas/air ratio controls

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

Pneumatic gas/air ratio controls shall comply with the relevant requirements of EN 12067-1.

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

Control tubes may be made of metal with suitable mechanical connections or of other materials with at least equivalent properties. In this case, they are considered immune to breakage, accidental disconnection and leakage after initial soundness checks. As such, they are not subject to the tests in 7.5.5.4.1.

Control tubes for air or combustion products shall have a minimum cross-sectional area of 12 $mm^2$ with a minimum internal dimension of 1 mm. They shall be located and fixed so that any retention of condensate is avoided and positioned such that creasing, leakage or breakage is prevented. Where more than one control tube is used, the relevant connection position for each shall be obvious.

#### 5.8.5 Condensate discharge

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 for the maximum pressure at the outlet as specified by the manufacturer according to the connecting conditions to the duct for the evacuation of the combustion products.

### 5.9 Checking the state of operation

The ignition and operation of the burner(s) and also the length of the flame(s) of the ignition burner, if any, shall be observable visually by the installer. The momentary opening of a door or the removal of a case shall not disturb the operation of the burners.

In addition, mirrors, sight glasses etc., shall continue to retain their optical properties. However, when the main burner is fitted with its own flame detector, an indirect means of indication (e.g. an indicator light) is allowed. The indication of flame presence shall not be used to indicate any fault, except for a fault in the operation of the means of checking the flame itself, which shall result in an indication that there is no flame.

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

### 5.10 Drainage

If it is not possible to drain the boiler by means of the water connections, it shall carry a device that enables it to be drained and which can be operated by means of a tool such as a spanner or screwdriver. Adequate directions for drainage shall be included in the instructions.

## 5.11 Electrical equipment

The electrical equipment shall comply with the requirements of EN 50165 except where reference is made to another electrical standard in 5.13.

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

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

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

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

Where a three-phase supply is used, all control and safety devices shall be supplied by the same single-phase conductor which shall be identifiable without any possible ambiguity.

## 5.12 Operational safety in the event of failure of the auxiliary energy

If the boiler uses auxiliary energy, its design shall be such that no risk can occur in the event of abnormal fluctuations or failure of the auxiliary energy, or following its restoration.

## 5.13 Adjusting, control and safety devices

### 5.13.1 General

Safety systems shall be designed in accordance with the de-energized to trip principle.

The operation of safety devices shall not be overruled by adjusting and control devices.

The design of the control and safety system shall be such that it is never possible to perform two or more actions which would be unacceptable in combination. The order of the actions shall be fixed in such a manner that it is not possible to change it.

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

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

Control and safety devices shall comply with relevant CEN/TC 58 standards such as EN 88, EN 125, EN 126, EN 161, EN 257, EN 298, EN 12067-1, EN 12067-2 and EN 1643.

### 5.13.2 Adjusters and range rating devices

#### 5.13.2.1 General

Adjusters shall be designed so that they are protected against accidental maladjustment by the operator once the appliance has been installed and put into service. It shall be possible to seal them (e.g. with paint) after adjustment; this sealing shall resist the heat to which it is subjected during normal operation of the boiler. Adjusting screws shall be located so that they cannot fall into the gas ways.

The soundness of the gas circuit shall not be put at risk by the presence of adjusters.

#### 5.13.2.2 Adjusters

Boilers shall be fitted with a gas rate adjuster and/or gas regulator.

An adjuster shall:

— be sealed if adjustment is only made by the manufacturer;

— be able to be sealed if adjustment is carried out by the installer.

The adjusters shall be sealed by the manufacturer for boilers which are intended to operate on a gas of group 2E or 3 and include a pressure couple sign “+” (e.g. 2E+ or 3+).

#### 5.13.2.3 Range rating devices

The boiler may have a range rating device.

If the gas rate adjuster and the range-rating device are one and the same, the manufacturer shall give suitable instructions for the use of the adjuster in his installation instructions.

### 5.13.3 Gas circuit

#### 5.13.3.1 General

A device to protect against dust shall be positioned near the gas inlet. The maximum dimension of the mesh of the filter shall not exceed 1,5 mm; furthermore the mesh shall not allow passage of a 1 mm pin gauge.

#### 5.13.3.2 Control devices

Every boiler shall be provided with at least one device that enables the user to control the gas supply to the burner and to the ignition burner, if any.

The shut-off shall be effected without delay, for example it shall not be subject to the delay time of the thermoelectric flame supervision device.

No markings are required if incorrect operation is impossible, for example when a single button controls a flame supervision device for the burner and ignition burner. However, where it is necessary to use markings, the following signs shall be used:

| | | | | |
|---|---|---|---|---|
| — | Off | : | Full disc | ● |
| — | Ignition | : | Stylized star | ★ |
| — | Full rate of the burner | : | Stylized flame |  |

If the boiler has two distinct gas rate controls, one for the burner and one for the ignition burner, the operation of these devices shall be interlocked in such a way that it is impossible for the burner to be supplied before the ignition burner.

If the burner and ignition burner are served by a single tap, the position for ignition of the latter shall have a stop or notch making this position clearly perceptible to the user. It shall be possible to carry out the unlatching operation (if any) with one hand.

If the only control to cut off the gas supply operates by turning, it shall turn off in a clockwise direction as seen by an observer facing the knob.

#### 5.13.3.3 Composition of the gas circuit

The gas circuit shall be fitted with automatic shut-off valves in accordance with EN 161 and Table 8.

Valve proving systems shall comply with EN 1643.

**Table 8 — Composition of the gas circuit**

| | Boiler without fan | Boiler with fan | | |
|---|---|---|---|---|
| Heat input of the Individual gas line within the gas circuit<br>kW | | With pre-purge | Without pre-purge but with a valve proving system or permanent or alternating ignition flame | Without pre-purge |
| input ≤ 0,250 | C [a] | | | C [a] |
| input ≤ 150 | C [a b] + J | | | C [a b]+ C or B + J |
| 150 < input ≤ 300 | B + C | | | B + B |
| 300 < input ≤ 1 000 | B + B | | | A + A |
| [a] Or the valve of the flame supervision device. | | | | |
| [b] For heat inputs ≤ 1 000 W which meet the criteria of 6.5.3.3.1 second paragraph, only one Class C valve is needed. | | | | |

Safety devices which require non-volatile lockout to occur shall give rise to simultaneous signals to close the two valves. However, for a thermoelectric device, the safety devices may act only on this device.

In the case of direct ignition of the main burner and if the order to close in response to a control device is not given simultaneously to the two valves, the two valves shall be at least Class C (B for > 150 kW and A for > 300 kW).

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

Illustrations of the composition of the gas circuit are given in Annex G.

#### 5.13.4 Gas pressure regulator

The gas regulator, if fitted, shall comply with EN 88.

Boilers using first and second family gases shall be fitted with a regulator. For boilers using third family gases this regulator is optional.

A regulator intended for operation with a pressure couple shall be adjusted or shall be capable of adjustment, so that it cannot operate between the two normal pressures.

However, when operating with a pressure couple, a non-adjustable gas regulator for the ignition burner is permitted.

The design and accessibility of the regulator shall be such that it can easily be adjusted and put out of operation when another gas is supplied, but precautions shall be taken to make unauthorized interference with the adjuster difficult.

### 5.13.5 Ignition devices

#### 5.13.5.1 Ignition of the ignition burner

It shall be possible to light, in a simple manner, ignition burners that are directly ignited by hand.

Ignition devices for the ignition burner shall be designed and fitted in such a way that they are located correctly in relation to the components and the ignition burner. It shall be possible to fit or remove the ignition device for the ignition burner, or the ignition burner-ignition device assembly, using commonly available tools.

#### 5.13.5.2 Ignition device for the main burner

Main burners shall be fitted with an ignition burner or a device for direct ignition.

Direct ignition shall not cause deterioration of the burner.

#### 5.13.5.3 Ignition burners

Ignition burners shall be designed and fitted in such a way that they are located correctly in relation to the components and to the burners which they ignite. If different ignition burners are used for the different gases they shall be marked, easy to substitute for one another and easy to fit. The same applies to injectors where only they have to be changed.

If the gas rate of the ignition burner is not governed, a gas rate adjuster is mandatory for boilers operating on first family gases, optional for second family gases and third family gases without a pressure couple. However, it is forbidden for second and third family gases if a pressure couple is used. The adjuster may be omitted if ignition burners and/or injectors suiting the characteristics of the gas used can be changed easily.

#### 5.13.5.4 Direct ignition

Direct ignition devices shall ensure safe ignition even if the voltage is varied from 85 % to 110 % of the nominal voltage. The order to energize ignition devices shall be given no later than the order to open the automatic valve controlling the gas to be ignited. Excluding flame detection, the ignition device shall be de-energized no later than at the end of the ignition safety time.

### 5.13.6 Flame supervision systems

#### 5.13.6.1 General

The presence of a flame shall be detected:

— either by a thermoelectric flame supervision device,

— or by the flame detector of an automatic burner control system.

At least one flame detector is required.

Where the main burner is ignited by an ignition burner, the presence of the ignition burner flame shall be detected before gas is admitted to the main burner.

#### 5.13.6.2 Thermoelectric flame supervision device

The device shall cause non-volatile lockout of the boiler in the event of flame failure and in the event of damage to the sensing element or to the connection between the sensing element and the shut-off valve.

The device shall include:

— either an ignition interlock,

— or a restart interlock.

It is permitted to use a burner ≤ 150 kW using a thermo-electric flame supervision device provided that the additional heat input is supervised by an automatic burner control system (see 6.5.3.3).

#### 5.13.6.3 Automatic burner control system

Automatic burner control systems shall comply with the appropriate requirements of EN 298. In case of flame failure, the system shall cause at least spark restoration or recycling or volatile lockout. In the case of spark restoration or recycling, an absence of flame at the end of the ignition safety time ($T_{SA}$) shall result in, at least, volatile lockout.

In the case of recycling a waiting time of at least 30 s shall be included for appliances without a fan.

### 5.13.7 Thermostats and water temperature limiting devices

#### 5.13.7.1 General

Boilers shall be fitted with at least:

— an adjustable or fixed control thermostat (in accordance with 5.13.7.2), and

— a safety temperature limiter (in accordance with 5.13.7.3).

#### 5.13.7.2 Control thermostat

The control thermostat shall comply with the requirements of EN 60730-2-9 for Type 1 devices.

If the control thermostat is adjustable, the manufacturer shall at least state the maximum of the temperature range. The positions of the temperature selector shall be easy to establish and it shall be possible to ascertain in which direction the water temperature rises or falls. If numbers are used for this purpose, the highest number shall correspond to the highest temperature.

At its maximum setting, it shall cause at least controlled shutdown before the water flow temperature exceeds 105 °C.

#### 5.13.7.3 Safety temperature limiter

The safety temperature limiter shall comply with the requirements of EN 60730-2-9 for Type 2 devices.

This device shall cause non-volatile lockout before the water flow temperature exceeds 110 °C.

Normal operation of the boiler shall not give rise to a change in the set-point temperature of the device. However, the manufacturer may adjust the set-point temperature to achieve a maximum water flow temperature of less than 110 °C provided that once the adjustment has been made, re-adjustment above the new set-point is not possible without the use of a tool.

Interruption of the link between the sensor and the device responding to its signal shall cause at least safety shutdown.

#### 5.13.7.4 Sensors

Thermostats and safety temperature limiters shall have independent sensors.

The sensors shall withstand any thermal overload resulting from the overheat condition specified in this European Standard without the predetermined set-point being affected.

#### 5.13.7.5 Remote control

The boiler shall be designed so that it can be controlled remotely.

Connection of any remote controls recommended by the manufacturer shall be possible without disturbing any internal electrical connections except for purpose designed removable links. The necessary information shall be given in the installation instructions.

### 5.13.8 Device for monitoring the evacuation of combustion products

Where a boiler is fitted with a flue stabilizer instead of a draught diverter it shall be originally fitted with a device which monitors the evacuation of the combustion products.

The requirements and tests for this device are given in 6.5.8 and 7.5.8.

This device shall be an integral part of the boiler. It shall be resistant to thermal, chemical and mechanical effects occurring in normal use.

It shall not be adjustable. Adjustable components shall be sealed by the manufacturer.

The device shall be so designed that it cannot be dismantled without a tool.

It shall not be possible to fit the device incorrectly after servicing.

The device shall be designed so as to maintain the electrical insulation. Interruption of the link between the detection element and the control device shall lead to safety shutdown.

## 5.14 Burners

The cross-section of the flame ports and also the burner and ignition burner injectors shall not be adjustable.

Every injector and/or removable restrictor shall carry an indelible means of identification preventing any confusion. In the case of non-removable injectors and/or restrictors the marking may be on the manifold.

It shall be possible to change injectors and restrictors without the need to disconnect the boiler. When the injectors and restrictors are removable, their position shall be well defined and their method of fixing such that it is difficult to position them incorrectly.

Primary aeration adjusters are not allowed.

## 5.15 Pressure test points

The boiler shall be fitted with at least two pressure test points. The test points shall be fitted in a position carefully selected so as to permit the measurement of the inlet pressure and the burner pressure.

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

### 5.16 Chemical composition of the condensate for low-temperature boilers

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

## 6 Operational requirements

### 6.1 General

The following requirements are checked under the test conditions of 7.1.

### 6.2 Soundness

#### 6.2.1 Soundness of the gas circuit

The gas circuit shall be sound.

The soundness is checked on delivery of the boiler and after all the tests of this standard.

Soundness is assured if, under the conditions specified in 7.2.1, the air leakage rate does not exceed:

— for Test No. 1: 0,06 $dm^3/h$;

— for Test No. 2: 0,14 $dm^3/h$.

#### 6.2.2 Soundness of the combustion circuit and correct evacuation of the combustion products

When the appliance is tested under the conditions of 7.2.2 combustion products shall only escape from the flue.

#### 6.2.3 Soundness of the water circuit

Under the test conditions of 7.2.3 there shall be neither leakage during the test nor permanent visible distortion after the test.

### 6.3 Nominal, maximum and minimum heat inputs, and nominal output

#### 6.3.1 Nominal heat input or maximum and minimum heat inputs

The heat input obtained under the test conditions of 7.3.1 shall not differ by more than 5 % from:

— the nominal heat input, for boilers without a range rating device, or

— the maximum and minimum heat input for boilers with a range rating device.

#### 6.3.2 Adjustment of the heat input by the downstream pressure

When the manufacturer's instructions specify the value of the downstream pressure that enables the nominal heat input to be obtained, the heat input obtained under the test conditions of 7.3.2 shall not differ by more than 5 % from the nominal heat input.

#### 6.3.3 Minimum ignition rate

Under the test conditions of 7.3.3, it is checked that the heat input necessary for ignition of the burner does not exceed the minimum ignition rate declared by the manufacturer.

#### 6.3.4 Nominal output

It is verified that the output determined under the test conditions of 7.3.4 is not less than the nominal output.

#### 6.3.5 Gas pressure regulator

Under the test conditions of 7.3.5, the gas rate of boilers fitted with a regulator shall not differ from the gas rate obtained at normal pressure by more than:

— + 7,5 % and -10 % for first family gases;

— + 5 % and -7,5 % for second family gases without a pressure couple;

— ± 5 % for second and third family gases with a pressure couple;

— ± 5 % for third family gases without a pressure couple.

In the case where boilers using gases of the second and third family without a pressure couple do not meet the requirements between $p_n$ and $p_{min}$, these boilers shall meet the requirements for a boiler without a gas regulator, for this pressure range.

### 6.4 Safety of operation

#### 6.4.1 Limiting temperatures

##### 6.4.1.1 General

The boiler shall be installed as specified in 7.4.1.1.

##### 6.4.1.2 Limiting temperatures of adjusting, control and safety devices

Under the test conditions specified in 7.4.1.2, the temperature of the adjusting, control and safety devices shall not exceed the value stated by their manufacturer and the operation shall remain satisfactory.

The surface temperatures of the control knobs and of all the parts that have to be touched during normal use of the boiler, measured only in the zones intended to be gripped, and under the conditions stated in 7.4.1.2, shall not exceed the ambient temperature by more than:

— 35 K for metals;

— 45 K for porcelain;

— 60 K for plastics.

#### 6.4.1.3 Limiting temperatures of the side walls, the front and the top

The temperature of the side walls, front and top of the boiler, except for the walls of any draught diverter and any duct between the boiler case and the draught diverter, shall not exceed the ambient temperature by more than 80 K, when measured under the test conditions of 7.4.1.3.

Nevertheless, parts of the case within 5 cm of the edge of the lighting hole or sight glass, and within 15 cm of the flue duct are exempt from this requirement.

#### 6.4.1.4 Limiting temperature of the floor

The temperature of the floor on which the boiler is placed shall not at any point exceed the ambient temperature by more than 80 K under the test conditions of 7.4.1.4.

When this temperature rise is between 60 K and 80 K, the manufacturer shall state in the technical instructions for the installer the nature of the protection which has to be applied between the appliance and the floor when this is made of flammable material.

This protection shall be supplied to the test laboratory which shall check that, with the appliance fitted with it, the floor temperatures measured under the test conditions of 7.4.1.4 do not exceed the ambient temperature by more than 60 K.

### 6.4.2 Ignition — Cross-lighting — Flame stability

#### 6.4.2.1 General

All tests shall be carried out in accordance with 7.4.2.1.

#### 6.4.2.2 Limit conditions

Under the test conditions specified in 7.4.2.2 and in still air, ignition and cross lighting shall be capable of being effected correctly, rapidly and quietly. The flames shall be stable. A slight tendency to lift at the moment of ignition is permissible but the flames shall be stable thereafter.

Ignition of the burner shall occur at all gas rates which can be given by the controls as stated by the manufacturer and there shall be neither light-back nor prolonged flame lift. However, brief light-back during ignition or extinction of the burner is accepted if this does not affect correct operation. Nevertheless flames shall not issue from the case.

A permanent ignition burner shall not be extinguished during ignition or extinction of the burner; while the boiler is operating, the ignition burner flame shall not change to such an extent that it can no longer fulfil its function (ignition of the burner, operation of the flame supervision device).

When the ignition burner has been alight for a sufficient time for normal and regular operation of the boiler to be obtained, it shall always be ready to operate without fail, even if the gas supply to the burner is turned off and on by several quick and successive adjustments of the thermostat.

For boilers fitted with a range rating device, these requirements are checked both at the maximum heat input and the minimum heat input stated by the manufacturer.

In addition, to test flame stability for boilers which have an indirect means of indicating the presence of the flame, the carbon monoxide concentration, at thermal equilibrium, of the dry, air-free combustion products, using flame lift limit gas, shall not be more than $1\,000 \times 10^{-6}$ ($V/V$).

Where spark restoration or recycling is provided, the above requirements shall also be met.

#### 6.4.2.3 Special conditions

##### 6.4.2.3.1 Resistance to draught

The flames shall be stable under the test conditions of 7.4.2.3.1.

##### 6.4.2.3.2 Flue conditions (Type $B_1$ boilers)

Under the test conditions of 7.4.2.3.2 no extinction of the burner is permitted even when this occurs through operation of the flame supervision device.

##### 6.4.2.3.3 Reduction of the gas rate of the ignition burner

Under the test conditions of 7.4.2.3.3 and when the gas rate of the ignition burner is reduced to the minimum required to keep open the gas supply to the main burner, ignition of the main burner shall be assured without damage to the boiler and without flame roll-out outside the case.

##### 6.4.2.3.4 Defective closure of the gas valve immediately upstream of the main burner

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 7.4.2.3.4 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.

##### 6.4.2.3.5 Reduction of the gas pressure

Under the test conditions of 7.4.2.3.5 there shall be no dangerous situation for the user or damage to the boiler.

##### 6.4.2.3.6 Stability of the ignition burner flame

This requirement shall apply where a permanent or alternating ignition burner is incorporated in:

— a boiler with a fan and, by design, the fan does not operate while the main burner is shut down, or

— a boiler having an automatic flue damper or combustion air damper that returns to the fully closed position, when the main burner is shut down.

For such boilers, the ignition burner flame shall remain stable under the test conditions of 7.4.2.3.6.

#### 6.4.3 Pre-purge

For fan assisted boilers, burner ignition shall be preceded by a pre-purge, which is not mandatory in the following cases:

— boilers fitted with a permanent ignition burner or an alternating ignition burner;

— boilers in which the main burner gas line is fitted with a valve proving system;

— boilers fitted with two Class A valves (see 5.13.3.3).

Pre-purge is always necessary after a safety shut down or a lock out situation unless when tested in accordance with 7.4.3.4 no hazard or damage occurs.

The pre-purge shall correspond to either:

— a volume of at least three times the volume of the combustion chamber at an air rate of at least 0,4 ($Q_{n\ AIR}$), or

— a time of:

  — at least 30 s at an air rate of: $Q_{n\,AIR}$, or

  — a proportionally longer time when 0,4 ($Q_{n\,AIR}$) < $Q_{AIR}$ < $Q_{n\,AIR}$.

For modular boilers, in which the products of combustion from each module vent into a common chamber before entering the flue system, the pre-purge at the time of each initial start-up shall be at least three times the volume of the complete assembly of modules.

When at least one module is already operating, the pre-purge for the start-up of any other modules shall be that provided for the individual module.

For modular boilers in which the products of combustion from each module vent directly into the flue system, the pre-purge shall be that provided for the individual module.

The test conditions are described in 7.4.3.

## 6.5 Adjusting, control and safety devices

### 6.5.1 General

The following requirements shall be met under the test conditions of 7.5.1. Unless otherwise stated, the devices shall operate correctly under extreme conditions, namely, at the maximum temperature to which they are subjected in the boiler and when the voltage is varied between 1,10 times and 0,85 times the nominal voltage, and under any combination of these conditions.

For voltages below 85 % of the nominal value, the devices shall either continue to assure safety or cause safety shutdown.

### 6.5.2 Ignition devices

#### 6.5.2.1 Manual ignition devices for ignition burners

Under the test conditions of 7.5.2.1 at least half the manual ignition attempts shall result in ignition of the ignition burner.

The effectiveness of the ignition device shall be independent of the operating speed and sequence. The operation of manually operated electrical ignition devices shall remain satisfactory when they are subjected to the extreme voltages stated in 6.5.1.

The supply of gas to the main burner shall only be permitted after detection of the ignition burner flame.

#### 6.5.2.2 Automatic ignition system for the ignition burner and the main burner

##### 6.5.2.2.1 Ignition

Under the test conditions of 7.5.2.2.1, direct ignition devices shall ensure safe ignition.

Ignition shall be effected at each ignition attempt, which starts with the opening of the valve(s) and ends with the closing of the valve(s).

The ignition system shall be activated at the latest at the same time as the signal to open the valve(s).

If ignition does not occur, the spark shall continue until the end of the $T_{SA}$ (a limit deviation of 0,5 s is permitted). Following this, at least volatile lockout shall take place.

#### 6.5.2.2.2 Endurance

Spark generators shall withstand an endurance test of 250 000 cycles under the test conditions of 7.5.2.2.2.

After the tests, the operation of the device shall remain satisfactory and comply with the requirements of 6.5.2.2.1.

### 6.5.2.3 Ignition burner

Under the test conditions of 7.5.2.3, the heat input of any ignition burner that remains alight when the main burner is extinguished shall not exceed 250 W.

The signal to open the gas supply to the main burner shall only be given after the ignition burner flame has been detected.

### 6.5.3 Flame supervision devices

#### 6.5.3.1 General

Under the test conditions of 7.5.3.1, the following requirements for safety times shall be met.

#### 6.5.3.2 Thermoelectric devices

#### 6.5.3.2.1 Ignition Opening Time ($T_{IA}$)

Under the test conditions of 7.5.3.2.1 the $T_{IA}$ of a permanent ignition burner shall not exceed 30 s.

This time can be raised to 60 s if no manual intervention is required during it.

#### 6.5.3.2.2 Extinction Delay Time ($T_{IE}$)

Under the test conditions of 7.5.3.2.2 the extinction delay time of a thermoelectric flame supervision device shall not exceed 45 s.

When a safety device acts on the thermoelectric flame supervision device, closure shall be effected without delay.

#### 6.5.3.3 Automatic burner control systems

#### 6.5.3.3.1 Ignition Safety Time ($T_{SA}$)

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

Where the heat input of the ignition burner is between 250 W and 1 000 W, there is no requirement in respect of $T_{SA,max}$ if suitable evidence is given by the manufacturer that no dangerous situation for the user or damage to the boiler occurs.

In all other cases, the $T_{SA,\max}$ is chosen by the manufacturer in accordance with 6.5.3.4.3. However, a delayed ignition test is not necessary if the $T_{SA,max}$ determined under the test conditions of 7.5.3.3.1 does not exceed 10 s and if it complies with the following requirement:

$$T_{SA,max} \leq \frac{5 \times 150}{Q_{ign}} s$$

Where $Q_{ign}$ is the ignition input (with a limitation on $Q_{ign}$ of 150 kW in accordance with 6.5.4.2).

Where several automatic ignition attempts are made, the sum of the durations of the ignition attempts shall comply with the above requirement for the $T_{SA,max}$. The delay time of safety valves (in accordance with EN 161) is not included in the $T_{SA.}$

#### 6.5.3.3.2 Extinction safety time ($T_{SE}$)

The extinction safety time $(T_{SE})$ shall not exceed 3 s.

The relevant test conditions are described in 7.5.3.3.2.

### 6.5.3.4 Ignition sequences

#### 6.5.3.4.1 Automatic ignition of an ignition burner or the main burner at ignition rate

The ignition source shall not be energized before a safe start check has been made of the flame supervision system. If the flame has not been detected by the end of the ignition safety time, safety shutdown and lockout shall result.

Flame failure after establishment of the ignition burner or the main burner flame at start gas rate, but before the main gas safety valves have been signalled to open, shall lead to safety shutdown or an attempt at recycling or spark restoration. If recycling or spark restoration is attempted and the ignition burner flame is not detected within the ignition safety time, safety shutdown and lockout shall result.

These requirements are verified under the conditions of 7.5.3.4.1 so that in accordance with 6.5.3.4.3 and 7.5.3.4.3 no dangerous situation for the user or damage to the boiler occurs.

#### 6.5.3.4.2 Direct ignition of the main burner

The ignition source shall not be energized before a safe start check has been made of the flame supervision system. If the main burner flame has not been detected by the end of the ignition safety time, safety shutdown with lockout shall result.

These requirements are verified under the conditions of 7.5.3.4.2.

#### 6.5.3.4.3 Delayed ignition

Under the test conditions of 7.5.3.4.3 there shall be no dangerous situation for the user or damage to the boiler.

#### 6.5.3.4.4 Modular boilers

For assemblies where the products of combustion from the modules are vented into ducts or chambers separated from one another and which meet only at the flue gas outlet connection, simultaneous ignition of two or more modules shall be permissible.

For assemblies where products of combustion from the modules vent into a common chamber before passing into the assembly flue, there shall be a minimum of 5 s separation between the ignition of any two modules.

These requirements are verified under the conditions of 7.5.3.4.4.

### 6.5.4 Ignition burner and ignition rates

#### 6.5.4.1 Permanent ignition burner and alternating ignition burner

The heat input of a permanent or alternating ignition burner shall not exceed 250 W under the conditions specified in 7.5.4.1.

#### 6.5.4.2 Main burner ignition rate

For direct ignition of the main burner the ignition rate shall not exceed 150 kW unless a delayed ignition test in accordance with 6.5.3.4.3 is carried out. The ignition rate shall be determined as described in 7.5.4.2.

### 6.5.5 Air proving

#### 6.5.5.1 General

For boilers with fans, depending on the principle of air proving, the requirements of 6.5.5.2, 6.5.5.3 or 6.5.5.4 shall be met under the test conditions of 7.5.5.

#### 6.5.5.2 Supervision of the combustion air or the combustion products pressure

By choice of the manufacturer, the boiler shall meet one of the following requirements:

— when the fan supply voltage is progressively reduced, the gas supply shall be shut off before the CO concentration exceeds 0,20 %, or

— for a voltage corresponding to a CO concentration greater than 0,10 % at equilibrium, restart shall not be possible from cold.

#### 6.5.5.3 Supervision of the combustion air or the combustion products rate

By choice of the manufacturer, the boiler shall meet one of the following requirements:

— when the combustion products evacuation duct is progressively blocked, the gas supply shall be shut off before the CO concentration exceeds 0,20 %, or

— for a blockage of the combustion products evacuation duct, corresponding to a CO concentration greater than 0,10 % at equilibrium, restart shall not be possible from cold, or

— when the fan supply voltage is progressively reduced, the gas supply shall be shut off before the CO concentration exceeds 0,20 %, or

— for a voltage corresponding to a CO concentration greater than 0,10 % at equilibrium, restart shall not be possible from cold.

#### 6.5.5.4 Gas/air ratio controls

##### 6.5.5.4.1 Leakage of non-metallic control tubes

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

#### 6.5.5.4.2 Safety of operation

By choice of the manufacturer, the boiler shall meet one of the following requirements:

— When the combustion products evacuation duct is progressively blocked, the gas supply shall be shut off before the CO concentration exceeds:

  — 0,20 % over the range of modulation provided by the manufacturer, or

  — $\frac{Q}{Q_{KB}} \bullet CO_{mes} \geq 0{,}20\ \%$ below the minimum rate of the modulation range

  where

  $Q$ is the instantaneous heat input, in kilowatts (kW);

  $Q_{KB}$ is the heat input at the minimum rate, in kilowatts (kW);

  $CO_{mes}$ is the measured CO concentration, in percent (%).

— For a blockage of the combustion products evacuation outlet corresponding to a CO concentration greater than 0,10 %, restart shall not be possible from cold.

— When the fan supply voltage is progressively reduced, the gas supply shall be shut off before the CO concentration exceeds 0,20 %.

— For a voltage corresponding to a CO concentration greater than 0,10 % at equilibrium, restart shall not be possible from cold.

#### 6.5.5.4.3 Adjustment of the air/gas or gas/air ratio

When the air/gas or gas/air ratio is adjustable, the device shall operate at the extreme limits and the range of adjustable pressures shall match the field of adjustment completely.

### 6.5.6 Gas pressure switches

#### 6.5.6.1 General

Gas pressure switches shall comply with EN 1854.

#### 6.5.6.2 Low pressure cut off device

When a boiler is fitted with a device which is intended to operate under conditions of low gas supply pressure, it is determined that when tested in accordance with 7.5.6.2, the device operates before the flame supervision device shuts off the gas supply to the main burner and, if appropriate, any ignition burner.

#### 6.5.6.3 High pressure cut off device

When a boiler is fitted with a high pressure cut off device it is verified that, when tested in accordance with 7.5.6.3, the gas supply to the main burner is shut off at the pressure specified by the manufacturer.

### 6.5.7 Control thermostat and safety temperature limiter

#### 6.5.7.1 General

Under the conditions of 7.5.7.1 it is checked that the opening and closing temperatures of the devices do not differ from those stated by the manufacturer by more than 6 K. For adjustable thermostats this requirement is checked at the minimum and maximum temperatures of the control range.

#### 6.5.7.2 Control thermostat

##### 6.5.7.2.1 Accuracy of adjustment

Under the test conditions of 7.5.7.2.1:

— the maximum water temperature of boilers fitted with a fixed setting thermostat shall be within ± 10 K of the temperature stated by the manufacturer;

— for boilers fitted with an adjustable thermostat, it shall be possible to select, to within ± 10 °C, the water flow temperatures stated by the manufacturer;

— the flow temperature shall not exceed 105 °C;

— the safety temperature limiter shall not operate.

##### 6.5.7.2.2 Endurance

The control thermostat shall withstand an endurance test of 250 000 cycles under the test conditions of 7.5.7.2.2. At the end of the tests its operation shall comply with the requirements of 6.5.7.2.1.

#### 6.5.7.3 Safety temperature limiter

##### 6.5.7.3.1 Inadequate water circulation

Under the test conditions of 7.5.7.3.1 the safety temperature limiter shall cause non-volatile lockout of the boiler before the water flow temperature exceeds 110 °C.

##### 6.5.7.3.2 Overheating

Under the test conditions of 7.5.7.3.2 the safety temperature limiter shall cause non-volatile lockout of the boiler before the water flow temperature exceeds 110 °C.

##### 6.5.7.3.3 Endurance

Under the test conditions of 7.5.7.3.3 an interruption of the link between the sensor and the device responding to its signal shall result in at least safety shutdown.

The device shall withstand an endurance test of 4 500 thermal cycles without activation and 500 cycles of locking and resetting, under the test conditions of 7.5.7.3.3. At the end of the tests its operation shall comply with the requirements of 6.5.7.1 and 6.5.7.3.2.

### 6.5.8 Device for monitoring the evacuation of combustion products

Under the test conditions of 7.5.8 it is checked that for Test No. 1:

— the control causes safety shutdown to occur within 30 s;

— the waiting time before restart is at least 3 min.

For Test No. 2 it is checked that when the flue is progressively blocked, the CO concentration in the products of combustion does not exceed 0,10 %.

After Test No. 3 it is checked that the control complies with the requirements of this clause.

#### 6.5.9 Condensate discharge blockage

Under the test conditions of 7.5.9, the formation of condensate shall not impair the correct operation of the boiler.

By choice of the manufacturer, the boiler shall meet one of the following requirements:

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

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

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

### 6.6 Combustion

#### 6.6.1 Carbon monoxide

Under the test conditions of 7.6.1 the CO concentration of the dry air-free combustion products shall not exceed:

— 0,10 % when the boiler is supplied with the reference gas or distributed gas under normal conditions (7.6.1.2 a);

— 0,20 % when the boiler is supplied with the incomplete combustion limit gas, or overload conditions (7.6.1.2 b) under special conditions (7.6.1.3) and flame lift limit gas (7.6.1.4).

In addition, when the boiler is supplied with the sooting limit gas, no soot deposit shall be observed although yellow tipping is acceptable.

#### 6.6.2 Other pollutants

The manufacturer shall select the $NO_x$ class of the boiler from Table 9. Under the test and calculation conditions of 7.6.2 the permissible $NO_x$ concentration assigned to this class in the dry, air free products of combustion shall not be exceeded.

**Table 9 — $NO_x$ classes**

| $NO_x$ Classes | Limit $NO_x$ concentration mg/kWh |
|---|---|
| 1 | 260 |
| 2 | 200 |
| 3 | 150 |
| 4 | 100 |
| 5 | 70 |

## 6.7 Useful efficiencies

### 6.7.1 Useful efficiency at the nominal heat input

Under the test conditions of 7.7.1 the useful efficiency at the nominal heat input shall be in accordance with Table 10.

**Table 10 — Useful efficiency at the nominal heat input**

| Boiler type | Boilers with nominal output ≤ 400 kW % | Boilers with nominal output > 400 kW % |
|---|---|---|
| Standard | $\geq 84 + 2 \log_{10} P_n$ [a] | ≥ 89,2 [b] |
| | | |
| Low-temperature | $\geq 87{,}5 + 1{,}5 \log_{10} P_n$ [a] | ≥ 91,4 [c] |
| [a] $P_n$ is the nominal output expressed in kilowatt (kW). | | |
| [b] $84 + 2 \log_{10} 400 = 84 + 2\,[2{,}60] = 89{,}2$ | | |
| [c] $87{,}5 + 1{,}5 \log_{10} 400 = 87{,}5 + 1{,}5\,[2{,}60] = 91{,}4$ | | |

### 6.7.2 Useful efficiency at part load

Under the test conditions of 7.7.2, the useful efficiency for a load corresponding to 30 % of the nominal heat input shall be in accordance with Table 11.

**Table 11 — Useful efficiency at part load**

| Boiler type | Boilers with nominal output ≤ 400 kW | Boilers with nominal output > 400 kW |
|---|---|---|
| | % | % |
| Standard | $\geq 80 + 3 \log_{10} P_n$ [a] | ≥ 87,8 [b] |
| Low-temperature | $\geq 87,5 + 1,5 \log_{10} P_n$ [a] | ≥ 91,4 [c] |
| [a] $P_n$ is the nominal output expressed in kilowatts (kW). | | |
| [b] $80 + 3 \log_{10} 400 = 80 + 3\ [2,60] = 87,8$ | | |
| [c] $87,5 + 1,5 \log_{10} 400 = 87,5 + 1,5\ [2,60] = 91,4$ | | |

## 6.8 Criteria for condensation in the flue

For standard boilers it is determined whether condensation occurs in the flue. Condensation may occur when one of the following criteria, depending on the manufacturer's choice, is met:

— either the flue losses are less than 8 % under the test conditions of 7.8.1; or

— the temperature of the combustion products is less than 80 °C under the test conditions of 7.8.2.

## 6.9 Resistance of materials to pressure

### 6.9.1 General

Boilers and/or their elements shall withstand a hydraulic test.

The tests are carried out under the test conditions of 7.9 in so far as these tests have not been carried out under 7.2.3.

Corrosion resistant coatings shall show no sign of damage after the pressure tests described in 7.9.

### 6.9.2 Boilers of sheet steel or non-ferrous metals

Under the test conditions of 7.9.2 there shall be neither leakage nor permanent visible distortion at the end of the test.

### 6.9.3 Boilers of cast iron and cast materials

#### 6.9.3.1 Boiler body

Under the test conditions of 7.9.3.1 there shall be neither leakage during the test nor permanent visible distortion at the end of the test.

#### 6.9.3.2 Resistance to bursting

Under the test conditions of 7.9.3.2 the elements shall remain sound.

#### 6.9.3.3 Tie bars

Under the test conditions of 7.9.3.3 the tie bars shall resist the applied stresses.

### 6.10 Hydraulic resistance

Under the test conditions of 7.10 the values of the hydraulic resistance or the curve of available pressures shall comply with the values given by the manufacturer in the technical instructions for the installer.

### 6.11 Combustion air and flue dampers

Under the test conditions of 7.11 the damper assembly shall continue to operate correctly and there shall be no distortion of any part of the assembly.

### 6.12 Condensation in a standard boiler

If condensation occurs in the flue of a standard boiler, according to one of the criteria of 6.8, additional tests are carried out to determine whether condensation also occurs in the boiler.

Under the test conditions of 7.12, it is checked whether formation of condensate occurs in the boiler.

If there is condensation in the boiler, the appropriate requirements for low temperature boilers in 5.3.1, 5.8.5, 5.16, 6.5.9, 6.9.1, 7.5.9 and 8.2.1 shall be met.

## 7 Test methods

### 7.1 General

#### 7.1.1 Characteristics of the reference and limit gases

##### 7.1.1.1 General

Boilers are intended to use gases of various qualities. One of the aims of these specifications is to check that the operation of the boilers is satisfactory for each of the gas families or gas groups and for the pressures for which they are designed, after making use of adjusters where appropriate. Where it is impractical to use test gases, refer to the Foreword and Annex L.

##### 7.1.1.2 Requirements for the preparation of test gases

The requirements for the preparation of test gases are given in EN 437.

##### 7.1.1.3 Characteristics and choice of test gases

The characteristics of the test gases are given in Table 12, Table 13 and Table 14. The choice of the reference gases and limit gases is given in Table 15, according to the boiler category. For gases distributed nationally or locally, the choice of reference gases and limit gases is given in A.4.

Tables 12 to 15 have been reproduced from EN 437:2003.

When tests have to be carried out with only one of the reference gases, the priority according to the boiler category shall be G 20, G 25, G 30 or G 31.

**Table 12 — Calorific values of the third family test gases**

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

**Table 13 — Second family reference gas characteristics at 0 °C and 1 013,25 mbar**

| Gas Group | Test gases | Designation | Composition by volume | $W_i$ | $H_i$ | $W_s$ | $H_s$ | $d$ |
|---|---|---|---|---|---|---|---|---|
| | | | % | $MJ/m^3$ | $MJ/m^3$ | $MJ/m^3$ | $MJ/m^3$ | |
| Group H | Reference gas | G 20 | $CH_4$ = 100 | 48,20 | 35,90 | 53,61 | 39,94 | 0,555 |
| Group L | Reference gas and light-back limit gas | G 25 | $CH_4$ = 86<br>$N_2$ = 14 | 39,45 | 30,87 | 43,88 | 34,34 | 0,613 |
| Group E | Reference gas | G 20 | $CH_4$ = 100 | 48,20 | 35,90 | 53,61 | 39,94 | 0,555 |

**Table 14 — Characteristics of the test gases [a] Dry gas at 15 °C and 1 013,25 mbar**

| Gas family and group | Test gases | Designation | Composition by volume % [d] | $W_i$ MJ/m$^3$ | $H_i$ MJ/m$^3$ | $W_s$ MJ/m$^3$ | $H_s$ MJ/m$^3$ | $d$ |
|---|---|---|---|---|---|---|---|---|
| **Gases of the first family** [b] | | | | | | | | |
| Group a | Reference gas<br>Incomplete combustion, flame lift and sooting limit gas | G 110 | $CH_4$ = 26<br>$H_2$ = 50<br>$N_2$ = 24 | 21,76 | 13,95 | 24,75 | 15,87 | 0,411 |
| | Light-back limit gas | G 112 | $CH_4$ = 17<br>$H_2$ = 59<br>$N_2$ = 24 | 19,48 | 11,81 | 22,36 | 13,56 | 0,367 |
| **Gases of the second family** [b] | | | | | | | | |
| Group H | Reference gas | G 20 | $CH_4$ = 100 | 45,67 | 34,02 | 50,72 | 37,78 | 0,555 |
| | Incomplete combustion and sooting limit gas | G 21 | $CH_4$ = 87<br>$C_3H_8$ = 13 | 49,60 | 41,01 | 54,76 | 45,28 | 0,684 |
| | Light-back limit gas | G 222 | $CH_4$ = 77<br>$H_2$ = 23 | 42,87 | 28,53 | 47,87 | 31,86 | 0,443 |
| | Flame lift limit gas | G 23 | $CH_4$ = 92,5<br>$N_2$ = 7,5<br>continued | 41,11 | 31,46 | 45,66 | 34,95 | 0,586 |
| Group L | Reference gas and light-back limit gas | G 25 | $CH_4$ = 86<br>$N_2$ = 14 | 37,38 | 29,25 | 41,52 | 32,49 | 0,612 |
| | Incomplete combustion and sooting limit gas | G 26 | $CH_4$ = 80<br>$C_3H_8$= 7<br>$N_2$ = 13 | 40,52 | 33,36 | 44,83 | 36,91 | 0,678 |
| | Flame lift limit gas | G 27 | $CH_4$ = 82<br>$N_2$ = 18 | 35,17 | 27,89 | 39,06 | 30,98 | 0,629 |
| Group E | Reference gas | G 20 | $CH_4$ = 100 | 45,67 | 34,02 | 50,72 | 37,78 | 0,555 |
| | Incomplete combustion and sooting limit gas | G 21 | $CH_4$ = 87<br>$C_3H_8$= 13 | 49,60 | 41,01 | 54,76 | 45,28 | 0,684 |
| | Light-back limit gas | G 222 | $CH_4$ = 77<br>$H_2$ = 23 | 42,87 | 28,53 | 47,87 | 31,86 | 0,443 |

**Table 14 — Characteristics of the test gases [a] Dry gas at 15 °C and 1 013,25 mbar**

| Gas family and group | Test gases | Designation | Composition by volume % [d] | $W_i$ MJ/m$^3$ | $H_i$ MJ/m$^3$ | $W_s$ MJ/m$^3$ | $H_s$ MJ/m$^3$ | $d$ |
|---|---|---|---|---|---|---|---|---|
| | Flame lift limit gas | G 231 | $CH_4$ = 85<br>$N_2$ = 15 | 36,82 | 28,91 | 40,90 | 32,11 | 0,617 |
| **Gases of the third family** [c] | | | | | | | | |
| Third family and Groups B/P and B | Reference gas, incomplete combustion and sooting limit gas | G 30 | n-$C_4H_{10}$ = 50<br>i-$C_4H_{10}$ = 50 | 80,58 | 116,09 | 87,33 | 125,81 | 2,075 |
| | Flame lift limit gas | G 31 | $C_3H_8$ = 100 | 70,69 | 88,00 | 76,84 | 95,65 | 1,550 |
| | Light-back limit gas | G 32 | $C_3H_6$ = 100 | 68,14 | 82,78 | 72,86 | 88,52 | 1,476 |
| Group P | Reference gas, incomplete combustion, flame lift and sooting limit gas | G 31 | $C_3H_8$ = 100 | 70,69 | 88,00 | 76,84 | 95,65 | 1,550 |
| | Light-back and sooting limit gas | G 32 | $C_3H_6$ = 100 | 68,14 | 82,78 | 72,86 | 88,52 | 1,476 |

[a] For gases used nationally or locally, see A.4.

[b] For other groups, see A.4.

[c] See also Table 12.

[d] See also Annex A of EN 437:2003, Conditions for preparation of the test gases.

**Table 15 — Test gases corresponding to the boiler categories [a] [b]**

| Category | Reference gas | Incomplete combustion limit gas | Light-back limit gas | Flame lift limit gas | Sooting limit gas |
|---|---|---|---|---|---|
| $I_{2H}$ | G 20 | G 21 | G 222 | G 23 | G 21 |
| $I_{2L}$ | G 25 | G 26 | G 25 | G 27 | G 26 |
| $I_{2E}$, $I_{2E+}$ | G 20 | G 21 | G 222 | G 231 | G 21 |
| $I_{2N}$ | G 20 [c d]<br>G 25 [c d] | G 21 [d]<br>G 26 [d] | G 222 [d]<br>G 25 [d] | G 231 [d]<br>G 27 [d] | G 21 [d]<br>G 26 [d] |
| $I_{3B/P}$, $I_{3+}$ | G 30 | G 30 | G 32 | G 31 | G 30 |
| $I_{3P}$ | G 31 | G 31 | G 32 | G 31 | G 31, G 32 |
| $I_{3B}$ | G 30 | G 30 | G 32 | G 31 | G 30 |
| $II_{1a2H}$ | G 110, G 20 | G 21 | G 112 | G 23 | G 21 |
| $II_{2H3B/P}$, $II_{2H3+}$ | G 20, G 30 | G 21 | G 222, G 32 | G 23, G 31 | G 30 |
| $II_{2H3P}$ | G 20, G 31 | G 21 | G 222, G 32 | G 23, G 31 | G 31, G 32 |
| $II_{2L3B/P}$ | G 25, G 30 | G 26 | G 32 | G 27, G 31 | G 30 |
| $II_{2L3P}$ | G 25, G 31 | G 26 | G 32 | G 27, G 31 | G 31, G 32 |
| $II_{2E3B/P}$,<br>$II_{2E+3B/P}$, $II_{2E+3+}$ | G 20, G 30 | G 21 | G 222, G 32 | G 231, G 31 | G 30 |
| $II_{2E+3P}$ | G 20, G 31 | G 21 | G 222, G 32 | G 231, G 31 | G 31, G 32 |

[a] For test gases corresponding to gases distributed nationally or locally, refer to Annex A.

[b] Tests with the limit gases are carried out with the injector and adjustment corresponding to the reference gas of the group to which limit gas used for test belongs.

[c] Heat input should be equivalent and within tolerances specified in this European Standard.

[d] Since the adjustment of the burner changes automatically when the appliance is supplied with different test gases it may be necessary to examine all phenomena (e.g. incomplete combustion, sooting, light back, flame lift) with all test gases.

#### 7.1.1.4 Test pressures

The test pressures, i.e. the pressure required at the gas inlet connection of the boiler, are given in Table 16 and Table 17 reproduced from EN 437:2003.

**Table 16 — Test pressures where no pressure couple exists [a]**

| Appliance categories having as index | Test gas | $p_n$ mbar | $p_{min}$ mbar | $p_{max}$ mbar |
|---|---|---|---|---|
| 1st family 1a | G 110, G 112 | 8 | 6 | 15 |
| 2nd family 2H | G 20, G 21, G 222, G 23 | 20 | 17 | 25 |
| 2nd family 2L | G 25, G 26, G 27 | 25 | 20 | 30 |
| 2nd family 2E | G 20, G 21, G 222, G 231 | 20 | 17 | 25 |
| 2nd family 2N [d] | G 20, G 21, G 222, G 231,<br>G 25, G 26, G 27[a] | 20 | 17 | 30 |
| | G 25, G 26, G 27 | 25 | 20 | 30 |
| 3rd family 3B/P | G 30, G 31, G 32 | 29 [b] | 25 | 35 |
| | G 30, G 31, G 32 | 50 | 42,5 | 57,5 |
| 3rd family 3P | G 31, G 32 | 37 | 25 | 45 |
| | G 31, G 32 | 50 | 42,5 | 57,5 |
| 3rd family 3B [c] | G 30, G 31, G 32 | 29 | 20 | 35 |

[a] For test pressures corresponding to gases distributed nationally or locally, see A.3.

[b] Appliances of this category may be used, without adjustment, at the specified supply pressures of 28 mbar to 30 mbar.

[c] The tests with G 31 and G 32 are carried out at the normal pressure only ($p_n$ = 29 mbar), these test gases being more severe than any gas distributed. This condition covers the normal variations in the gas supply.

[d] Category $I_{2N}$ is defined in 6.1.2.2 of EN 437:2003 as appliances using only second family gases at the prescribed supply pressure and that automatically adapt to all gases of the second family.

**Table 17 — Test pressures where a pressure couple exists**

| Appliance categories having as index | Test gas | $p_n$ mbar | $p_{min}$ mbar | $p_{max}$ mbar |
|---|---|---|---|---|
| 2nd family 2E+ | G 20, G 21, G 222 | 20 | 17 | 25 |
| | G 231 | (25) [a] | 17 [b] | 30 |
| 3rd family 3+ (28-30/37 couple) | G 30 | 29 [c] | 20 | 35 |
| | G 31, G 32 | 37 | 25 | 45 |
| 3rd family 3+ (50/67 couple) | G 30 | 50 | 42,5 | 57,5 |
| | G 31, G 32 | 67 | 50 | 80 |
| 3rd family 3+ (112/148 couple) | G 30 | 112 | 60 | 140 |
| | G 31, G 32 | 148 | 100 | 180 |

[a] This pressure corresponds to the use of low Wobbe index gas but in principle no test is carried out at this pressure.

[b] See Annex B.

[c] Appliances of this category may be used without adjustment at the specified supply pressures of 28 mbar to 30 mbar.

### 7.1.2 General test conditions

#### 7.1.2.1 General

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

#### 7.1.2.2 Test room

The boilers are installed in a well-ventilated, draught-free room (air speed less than 0,5 m/s), which has an ambient temperature of about 20 °C; the boiler is protected from direct solar radiation.

#### 7.1.2.3 Installation and sampling

The manufacturer shall supply the appliance, with all the accessories necessary for its installation accompanied by the installation instructions.

For all the tests, except where otherwise stated in the particular clauses, the boiler is installed and used under the conditions specified in the manufacturer's instructions.

Except where otherwise stated, the boiler is subjected to the draught created by a test flue of the minimum height stated in the manufacturer's instructions, or of 1 m height where no minimum is stated in the instructions. The internal diameter of the test flue shall be equal to the smallest diameter stated by the manufacturer and mentioned in the instructions. The thickness of the flue is less than 1 mm.

If the diameter of the boiler flue outlet does not correspond to the external diameter in local use, a linking piece of thickness 1 mm is used to adapt the flue outlet diameter to the diameter of the test flue.

The height of the flue is measured:

— for a boiler having a flue outlet with a horizontal axis, from this axis;

— for a boiler having a flue outlet with a vertical axis, from the plane of the flue outlet.

The combustion products are sampled at a point in the flue 0,2 m from the top, using the probe shown in Figure 3 or Figure 4.

#### 7.1.2.4 Gas circuit

The tests are carried out with reference gases and limit gases with the boiler fitted with the appropriate parts (ignition burners, pressure regulators, adjusters, injectors etc.) for the gas range, gas group or gas family in accordance with the information given by the manufacturer.

#### 7.1.2.5 Water circuit

The boiler is connected to the insulated test rig shown schematically in Figure 1 or Figure 2, 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 a water thermostat which is adjustable up to 105 °C or with a non-adjustable water thermostat which has a set point in the range 70 °C to 105 °C, the tests are carried out with a flow temperature of (80 ± 2) °C.

However, where the maximum flow temperature, by design, cannot exceed a lower value, the tests are carried out at the maximum flow temperature stated by the manufacturer in his technical instructions.

Valves I and II in Figure 1 or Figure 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.

#### 7.1.2.6 Conduct of the test to obtain the heat input

When in specific clauses tests at the nominal heat input are required, these tests are carried out at:

— nominal heat input, or

— maximum heat input for range rated boilers.

The tests are carried out under the following conditions.

The required gas rate that has to be measured at the meter is determined for the appropriate heat input (nominal, maximum or minimum) as follows:

For the mass rate:

$$M = \frac{Q_{\mathrm{i}}}{H_{\mathrm{i}}} \bullet 3{,}6$$

or, for the volumetric rate:

$$V = \frac{Q_{\mathrm{i}}}{H_{\mathrm{i}}} \bullet \frac{1\ 013{,}25}{p_{\mathrm{a}} + p_{\mathrm{g}} - p_{\mathrm{s}}} \bullet \frac{273{,}15 + t_{\mathrm{g}}}{288{,}15} \bullet 3{,}6$$

where

$V$ is the measured volumetric rate, in $m^3/h$;

$M$ is the measured mass rate, in kg/h;

$Q_i$ is the appropriate heat input, in kW:

nominal heat input;

maximum heat input;

minimum heat input;

$H_i$ is the net calorific value of the dry reference gas at 15 °C, 1 013,25 mbar, in MJ/kg or $MJ/m^3$;

$t_g$ is the gas temperature at the meter, in °C;

$p_g$ is the gas pressure at the meter, in mbar;

$p_a$ is the atmospheric pressure at the time of the test, in mbar;

$p_s$ is the saturated vapour pressure of water at $t_g$ in mbar.

Depending on the supply conditions, the temperature of the test room, the atmospheric pressure and the measuring conditions (dry meter or wet meter), the test laboratory will arrange that the nominal heat input can be obtained to within ± 2 %.

When this gas rate cannot be obtained a correction to the boiler is carried out, except for the verification done in 7.3.1:

— by adjustment of the determined gas rate by altering the gas rate adjuster or the boiler regulator for adjustable boilers, or

— by changing the supply pressure for boilers without an adjuster. Any non-adjustable pressure regulator is put out of action. For tests at limit pressures, the pressures of Table 16 and Table 17 shall be corrected such that:

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

#### 7.1.2.7 Thermal equilibrium

Except where otherwise stated, the tests are carried out with the boiler at thermal equilibrium, i.e. with the flow temperature of the boiler constant to ± 2 °C.

However, this temperature is constant to ± 0,5 °C for the efficiency tests.

#### 7.1.2.8 Influence of thermostats

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

#### 7.1.2.9 Electrical supply

The boiler is connected to an electrical supply at the nominal voltage, except where otherwise stated in the particular clauses.

#### 7.1.2.10 Uncertainty of measurements

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

- Atmospheric pressure ± 5 mbar
- Combustion chamber and test flue pressure ± 5 % full scale or 0,05 mbar
- Gas pressure ± 2 % full scale
- Water-side pressure loss ± 5 %
- Water rate ± 1 %
- Gas rate ± 1 %
- Air rate ± 2 %
- Time ± 0,2 s up to 1 h, ± 0,1 % beyond 1 h
- Auxiliary electrical energy ± 2 %
- Temperature:
  - Ambient ± 1 °C
  - Heat carrier ± 2 °C
  - Combustion products ± 5 °C
  - Gas ± 0,5 °C
  - Surface ± 5 °C
- CO, $CO_2$ and $O_2$ ± 6 % full scale
- Gas calorific value ± 1 %
- Gas density ± 0,5 %
- Mass ± 0,05 %
- Torque ± 10 %
- Force ± 10 %

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

For the determination of the leakage rate during the soundness tests a volumetric method is used which gives a direct reading of the leakage rate and which is of such accuracy that the error in its determination does not exceed 0,01 $dm^3/h$. The apparatus shown schematically in Figure 6 or another device giving equivalent results is used.

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

## 7.2 Soundness

### 7.2.1 Soundness of the gas circuit

The tests are carried out at ambient temperature, using air.

The two following tests are carried out when the boiler is delivered and before any other test, and again on completion of all the tests in the standard, after removing and replacing five times the assemblies in the gas circuit that have gas-tight joints whose removal is provided for in the manufacturer's instructions regarding routine servicing.

**Test No. 1**
The soundness of the first closure member (see 5.13.3.2) is checked, all other closure members being open.

The pressure upstream of the boiler is 150 mbar.

It is checked that the requirement of 6.2.1 is satisfied.

**Test No. 2**
The leakage rate is checked with all the valves open, as if the boiler were in operation, and the gas way blocked off by the use of suitable parts, to be supplied by the manufacturer, in place of the injectors.

The upstream pressure is 50 mbar for boilers which do not use third family gas and 150 mbar for boilers which do use third family gas.

It is checked that the requirement of 6.2.1 is satisfied.

### 7.2.2 Soundness of the combustion circuit and correct evacuation of the combustion products

The boiler is installed as described in 7.1.2 and connected to a flue as described in 7.1.2.3 but with the sampling probe removed. The test is carried out with one of the reference gases for the category concerned at the normal pressure and nominal heat input.

Possible leaks are looked for with a dew point plate, whose temperature is maintained at a value slightly above the dew point of the ambient air. The plate is brought near to all the places where a leak is suspected.

In doubtful cases, however, leaks are looked for with a sampling probe connected to a $CO_2$ analyser with a rapid response and with a sensitivity of the order of 0,1 %.

In this case, precautions shall be taken to ensure that sampling does not interfere with the normal evacuation of the combustion products.

It is checked that the requirement of 6.2.2 is satisfied.

### 7.2.3 Soundness of the water circuit

The water circuit of the boiler is subjected for 10 min to a pressure of 2 times the maximum operating pressure given on the data plate. It is checked that the requirement of 6.2.3 is satisfied.

## 7.3 Nominal, maximum and minimum heat inputs and nominal output

### 7.3.1 The nominal heat input or the maximum and minimum heat inputs

The boiler is supplied with each of the reference gases for the boiler category at the normal pressure. For boilers with a fixed output the adjustment is not changed for this test. 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 equations:

— If the volumetric rate $V$ is measured:

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

whence

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

— If the mass rate $M$ is measured:

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

whence

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

where

$Q_c$ is the corrected heat input (1 013,25 mbar, 15 °C, dry gas) on the net calorific value, in kilowatts (kW);

$V$ is the measured volumetric rate expressed under the humidity, temperature and pressure conditions at the meter, in cubic metres per hour ($m^3/h$);

$M$ is the measured mass rate, in kilograms per hour (kg/h);

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

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

$d$ is the density of the test gas[5)];

$d_r$ is the density of the reference gas;

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

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

It is checked that the requirements of 6.3.1 are met.

### 7.3.2 Adjustment of the heat input by the downstream pressure

The boiler is supplied with each of the reference gases for the boiler category at the normal pressure.

The gas rate adjuster is set to the position giving the burner pressure stated by the manufacturer, measured at the downstream pressure test point.

It is checked that the heat input, determined under the conditions of 7.3.1, meets the requirement of 6.3.2.

### 7.3.3 Minimum ignition rate

For boilers which may be ignited at a heat input less than the nominal heat input, the minimum heat input for ignition is determined in accordance with 7.3.1. It is checked that the requirement of 6.3.3 is satisfied.

### 7.3.4 Nominal output

It is checked that the product of the efficiency determined under the test conditions of 7.7.1 and the nominal heat input is not less than the nominal output.

### 7.3.5 Gas regulator

If the boiler is fitted with a regulator, an adjustment is made, if necessary, to give the nominal heat input with the reference gas at the normal pressure given in 7.1.1.4 and corresponding to this gas. Keeping the initial adjustment, the supply pressures are varied between:

— $p_n$ and $p_{max}$ for first family gases;

— $p_{min}$ and $p_{max}$ for second and third family gases without a pressure couple;

— upper $p_n$ and upper $p_{max}$ for second and third family gases with a pressure couple.

This test is carried out for all the reference gases for which the regulator is not put out of action.

It is checked that the requirements of 6.3.5 are satisfied.

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5) 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 equation:

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

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

## 7.4 Safety of operation

### 7.4.1 Limiting temperatures

#### 7.4.1.1 General

The boiler is installed as stated in 7.1.2, supplied with one of the reference gases, or a gas actually distributed, at the nominal heat input and an adjustable thermostat is set to the position giving the highest temperature.

The limiting temperatures are measured when thermal equilibrium is reached.

#### 7.4.1.2 Limiting temperatures of adjusting, control and safety devices

The temperatures are measured using temperature sensors.

It is checked that the requirements of 6.4.1.2 are satisfied.

#### 7.4.1.3 Limiting temperatures of the side walls, the front and the top

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

It is checked that the requirements of 6.4.1.3 are satisfied.

#### 7.4.1.4 Limiting temperature of the floor

In determining the floor temperatures, the boiler should be installed on a test floor e.g. conforming to Figure 8. The surface temperatures of the test floor shall be measured at the maximum nominal output 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 9, or commercially available surface temperature sensors.

It is checked that the requirements of 6.4.1.4 are satisfied.

### 7.4.2 Ignition — Cross-lighting — Flame stability

#### 7.4.2.1 General

In the place of the following tests the manufacturer may provide evidence that the requirements of 6.4.2 are satisfied.

All tests are carried out twice, with the boiler at ambient temperature and at thermal equilibrium.

#### 7.4.2.2 Limit conditions

The burner and ignition burner, if any, fitted with the appropriate injectors are first adjusted as follows: they are supplied successively with each reference gas for the boiler category, so as to obtain the nominal heat input.

**Test No. 1**
The test is carried out without altering the initial adjustment of the burner and ignition burner.

The pressure at the boiler inlet is reduced to 70 % of the normal pressure for first and second family gases and to the minimum pressure for third family gases (see 7.1.2).

Under these supply conditions, it is checked that the requirements of 6.4.2.2 are satisfied.

This test is repeated at the minimum heat input permitted by the controls, if ignition is possible under these conditions.

**Test No. 2**
Without altering the initial adjustment of the burner and ignition burner, the reference gases are replaced by the corresponding light-back limit gas and the pressure at the boiler inlet is reduced to the minimum pressure.

It is then checked that ignition of the burner, by the ignition burner or ignition device, takes place correctly and that the requirements of 6.4.2.2 are satisfied.

This test is repeated at the minimum heat input given by the controls, if ignition is possible under these conditions.

**Test No. 3**
Without altering the initial adjustment of the burner and ignition burner, the reference gases are replaced by the corresponding flame lift limit gas and the pressure at the boiler inlet is reduced to the minimum pressure.

It is then checked that ignition of the burner, by the ignition burner or ignition device, and the cross-lighting of the elements of the burner take place correctly and that the requirements of 6.4.2.2 are satisfied.

This test is repeated at the minimum heat input given by the controls, if ignition is possible under these conditions.

**Test No. 4**
Without altering the initial adjustment of the burner and ignition burner, the boiler is supplied with the flame lift limit gas at the maximum pressure and the absence of lift is checked.

It is checked that the requirements of 6.4.2.2 are satisfied.

**Test No. 5**
For boilers incorporating an indirect means of indicating the presence of flame, without altering the initial adjustment of the burner and ignition burner, the boiler is supplied with the flame lift limit gas at the normal pressure.

It is checked that the requirements of 6.4.2.2 are satisfied.

#### 7.4.2.3 Special conditions

##### 7.4.2.3.1 Resistance to draught

The boiler is supplied with the reference gas or a distributed gas at nominal heat input and is subjected at burner level to a wind stream of speed 2 m/s. The wind stream covers at least the width of the burners and is made up of essentially parallel components (speed uniform to within ± 20 %).

The axis of the wind stream is in a horizontal plane and is moved through one or more (at the discretion of the laboratory) angles of incidence within a semi-circle in front of the boiler, the centre of the semi-circle being at intersection of the plane of symmetry of the boiler and the plane of the test.

The test is carried out with the ignition burner, if any, alight. Then with the main burner alight at the maximum and minimum heat inputs permitted by the controls. If there is a lighting door for the ignition burner, the test is carried out with the door closed.

It is checked that the requirement of 6.4.2.3.1 is satisfied.

#### 7.4.2.3.2 Flue conditions (Type $B_1$ boilers)

The boiler is supplied with reference gas, or a distributed gas at the nominal heat input.

A first test is carried out applying a continuous downdraught of 3 m/s within the test flue (see Figure 5).

A second test is carried out with the flue blocked.

It is checked that the requirement of 6.4.2.3.2 is satisfied.

#### 7.4.2.3.3 Reduction of the gas rate of the ignition burner

The burner and ignition burner fitted with the appropriate injectors are supplied with the reference gases for the category at nominal heat input.

The boiler inlet pressure is reduced to the minimum pressure.

By means of an appropriate adjuster in the gas supply line to the ignition burner, the rate is reduced to give the minimum energy necessary to keep the gas way to the burner open. It is then checked that ignition of the burner by the ignition burner takes place in the conditions specified by 6.4.2.3.3.

For ignition burners having several separate ports, the ports of the ignition burners are sealed except for that of the flame heating the sensor element.

This test is repeated at the minimum heat input given by the controls, if ignition is possible under these conditions.

#### 7.4.2.3.4 Defective closure of the gas valve immediately upstream of the main burner

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 open artificially. The boiler is supplied with a reference gas or a distributed gas at nominal heat input.

Under these conditions, it is checked that the requirement of 6.4.2.3.4 is satisfied.

#### 7.4.2.3.5 Reduction of the gas pressure

Proceeding as in Test No. 1 of 7.4.2.2, ignition is attempted with progressively reduced inlet pressures until the gas supply is interrupted by operation of the flame supervision device or low pressure gas switch (where fitted). Compliance with the requirements of 6.4.2.3.5 is checked.

#### 7.4.2.3.6 Stability of the ignition burner flame

The boiler is supplied with the incomplete combustion limit gas at the maximum test pressure. With the appliance cold, the ignition burner is lit and left to operate on its own for a period of 1 h.

It is checked that the requirement of 6.4.2.3.6 is satisfied.

### 7.4.3 Pre-purge

#### 7.4.3.1 General

Under the test conditions defined below it is checked that, according to the option chosen by the manufacturer the requirements of 6.4.3 are satisfied.

#### 7.4.3.2 Pre-purge volume

The rate is measured at the outlet of the combustion products evacuation duct, at ambient temperature, with the boiler shut off and cold, and with the fan supplied with electricity at nominal voltage, under actual pre-purge conditions.

The rate is corrected to reference conditions.

The volume of the combustion circuit is stated by the manufacturer.

#### 7.4.3.3 Pre-purge time

It is checked that ignition is preceded by a pre-purge of duration at least equal to that fixed in 6.4.3.

#### 7.4.3.4 Ignition following safety shut down or lock out

The boiler is installed as indicated in 7.1.2. The boiler is supplied successively with each of the reference gases of the boiler category, at normal pressure.

A series of tests is carried out with gas admitted to the boiler at the maximum nominal heat input of the boiler in the hot condition. The ignition sequence is deactivated. The first test is carried out by supplying gas for a period of 1 s after which the ignition sequence, including any delay times within the sequence, is activated. Subsequent tests are carried out by increasing the time up to the end of the time given by the sum of the $T_{SE}$ and the valve(s) closing time declared by the manufacturer. At the end of each period of time, the ignition sequence, including any delay times within the sequence, is activated.

It is checked that the requirement of 6.4.3 is met.

### 7.5 Adjusting, control and safety devices

#### 7.5.1 General

Except where otherwise stated, the tests are carried out at ambient temperature and at the maximum temperature.

#### 7.5.2 Ignition devices

#### 7.5.2.1 Manual ignition devices for ignition burners

The tests are carried out with each of the reference gases for the boiler category at nominal heat input.

The ignition burners, fitted with the appropriate injectors and first adjusted to the nominal heat input, are operated 40 times, after a first positive ignition attempt, with intervals of at least 1,5 s.

It is checked that the requirements of 6.5.2.1 are satisfied.

#### 7.5.2.2 Automatic ignition system for the ignition burner and the main burner

##### 7.5.2.2.1 Ignition

The burner and the ignition burner, fitted with the appropriate injectors, are adjusted, if necessary, as stated by the manufacturer to the nominal heat input. The tests are carried out with each of the reference gases for the boiler category at normal pressure and a voltage of 0,85 times the nominal voltage.

After a first successful ignition attempt, 20 ignition attempts, with a waiting time of 30 s between consecutive attempts, are made with the boiler at ambient temperature.

After a first successful ignition attempt, 20 ignition attempts, with a waiting time of 30 s between consecutive attempts, are made immediately after the burner has been deliberately extinguished when the boiler is at thermal equilibrium.

It is checked that the requirements of 6.5.2.2.1 are satisfied.

#### 7.5.2.2.2 Endurance

The tests are carried out at ambient temperature. The devices are supplied at a voltage of 1,10 times the nominal voltage. The length of ignition sequence and the waiting time between consecutive attempts is given by the automatic burner control system.

After the endurance tests it is checked that the requirements of 6.5.2.2.2 are satisfied.

### 7.5.2.3 Ignition burner

The heat input of the ignition burner is determined by supplying it with the reference gas or gases at the maximum pressure given in 7.1.1.4 for first family gases and at normal pressure for second and third family gases. However, if the ignition burner has a gas rate adjuster, this is adjusted as stated by the manufacturer in the instructions.

It is checked that the requirements of 6.5.2.3 are satisfied.

## 7.5.3 Flame supervision device

### 7.5.3.1 General

The tests of 7.5.3 are carried out with the reference gas or an actually distributed gas appropriate to the boiler category, the boiler being connected to an electrical supply at the nominal voltage.

### 7.5.3.2 Thermoelectric device

#### 7.5.3.2.1 Ignition Opening Time ($T_{IA}$)

With the boiler cold, the gas supply is turned on and the ignition burner is lit. On expiry of the time limit for the $T_{IA}$ fixed in 6.5.3.2.1, manual assistance is withdrawn and it is checked that the ignition burner remains alight.

#### 7.5.3.2.2 Extinction Delay Time ($T_{IE}$)

The boiler is supplied successively with each of the gases appropriate to the boiler category. The boiler is first left to operate for at least 10 min at its nominal heat input.

The extinction delay time is measured between the moment when the ignition burner and the main burner are intentionally extinguished by shutting off the gas and the moment when, after admission of the gas is restored, it ceases by the action of the safety device.

The gas meter or any other appropriate device may be used to detect the closure of the flame supervision device.

It is checked that the requirements of 6.5.3.2.2 are satisfied.

#### 7.5.3.3 Automatic burner control systems

##### 7.5.3.3.1 Ignition Safety Time ($T_{SA}$)

The ignition safety time $(T_{SA,max})$ is checked under extreme conditions of electrical supply and temperature (cold and at thermal equilibrium).

With the relevant burner extinguished, the flame detector is disconnected. The order is given to admit gas to the ignition burner or to the main burner, as appropriate, and the time is measured that elapses between this order and the moment when the flame detector device shuts off the gas supply.

It is checked that the requirements of 6.5.3.3.1 are satisfied.

##### 7.5.3.3.2 Extinction Safety Time ($T_{SE}$)

The boiler is supplied successively with each of the gases appropriate to the boiler category. The boiler is first left to operate for at least 10 min at its nominal heat input.

The extinction safety time is measured between the moment when the ignition burner and main burner are intentionally extinguished by shutting off the gas and the moment when, after admission of the gas is restored, the safety device causes the gas supply to be shut off.

With the burner alight, flame failure is simulated by disconnection of the flame detector, and the time is measured that elapses between this moment and that when the flame supervision device effectively shuts off the gas supply.

The gas meter or any other appropriate device may be used to detect the closure of the flame supervision device.

It is checked that the requirement of 6.5.3.3.2 is satisfied.

#### 7.5.3.4 Ignition sequences

##### 7.5.3.4.1 Automatic ignition of an ignition burner or the main burner at ignition rate

With the gas supply to the boiler shut off an ignition attempt is made. Following failure to ignite, it is confirmed that lockout occurs.

With the gas supply to the boiler connected, the ignition burner or the ignition flame is ignited. The main burner is prevented from igniting at other than ignition rate. Following shut-off of the gas supply it is confirmed that either safety shutdown or spark restoration or recycling occurs.

If an attempt at spark restoration or recycling is made, it is confirmed that, following failure to detect a flame, lockout occurs.

##### 7.5.3.4.2 Direct ignition of the main burner

With the gas supply to the boiler shut off an ignition attempt is made. The time for the ignition source to be de-energized is determined. Following failure to ignite, it is confirmed that lockout occurs.

##### 7.5.3.4.3 Delayed ignition test

The boiler is installed as indicated in 7.1.2. The boiler is supplied successively with each of the gases appropriate to the boiler category, at normal pressure.

A series of tests is carried out with gas admitted to the boiler at the ignition rate and in the cold condition. The ignition circuit of the boiler is deactivated. The first test is carried out by supplying gas for a period of 1 s after which the ignition circuit is activated.

Subsequent tests are carried out by increasing the time up to the end of the $T_{SA,max}$. At the end of each period of time, the ignition circuit is activated.

It is checked that the requirement of 6.5.3.4.3 is satisfied.

#### 7.5.3.4.4 Modular boilers

For assemblies where the products of combustion from the modules vent into a common chamber before passing into the assembly flue, following a signal to ignite the assembly, the period between the ignition of two modules is determined.

It is checked that the requirement of 6.5.3.4.4 is satisfied.

### 7.5.4 Ignition burner and ignition rates

#### 7.5.4.1 Permanent ignition burner and alternating ignition burner

The heat input of the ignition burner is determined by supplying it with the reference gas or gases at the maximum pressure given in 7.1.1.4 for first family gases and at the normal pressure for second and third family gases. However, if the ignition burner has a gas rate adjuster this is adjusted as stated by the manufacturer in the instructions.

#### 7.5.4.2 Main burner ignition rate

The heat input at the ignition rate is determined by supplying the burner with the reference gas or gases at the maximum pressure given in 7.1.1.4 for first family gases and at the normal pressure for second and third family gases.

### 7.5.5 Air proving

#### 7.5.5.1 General

The boiler is installed as stated in 7.1.2. The boiler is supplied with one of the reference gases for the category to which it belongs.

The CO concentration is determined as stated in 7.6.1.

#### 7.5.5.2 Supervision of the combustion air or the combustion products pressure

The boiler is adjusted to the nominal heat input. The CO and $CO_2$ concentrations are measured continuously.

Depending on the manufacturer's choice, one of the following tests is carried out.

— The voltage at the fan terminals is progressively reduced. It is checked that the gas supply is shut off before the CO concentration of the combustion products exceeds 0,20 %.

— Alternatively, with the boiler cold, the fan voltage is progressively increased from zero. The voltage at which the burner ignites is determined. At this voltage it is checked that, at thermal equilibrium, the CO concentration of the products of combustion does not exceed 0,10 %.

#### 7.5.5.3 Supervision of the combustion air or the combustion products rate

The test is carried out when the boiler is in thermal equilibrium, at the nominal heat input, or for modulating boilers, at the maximum and the minimum heat input and the heat input corresponding to the arithmetic mean of these two inputs. When several rates are provided, supplementary tests are needed at each of these rates.

The CO and $CO_2$ concentrations are measured continuously.

Depending on the manufacturer's choice, one of the following tests is carried out.

— The flue is progressively blocked; for type $B_1$ boilers, the blockage takes place upstream of the draught diverter. It is checked that the gas supply is shut off before the CO concentration exceeds 0,20 %.

— Alternatively, with the boiler cold, the flue is gradually re-opened. The blockage at which the burner ignites is determined; for type $B_1$ boilers, the blockage is upstream of the draught diverter. At this blockage, it is checked that, at thermal equilibrium, the CO concentration of the products of combustion does not exceed 0,10 %.

— The voltage at the fan terminals is progressively reduced. It is checked that the gas supply is shut off before the CO concentration of the combustion products exceeds 0,20 %.

— Alternatively, with the boiler cold, the fan voltage is progressively increased from zero. The voltage at which the burner ignites is determined. At this voltage it is checked that, at thermal equilibrium, the CO concentration of the products of combustion does not exceed 0,10 %.

#### 7.5.5.4 Gas/air ratio controls

##### 7.5.5.4.1 Leakage of non-metallic control tubes

The boiler is installed as stated in 7.1.2.

It is supplied with reference gas at its nominal heat input.

The requirements of 6.5.5.4.1 are checked under the various situations that could occur, in particular:

— simulated leak from the air pressure tube;

— simulated leak from the combustion chamber pressure tube;

— simulated leak from the gas pressure tube.

When control tubes are made of metal with suitable mechanical connections or of other materials with equivalent properties, they are considered immune to breakage, accidental disconnection and leakage after initial soundness checks.

##### 7.5.5.4.2 Safety of operation

The boiler is operated at the nominal heat input. Depending on the manufacturer's choice one of the following tests is conducted:

— The combustion products evacuation duct is progressively blocked; for type $B_1$ boilers, the blockage takes place upstream of the draught diverter. It is checked that the requirements of 6.5.5.4.2 are met.

— With the boiler cold, the combustion products evacuation duct is re-opened gradually. The blockage at which the burner ignites is determined; for type $B_1$ boilers, the blockage is upstream

of the draught diverter. At this blockage, it is checked that, at thermal equilibrium, the CO concentration of the products of combustion does not exceed 0,10 %.

— The voltage at the fan terminals is progressively reduced. It is checked that the gas supply is shut off before the CO concentration of the combustion products exceeds 0,20 %.

— With the boiler cold, the fan voltage is progressively increased from zero. The voltage at which the burner ignites is determined. At this voltage it is checked that, at thermal equilibrium, the CO concentration of the products of combustion does not exceed 0,10 %.

#### 7.5.5.4.3 Adjustment of the air/gas or gas/air ratio

For adjustable automatic air/gas or gas/air ratio controls, supplementary tests are carried out at the maximum and minimum ratios.

It is checked that the requirements of 6.5.5.4.3 are met.

### 7.5.6 Gas pressure switches

#### 7.5.6.1 General

Tests are carried out with gas pressure switches which comply with EN 1854.

#### 7.5.6.2 Low pressure cut off device

The appliance is installed in accordance with 7.1.2 and supplied with an appropriate reference gas or an actually distributed gas at normal pressure. The gas supply pressure to the inlet of the appliance is gradually reduced and the requirements of 6.5.6.2 are verified.

#### 7.5.6.3 High pressure cut off device

The appliance is installed in accordance with 7.1.2 and supplied with an appropriate reference gas or an actually distributed gas at normal pressure. The gas supply pressure to the inlet of the appliance is gradually increased and the requirement of 6.5.6.3 is verified.

### 7.5.7 Control thermostat and safety temperature limiter

#### 7.5.7.1 General

If the tests are carried out away from the appliance, the sensor and body of the devices are each placed in a thermostatically controlled enclosure. The temperature of the body is the maximum temperature to which the device is subjected in the appliance, measured when thermal equilibrium is reached (with an adjustable thermostat set to the position giving the higher temperature) using the reference gas or an actually distributed gas at the nominal heat input, whereas the sensor is subjected to:

— 0,7 times the maximum setting temperature for adjustable thermostats, or

— the maximum temperature set by the manufacturer for non-adjustable thermostats.

60 % of the cycles are carried out at 1,10 times the nominal voltage; the remaining tests at 0,85 times the nominal voltage.

At the end of these tests it is checked that the requirements of 6.5.7.1 are satisfied.

#### 7.5.7.2 Control thermostat

##### 7.5.7.2.1 Accuracy of adjustment

The boiler is installed as stated in 7.1.2 and adjusted to the nominal heat input with one of the reference gases or an actually distributed gas for the boiler category. Using control valve I in Figure 1 or Figure 2, the cold water rate is adjusted to give a rate of increase of the flow temperature of about 2 K/min.

If the thermostat is adjustable, two tests are carried out:

— a test at the maximum setting temperature, and

— a test at the minimum temperature.

Under these test conditions, the boiler is started from cold and the controls left to operate.

It is checked that the requirements of 6.5.7.2.1 are satisfied.

##### 7.5.7.2.2 Endurance

The endurance test is carried out in accordance with EN 60730-2-9.

It is checked that the requirements of 6.5.7.2.2 are satisfied.

#### 7.5.7.3 Safety temperature limiter

##### 7.5.7.3.1 Inadequate water circulation

The boiler is installed and adjusted as stated in 7.5.7.2.1.

Using control valve II in Figure 1 or Figure 2, the water rate through the boiler is reduced progressively to obtain a temperature increase of about 2 K/min, and it is checked that the requirement of 6.5.7.3.1 is satisfied.

##### 7.5.7.3.2 Overheating

With the boiler at thermal equilibrium and after the control thermostat has been put out of service, the boiler cold water rate is progressively reduced by operating control valve I of Figure 1 or Figure 2, to obtain a temperature increase of about 2 K/min, until the burner is extinguished.

It is checked that the requirement of 6.5.7.3.2 is satisfied.

##### 7.5.7.3.3 Endurance

The endurance test is carried out in accordance with EN 60730-2-9.

After the endurance tests it is checked that the requirements of 6.5.7.3.3 are satisfied.

With the boiler at thermal equilibrium, the link between the sensor and the device responding to its signal is interrupted[6)]. It is checked that the requirements of 6.5.7.3.3 are fulfilled.

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6) If this test results in destruction of the safety device, an appropriate test on a device supplied separately by the manufacturer may be agreed between the test laboratory and the manufacturer.

### 7.5.8 Device for monitoring the evacuation of combustion products

The boiler is supplied with reference gas and adjusted in accordance with 7.6.1.2 and 7.6.1.3; it is at ambient temperature.

**Test No. 1**
The test flue is blocked following which the boiler is put into operation.

It is checked that the device causes safety shutdown within the limits given in 6.5.8.

The test flue remains blocked, it is then checked that automatic restart of the boiler does not occur before the delay given in 6.5.8.

**Test No. 2**
With the boiler at thermal equilibrium, the test flue is progressively blocked. It is checked that at the point of safety shutdown initiated by the device, the amount of CO in the dry, air free products of combustion does not exceed the limit given in 6.5.8.

**Test No. 3**
The boiler is operated for 4 h with a blocked flue, at thermal equilibrium with the nominal heat input and maximum water temperature; the device being rendered functionally inoperative. After this test it is checked that the device complies with the requirements of 6.5.8.

### 7.5.9 Condensate discharge blockage

The boiler is installed as stated in 7.1.2. The boiler is supplied with one of the reference gases or a distributed gas for the category to which it belongs.

The condensate discharge is blocked.

The boiler is operated with the temperature and heat input conditions specified for the low temperature boilers in either 7.7.2.2.2 or 7.7.2.2.3 at the manufacturer's choice.

By choice of the manufacturer one of the following tests is conducted:

— The boiler is operated, producing condensate, until the boiler goes to safety shutdown or lockout. The CO concentration of the flue gas is determined at the point of shutdown.

  It is checked that the requirements of 6.5.9.a) are met.

— The boiler is operated, producing condensate, until the CO concentration of the flue gas reaches the value of 0,10 % at which point the boiler is switched off and allowed to cool to ambient temperature.

  The boiler is manually switched on and restart shall not occur. The condensate is allowed to drain from the boiler to the point at which restart occurs. Further drainage of condensate is stopped. The CO concentration is measured.

It is checked that the requirements of 6.5.9 b) are met.

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

## 7.6 Combustion

### 7.6.1 Carbon monoxide

#### 7.6.1.1 General

The boiler is supplied with gas and is, if necessary, adjusted according to the instructions given in 7.6.1.2 and 7.6.1.3.

For range rated boilers, the tests are carried out at the maximum and minimum adjustable heat inputs. For modulating boilers, the tests are carried out at the nominal input and the minimum controlled input.

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 equation:

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

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 in Table 18:

| **Designation of the gas** | **G 20** | **G 21** | **G 23** | **G 25** | **G 26** | **G 27** | **G 30** |
|---|---|---|---|---|---|---|---|
| $(CO_2)_N$ | 11,7 | 12,2 | 11,6 | 11,5 | 11,9 | 11,5 | 14,0 |
| **Designation of the gas** | **G 110** | **G 120** | **G 130** | **G 150** | **G 231** | **G 271** | **G 31** |
| $(CO_2)_N$ | 7,6 | 8,35 | 13,7 | 11,7 | 11,5 | 11,2 | 13,7 |

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

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

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 equation is recommended where the $CO_2$ concentration is less than 2 %.

A summary of the conditions is given in Annex F.

#### 7.6.1.2 Normal conditions

The boilers are placed in a well ventilated room, installed and adjusted in accordance with 7.1.2.

— The boiler is first tested with the reference gas or gases for the boiler category:

NOTE It is permissible to use distributed gas of group H, E, or L and of the third family.

— for a non-regulated boiler with a gas rate adjuster, the test is carried out by adjusting the burner so as to obtain a burner rate of 1,10 times the nominal heat input;

— for a boiler with gas/air ratio controls, the test is carried out at maximum pressure $p_{max}$;

— for regulated boilers, the test is carried out by raising the burner rate to 1,07 times the nominal heat input for gases of the first family or 1,05 times the nominal input for gases of the second and third families;

— boilers with a gas rate adjuster and a regulator that is put out of action for one or more gas families are tested as non-regulated boilers with a gas rate adjuster.

It is checked that the requirements of 6.6.1 are satisfied.

— After the test with the reference or distributed gas or gases, the boiler is tested with the incomplete combustion limit test gas for the boiler category.

— For this test the boiler, in the four cases mentioned above, is first supplied with the reference or distributed gas and the heat input is adjusted to 1,05 times the nominal heat input if a regulator is fitted or to 1,075 times the nominal heat input if the boiler does not incorporate a regulator[7)] or to the maximum heat input $Q_{max}$ if the boiler does incorporate gas/air controls.

— Without changing the adjustment of the boiler or the supply pressure, the reference or distributed gas is replaced by the corresponding incomplete combustion gas.

It is checked that the requirements of 6.6.1 are satisfied.

Alternatively, it is permissible to carry out the incomplete combustion tests in b) using a distributed gas for the group for which the boiler is adjusted in which case the following procedures should be adopted:

— for a non-regulated boiler with a gas rate adjuster or for a boiler with gas/air ratio controls, the test is carried out by adjusting the burner so as to obtain a burner rate of 1,21 times the nominal heat input for first family gas, 1,19 times the nominal heat input for second family gas, 1,10 times the nominal heat input for third family gas;

— for regulated boilers, the test is carried out by adjusting the burner so as to obtain a burner rate of 1,16 times the nominal heat input for first family gas, 1,14 times the nominal heat input for second family gas, 1,05 times the nominal heat input for third family gas;

— boilers with a gas rate adjuster and regulator that is put out of action for one or more gas families are tested as non-regulated boilers with a gas rate adjuster.

It is checked that the requirements of 6.6.1 are satisfied.

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7) If the boiler is intended to be installed solely on a gas installation with a regulated meter, the 1,05 factor may be applied.

After the test(s) with the incomplete combustion limit gas(es), the boiler is tested with the sooting limit gas(es) for the boiler category.

Under the test conditions of b), the incomplete combustion limit gas is replaced by the sooting limit gas.

The boiler is operated for a maximum of 15 min.

It is checked, by visual examination, that the requirement of 6.6.1, last paragraph, is satisfied.

Alternatively, it is permissible for the manufacturer to provide evidence that the requirements of 6.6.1 are satisfied with regard to the application of the sooting limit gas.

#### 7.6.1.3 Special conditions

##### 7.6.1.3.1 Additional tests for type $B_1$ boilers

The tests are carried out with each of the reference gases appropriate to the boiler category at the nominal heat input; the boiler is connected to a test flue of the largest diameter stated by the manufacturer in his instructions.

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

A second test is carried out by applying a continuous downdraught of speeds 0,5 m/s, 1 m/s, 1,5 m/s and 2 m/s. The device for monitoring the evacuation of combustion products, if fitted, is put out of operation.

It is checked that the requirements of 6.6.1 are satisfied.

##### 7.6.1.3.2 Voltage variation

For fan assisted boilers, it is checked that the requirements of 6.6.1 are met when the supply voltage is varied between 85 % and 110 % of the nominal voltage stated by the manufacturer. The boiler is supplied with the appropriate reference or distributed gas(es) for its category(ies) at the normal pressure.

#### 7.6.1.4 Combustion test with flame lift limit gas

In place of the following test, the manufacturer may provide evidence that the requirements of 6.6.1 are satisfied.

The adjustment is modified as follows:

— for boilers without regulators , the pressure at the boiler inlet is reduced to the minimum pressure given in 7.1.1.4;

— for boilers with gas/air ratio controls, the boiler is adjusted to the minimum heat input;

— for boilers with regulators the boiler is adjusted to a heat input equal to 0,95 times the minimum heat input.

The reference gas is then replaced by the flame lift limit gas. It is checked that the requirements of 6.6.1 are met.

### 7.6.2 Other pollutants

#### 7.6.2.1 General

The boiler is installed as specified in 7.1.2.

For boilers intended to use second family gases, the tests are carried out with reference gas G 20.

For boilers intended to use only G 25, the tests are carried out with reference gas G 25.

For boilers intended to use only third family gases, the tests are carried out with reference gas G 30 and the limit $NO_x$ value is multiplied by a factor of 1,30.

For boilers intended to use propane only, the tests are carried out with reference gas G 31 and the limit $NO_x$ value is multiplied by a factor of 1,20.

It is permissible to use the distributed gas(es) for its category(ies) at the normal pressure.

The boiler is adjusted to its nominal heat input for a flow water temperature of 80 °C and a return temperature of 60 °C.

For measurements at partial heat inputs lower than the nominal heat input $Q_n$ the return water temperature $T_r$ is calculated as a function of the particular heat input using the following equation:

$$T_r = (0,4 \times Q) + 20$$

where

$T_r$ is the return water temperature, expressed in degrees Celsius (°C);

$Q$ is the partial heat input, expressed in percent of $Q_n$.

The flow is kept constant.

The $NO_x$ measurements are carried out when the boiler is at thermal equilibrium, conforming with details given in CR 1404. No wet meters are used.

The reference conditions for the combustion air are:

— temperature : 20 °C;

— relative humidity : 10 g $H_2O$ /kg air.

If the test conditions are different from these reference conditions, it will be necessary to correct the $NO_x$ values as specified below.

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

where

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

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

$h_m$ is the 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 $NO_{x,m}$ in °C in the range 15 °C to 25 °C.

Where appropriate, the measured $NO_x$ values are weighted in accordance with 7.6.2.2.

It is checked that the weighted $NO_x$ values comply with the values of 6.6.2, depending on the $NO_x$ class chosen.

For the calculation of conversions of $NO_x$, see Annex K.

#### 7.6.2.2 Weighting

##### 7.6.2.2.1 General

The weighting of the measured $NO_x$ values is described in 7.6.2.2.2 to 7.6.2.2.5, on the basis of the values in Table 19.

**Table 18 — Weighting factors**

| Partial heat input $Q_{pi}$ as % of $Q_n$ | 70 | 60 | 40 | 20 |
|---|---|---|---|---|
| Weighting factor $F_{pi}$ | 0,15 | 0,25 | 0,30 | 0,30 |

For range rated boilers $Q_n$ is replaced by $Q_a$, the arithmetic mean of the maximum and the minimum heat input, as stated by the manufacturer.

##### 7.6.2.2.2 On/off boilers

The $NO_X$ concentration is measured (and possibly corrected as specified in 7.6.2.1 at the nominal heat input, $Q_n$.

##### 7.6.2.2.3 Boilers with several rates

The $NO_x$ concentration is measured (and possibly corrected as specified in 7.6.2.1 at the partial heat input corresponding to each of the rates and weighted in accordance with Table 19.

If necessary, the weighting factor specified in Table 19 is recalculated for each rate as specified below.

If the heat inputs of two rates are between the partial heat inputs specified in Table 19, it will be necessary to apportion the weighting factor between the heat inputs of the higher and lower rates, as follows:

$$F_{p,\text{high rate}} = F_{pi} \bullet \frac{Q_{pi} - Q_{\text{low rate}}}{Q_{\text{high rate}} - Q_{\text{low rate}}} \bullet \frac{Q_{\text{high rate}}}{Q_{pi}}$$

$$F_{p,\text{low rate}} = F_{pi} - F_{p,\text{high rate}}$$

If the heat inputs of two rates cover more than one partial heat input specified in Table 19, then it is necessary to apportion each weighting factor between the heat inputs of the higher and lower rate as indicated above.

The weighted $NO_x$ value is then equal to the sum of the products of the measured $NO_x$ values at the different rates, $NO_{x,\,mes(rate)}$, multiplied by their weighting factor, calculated as specified above:

$$NO_{x,pond} = \Sigma (NO_{x,mes(rate)} \bullet F_{p,rate})$$

(See calculation example in Annex J).

#### 7.6.2.2.4 Modulating boilers in which the minimum modulating heat input is not greater than 0,20 $Q_n$

The $NO_x$ concentration is measured (and possibly corrected as specified in 7.6.2.1) at the partial heat inputs specified in Table 19.

The $NO_x$ value is weighted as specified below:

$$NO_{x,pond} = 0,15 \bullet NO_{x,mes\ (70)} + 0,25 \bullet NO_{x,mes\ (60)} + 0,30 \bullet NO_{x,mes\ (40)} + 0,30 \bullet NO_{x,mes\ (20)}$$

#### 7.6.2.2.5 Modulating boilers in which the minimum modulating heat input is greater than 0,20 $Q_n$

The $NO_x$ concentration is measured (and possibly corrected as specified in 7.6.2.1 at the minimum modulating rate and at the partial heat inputs $Q_{pi}$, specified in Table 19, which are greater than the minimum modulation rate.

The weighting factors for the partial heat inputs in Table 19, which are not greater than the minimum modulation rate, are added and multiplied by this heat input.

The $NO_x$ value is therefore weighted as follows:

$$NO_{x,pond} = (NO_{x,mes\ Q_{min}} \bullet \Sigma F_{pi}(Q \leq Q_{min})) + \Sigma (NO_{x,mes} \bullet F_{pi})$$

Symbols used in 7.6.2.2:

$Q_{min}$ is the minimum modulating heat input, expressed in kilowatts (kW);

$Q_n$ is the nominal heat input, expressed in kilowatts (kW);

$Q_{pi}$ is the partial heat input for weighting, expressed in percent of $Q_n$;

$F_{pi}$ is the weighting factor corresponding to the partial heat input $Q_{pi}$;

$NO_{x,pond}$ is the weighted value of the $NO_x$ concentration, in milligrams per kilowatt-hour (mg/kWh);

$NO_{x,mes}$ is the measured (and possibly corrected) value:

at the partial heat input: $NO_{x,mes\ (70)}$, $NO_{x,mes\ (60)}$, $NO_{x,mes\ (40)}$, $NO_{x,mes\ (20)}$;

at the minimum heat input (modulating boilers):$NO_{x,mes,Qmin;}$

at the heat input corresponding to a single rate: $NO_{x,mes(rate)}$;

$Q_{high\ rate}$ is the rate greater than $Q_{pi}$;

$Q_{low\ rate}$ is the rate less than $Q_{pi}$;

$F_{p,high\ rate}$ is the apportioned weighting factor, high rate;

$F_{p,low\ rate}$ is the apportioned weighting factor, low rate.

## 7.7 Useful efficiencies

### 7.7.1 Useful efficiency at the nominal heat input

The boilers are installed as stated in 7.1.2, connected to the insulated test rig shown schematically in Figure 1 or Figure 2, or to any other equipment giving equivalent results, and supplied with the reference gas for the boiler category.

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 tarred before the test) and at the same time measurement of the gas rate (reading the meter) is started.

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 during the 10 min of the test. A further 10 min wait is required in order to evaluate the evaporation corresponding to the test period. Mass $m_2$ is obtained.

$m_1 - m_2 = m_3$, the quantity which has to be taken into account in order to increase $m_1$ by the value corresponding to the evaporation, whence the 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 temperatures $t_1$ at the cold water inlet and $t_2$ at the boiler outlet.

The useful efficiency is determined by means of the following equation:

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

where

$\eta_u$ is the useful efficiency in percent;

$m$ is the corrected quantity of water expressed in kilogrammes (kg);

$V_{r(10)}$ is the gas consumption in cubic metres ($m^3$) measured during the test and corrected to 15 °C, 1 013,25 mbar;

$H_i$ is the net calorific value of the gas used in megajoules per cubic metre ($MJ/m^3$; at 15 °C, 1 013,25 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 loss from the circulation pump (a practical calibration method for determining $D_p$ is described in Annex D).

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

The useful efficiency is determined at the nominal heat input for boilers without a range-rating device. For range rated boilers the useful efficiency is determined at the maximum and minimum adjustable heat inputs specified by the manufacturer.

It is checked that the requirements of 6.7.1 are met.

### 7.7.2 Useful efficiency at part load

#### 7.7.2.1 General

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

It is checked that the requirements of 6.7.2 are met.

#### 7.7.2.2 Direct method

##### 7.7.2.2.1 General

The manufacturer has the choice of following operating mode No.1 or operating mode No.2.

The boiler is installed as stated in 7.1.2 and supplied with one of the reference gases as for the determination of the useful efficiency at nominal heat input (maximum and minimum adjustable heat inputs specified by the manufacturer in the case of range rated boilers).

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

##### 7.7.2.2.2 Operating mode No.1

The boiler is fitted to the test rig illustrated in Figure 12 (or any other test rig giving at least comparable results and equivalent measurement accuracies).

The boiler 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 return temperature that is low enough, the test is carried out at the lowest return temperature compatible with the operation of the boiler.

A time piece is fitted to the room thermostat to obtain a working cycle of 10 min.

The shutdown and operating times are calculated as indicated in Table 20.

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 results from three, 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 gas and water consumptions over complete cycles are measured.

The efficiency is determined using the equation in 7.7.1.

A variation of ± 2 % with respect to the 30 % of the nominal heat input is permitted. For variations 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.

#### 7.7.2.2.3 Operating mode No. 2

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

The boiler 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 nominal input or the maximum and minimum adjustable heat inputs as specified by the manufacturer for range rated boilers, is drawn through the heat exchanger.

The average water temperature shall not be 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 return temperature that is low enough, the test is carried out at the lowest return temperature compatible with the operation of the boiler.

The boiler is considered to be in thermal equilibrium when the efficiency measurement of three consecutive cycles, combining any two results from three, 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 gas and water consumptions over complete cycles are measured.

The efficiency is determined using the equation in 7.7.1.

A variation of ± 2 % with respect to the 30 % of the nominal heat input is permitted. For variations 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.

**Table 19 — Calculation of the useful part load efficiency**

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

[a] $Q_n$ is replaced by the maximum and minimum adjustable heat inputs for range rated boilers.

#### 7.7.2.3 Indirect method

##### 7.7.2.3.1 Measurements

###### 7.7.2.3.1.1 Useful efficiency at the nominal heat input at a reduced water temperature

The test of 7.7.1, at the nominal heat input or for range rated boilers at the maximum and minimum adjustable heat inputs specified by the manufacturer, is repeated with the following flow and return temperatures:

**Table 20 — Temperatures**

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

The measured value $\eta_1$ is noted.

###### 7.7.2.3.1.2 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:

**Table 21 — Temperatures**

| | Flow temperature (°C) | Return temperature (°C) |
|---|---|---|
| Standard boiler | 55 ± 2 | 45 ± 1 |
| Low-temperature boiler | 45 ± 2 | 35 ± 1 |

The measured value is designated $\eta_2$.

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:

— $\eta_{21}$ for the larger heat input;

— $\eta_{22}$ for the smaller heat input.

#### 7.7.2.3.1.3 Standby losses

The test installation is described in Figure 11.

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 H).

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

The boiler water temperature is brought to a mean temperature rise above ambient temperature of (30 ± 5) K for standard boilers or (20 ± 5) K for low-temperature boilers. The gas supply is then shut off, the 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 between the mean water temperature and the ambient temperature of (30 ± 5) K for standard boilers or (20 ± 5) K for low-temperature boilers.

Throughout the test, the variation in room temperature is not to exceed 2 K/h.

Then:

$P_m$ in kW, 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);

$T$ in °C, 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;

$T_A$ in °C, the mean ambient temperature during the test;

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.

#### 7.7.2.3.1.4 Pilot recovery factor

The pilot recovery factor is taken to be 0,8.

#### 7.7.2.3.2 Calculation

The useful efficiency for a load of 30 % of the nominal heat input (or the maximum and minimum adjustable heat inputs for range rated boilers) is calculated for a control cycle.

The symbols of Table 23 are used.

**Table 22 — Symbols and quantities needed to calculate the efficiency at part load**

| Operational phases of the main burner | Heat input<br>kW | Operation time<br>s | Measured values [a] |
|---|---|---|---|
| | | | Efficiency % |
| Full rate | $Q_1$ | $t_1$ | $\eta_1$ |
| Reduced rate | $Q_2$ | $t_2$ | $\eta_2$ |
| Reduced rate > 0,3 $Q_1$ | $Q_{21}$ | $t_{21}$ | $\eta_{21}$ |
| Reduced rate < 0,3 $Q_1$ | $Q_{22}$ | $t_{22}$ | $\eta_{22}$ |
| Controlled off | $Q_3$ | $t_3$ | Standby losses $P_s$ (kW) |
| [a] At a mean temperature of 50 °C for standard boilers or 40 °C for low-temperature boilers. | | | |

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

Depending on the means of control, the following operating cycles can be identified, which correspond to the equations in Table 20:

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

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

— 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);

— full rate/reduced rate operation (one or several reduced rates where the maximum of the reduced heat inputs $Q_2 < 0,3\ Q_1$);

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

— 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 shutdown ($t_3 > 0$); otherwise cycle 4 above applies).

The efficiency is calculated as indicated in Table 20.

## 7.8 Criteria for condensation in the flue

### 7.8.1 Determination of flue losses

Under the test conditions of 7.7.1, using an insulated flue, the temperature of the combustion products and the $CO_2$ concentration are measured at the maximum heat input and at the minimum heat input.

The flue losses are determined for example by the use of the following simplified equation:

$$q_c = (a + \frac{b}{CO_2}) \bullet \frac{t_c - t_a}{100}$$

where

$q_c$ are the flue losses of the heat input, in percent;

$a$ and $b$ are the coefficients given in Table 24;

$CO_2$ is the carbon dioxide concentration in the dry products of combustion, in percent;

$t_c$ is the temperature of the products of combustion, in degrees Celsius;

$t_a$ is the ambient temperature, in degrees Celsius.

**Table 23 — Coefficients**

| Reference gas | G 110 | G 20 | G 25 | G 30 |
|---|---|---|---|---|
| *a* | 1,05 | 0,85 | 0,85 | 0,65 |
| *b* | 23,2 | 36,6 | 36 | 42,5 |

The result is checked against the criteria of 6.8, first indent).

#### 7.8.2 Minimum temperature of the combustion products

Under the test conditions for the measurement of useful efficiency, the temperature of the combustion products is measured 150 mm below the top of a 1 m flue. The temperature of the combustion products is measured at the maximum and minimum heat input given either by the range rating device or by the controls and the result is checked against the criteria of 6.8, second indent).

### 7.9 Resistance of materials to pressure

#### 7.9.1 General

The tests are carried out with the water at ambient temperature and at the test pressures stated in 7.9.2 and 7.9.3.

The test pressure is maintained for at least 10 min.

It is checked, after each test, that the requirement of 6.9.1 is satisfied.

#### 7.9.2 Boilers of sheet steel or non-ferrous metals

The test pressure is ($2 \times PMS$) bar.

It is checked that the requirement of 6.9.2 is satisfied.

#### 7.9.3 Boilers of cast iron and cast materials

##### 7.9.3.1 Boiler body

The test pressure is ($2 \times PMS$) bar, with a minimum of 8 bar.

It is checked that the requirement of 6.9.3.1 is satisfied.

#### 7.9.3.2 Resistance to bursting

Three samples of each type of section are subjected to a test pressure of (4 × *PMS* + 2) bar.

It is checked that the requirement of 6.9.3.2 is satisfied.

#### 7.9.3.3 Tie bars

It is checked, by calculation, that the requirement of 6.9.3.3 is satisfied for a pressure of (4 × *PMS*) bar.

### 7.10 Hydraulic resistance

The hydraulic resistance of a boiler (measured in mbar) has to be determined for the water rate corresponding to operation of the boiler at the nominal output with a flow temperature of 80 °C and a temperature difference between the flow and the return of 20 K generally, or that stated by the manufacturer.

The test is carried out with the water cold.

The test rig is shown schematically in Figure 7. Before or after the test itself, the two test pipes are connected directly to each other in order to determine their own resistance for different flow rates.

Under the same test conditions the characteristic curve of available pressures supplied by the manufacturer, for boilers with integral pumps, is checked.

### 7.11 Combustion air and flue dampers

The boiler is installed and adjusted as described in 7.1.2 and supplied with one of the reference gases or with an actually distributed gas appropriate to the boiler category. Two tests are carried out.

**Test No. 1**
The gas is adjusted to enable the boiler to operate at 120 % of the nominal heat input. By means of a switching mechanism, the damper is alternately opened and closed 5 000 times at a rate consistent with normal operation of the damper.

**Test No. 2**
The boiler is adjusted to ensure a temperature rise of the damper of 45 K above ambient. By means of a switching mechanism, the damper is alternately opened and closed 5 000 times at a rate consistent with normal operation of the damper.

It is checked, after each test, that the requirements of 6.11 are satisfied.

### 7.12 Condensation in a standard boiler

The boiler is installed as specified in 7.1.2. However, the average water temperature in the boiler is set at 50 °C (return 40 °C, flow 60 °C). If the manufacturer specifies in the instruction for the installer that the boiler may be fitted to a heating system designed to operate at a lower temperature, the lowest indicated water temperatures are set.

The boiler is operated at maximum heat input for one hour at this temperature.

Immediately after, it is checked whether condensation has occurred in the boiler.

The test is repeated at the minimum heat input.

If condensation has occurred in the boiler, it is checked that the requirements of 6.12 are met.

# 8 Marking and instructions

## 8.1 Marking of the boiler

### 8.1.1 General

CR 1472[8)] applies.

### 8.1.2 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:

— name of the manufacturer[9)] or his identification symbol;

— serial number or year of manufacture;

— trade name of the boiler;

— if necessary, the CE Marking with:

  — identifying number of the boiler;

  — last two numbers of the year when the CE Marking was granted;

— 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 | Cyprus | CY |
| Estonia | EE | Hungary | HU |

8) “General guidance for the marking of gas appliances”.

9) Manufacturer means the organisation or company which assumes responsibility for the product.

| | | | |
|---|---|---|---|
| Latvia | LV | Lithuania | LT |
| Malta | MT | Poland | PL |
| Romania | RO | Slovakia | SK |
| Slovenia | SI | | |

— category(ies) of boiler in relation to the direct countries of destination. Any category shall be specified in accordance with 4.1 or Annex A;

— 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”;

— 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”;

— 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”;

— 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”;

— electrical supply;

  — nature given by the symbol “~” or “=“,

  — nominal voltage of the electrical supply in volts given by the numerical value followed by the unit “V”,

  — power consumption in watts given by the numerical value followed by the unit “W”;

— $NO_x$ class of the boiler.

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

### 8.1.3 Supplementary marking

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

— the direct country(ies) of destination in accordance with the symbols in 8.1.2;

— the gas group or range, the symbol of gas type, the gas supply pressure and/or the pressure couple in accordance with the column on marking in Table 25.

This information may be carried on the data plate.

**Table 24 — Supplementary markings**

| Gas family | Category index | State of adjustment | | | Marking |
|---|---|---|---|---|---|
| | | Gas group or range of gases | Symbol of gas type | Gas pressure (s) mbar | |
| First | 1a, 1ab, 1ad | 1a | G 110 | 8 | 1a - G 110 - 8 mbar |
| | 1ab, 1abd | 1b | G 120 | 8 | 1b - G 110 - 8 mbar |
| | 1c, 1ace, 1ce | 1c | G 130 | 8 | 1c - G 130 - 8 mbar |
| | 1ad, 1abd | 1d | G 140 | 8 | 1d - G 140 - 4 mbar |
| | 1ace, 1ce | 1e | G 150 | 8 | 1e - G 150 - 8 mbar |
| Second | 2H | 2H | G 20 | 20 | 2H - G 20 - 20 mbar |
| | 2L | 2L | G 25 | 25 | 2L - G 25 - 25 mbar |
| | 2E, 2ELL | 2E | G 20 | 20 | 2E - G 20 - 20 mbar |
| | 2ELL | 2LL | G 25 | 20 | 2LL - G 25 - 20 mbar |
| | 2E+ | 2E+ | G 20/G 25 | 20/25 | 2E+G 20/G 25 - 20/25 mbar |
| | 2Esi | 2Es | G 20 | 20 | 2Es - G 20 - 20 mbar |
| | | 2Ei | G 25 | 25 | 2Ei - G 25 - 25 mbar |
| | 2Er | 2Er | G 20/G 25 | 20/25 | 2ER - G 20/G 25 - 20/25 mbar |
| Third | 3B/P | 3B | G 30 | 30 | 3B - G 30 - 30 mbar |
| | | 3B | G 30 | 50 | 3B - G 30 - 50 mbar |
| | | 3P | G 31 | 30 | 3P - G 31 - 30 mbar |
| | | 3P | G 31 | 50 | 3P - G 31 - 50 mbar |
| | 3P | 3P | G 31 | 37 | 3P - G 31 - 37 mbar |
| | | 3P | G 31 | 50 | 3P - G 31 - 50 mbar |
| | 3+ | 3+ | G 30/G 31 | 28 - 30/37 | 3+ - G 30/G 31 - 28 - 30/37 mbar |
| | | 3+ | G 30/G 31 | 50/67 | 3+ - G 330/G 31 - 50/67 mbar |
| | | 3+ | G 30/G 31 | 112/148 | 3+ - G 30/G 31 - 112/148 mbar |

### 8.1.4 Packaging

The packaging shall carry the category(ies), the appliance type and information given on the additional data plate (see 8.1.3) as well as warnings in accordance with 8.1.5.

#### 8.1.5 Warnings on the boiler and on the packaging

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

— The boiler may only be installed in a room which complies with the appropriate ventilation requirements and which is separated from living rooms;

— read the installation instructions before installing the boiler;

— read the user's instructions before lighting the boiler.

#### 8.1.6 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.

### 8.2 Instructions

#### 8.2.1 Technical instructions for the installer

Each boiler shall be accompanied by technical instructions for installation, adjustment and servicing of the boiler according to the requirements in force in the country where it will be installed.

These instructions shall carry the following information:

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

b) maximum water temperature in degrees Celsius;

c) servicing necessary and the recommended service interval;

d) methods recommended for cleaning and draining the boiler;

e) references to certain standards and/or particular regulations where necessary for the correct installation and use of the boiler;

f) wiring diagram with the connection terminals (including those for external controls);

g) indication of the controls which can be used;

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

i) obligation to earth boilers incorporating electrical equipment;

j) for sealed water systems, instructions concerning the installation of a pressurised expansion vessel when the boiler is not originally fitted with such a device;

k) for boilers capable of operation on several gases, information on the procedures 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 information that the adjuster shall be sealed after the adjustment;

l) minimum distances to be maintained from easily inflammable materials;

m) if necessary, information that walls affected by heat, for example wood, shall be protected by appropriate insulation, and the distances that shall be observed between the wall on which the boiler is fixed and the hot external parts of the boiler;

n) table giving the volumetric rate or the mass rate, in cubic metres per hour or in kilograms per hour corrected to the average conditions of use (15 °C, 1 013,25 mbar, dry) for the various categories and the various gases, or the gas pressure at the burner;

o) general description of the boiler, with illustrations of the principal parts (sub-assemblies) which can be removed and replaced;

p) information on:

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

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

q) for flue calculations, information, if required, on the mass rate of combustion products in grams per seconds and the average temperature (measured under the conditions of 7.7.1, and minimum draught requirements;

r) details of the maximum combustion products temperature at the boiler exit to enable any connecting flue to be suitably specified;

s) information on the requirements to be observed in respect of the air supply and ventilation of the room in which the boiler is installed;

t) for type $B_{11}$ boilers, it is necessary to clearly indicate that the boiler is intended to be installed in a room separated from living rooms and provided with appropriate ventilation directly to the outside;

u) where it is determined that condensation occurs in the flue (measured under the conditions of 7.8, the manufacturer shall specify the special precautions to be taken for the flue;

v) where it is determined that condensation may occur in the boiler (measured under the conditions of 7.12, the manufacturer shall draw attention to the fact that the boiler shall not be fitted to a heating system designed for continuous operation at a temperature less than 50 °C when the boiler has not been designed to operate at this temperature;

w) adjustment of the heat input.

#### 8.2.2 Use and maintenance instructions for the user

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

They shall:

a) point out that a competent person should be called on to install the boiler and adjust it if necessary;

b) explain the procedure for starting up and shutting off the boiler;

c) explain the operations necessary for normal operation of the boiler and for its cleaning, and point out that it is recommended to have the boiler checked periodically by a competent person;

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

e) warn against incorrect use;

f) draw the attention of the user to the requirements concerning air supply and ventilation of the room in which the boiler is installed;

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

#### 8.2.3 Conversion instructions

Parts intended for conversion to another gas family, another group, another range and/or another supply pressure, shall be accompanied by conversion instructions intended for the 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 regulator shall either be made inoperative within the range of normal pressures, or be put out of operation and sealed in that position.

A self-adhesive label which is intended to be fitted on the 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 8.1.3, indicating:

e) gas group or range;

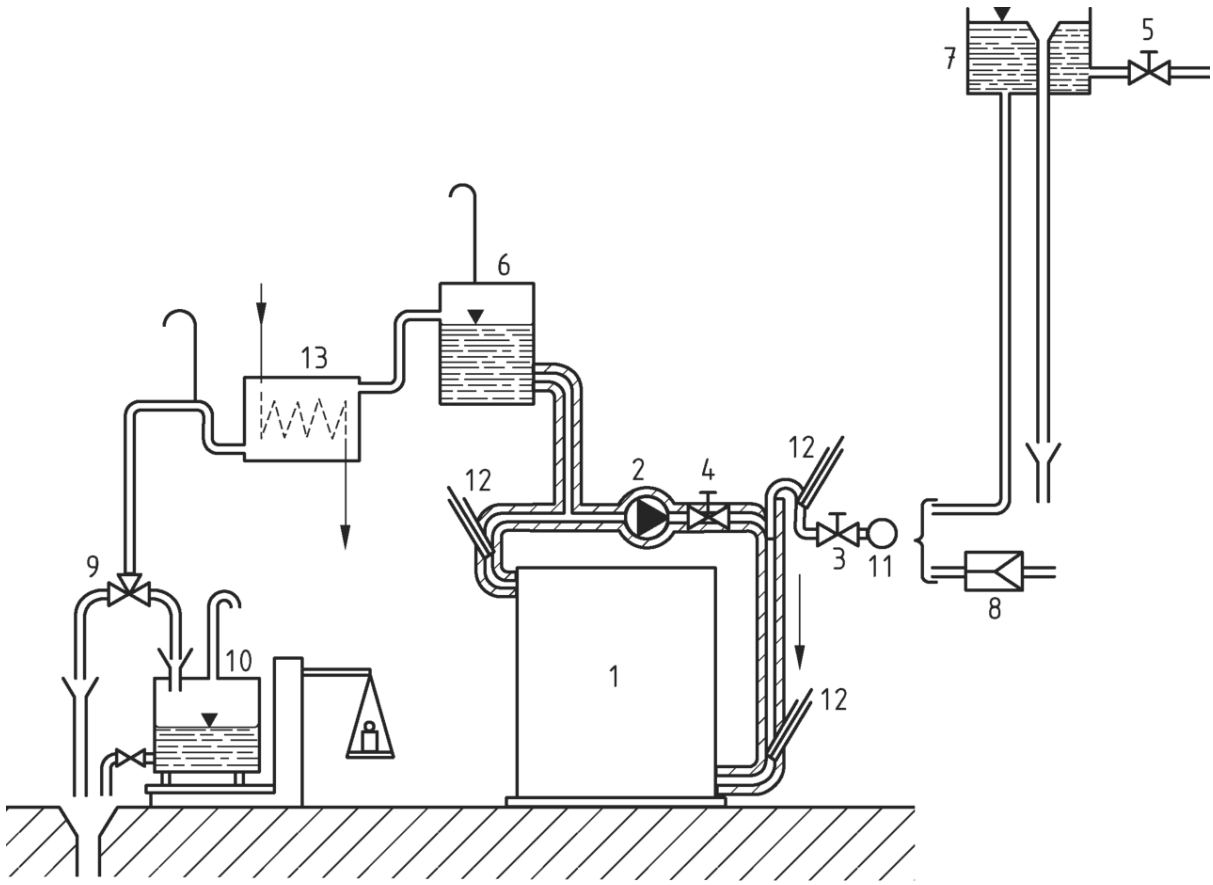
f) gas type;

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

h) adjusted heat input where appropriate.

### 8.3 Presentation

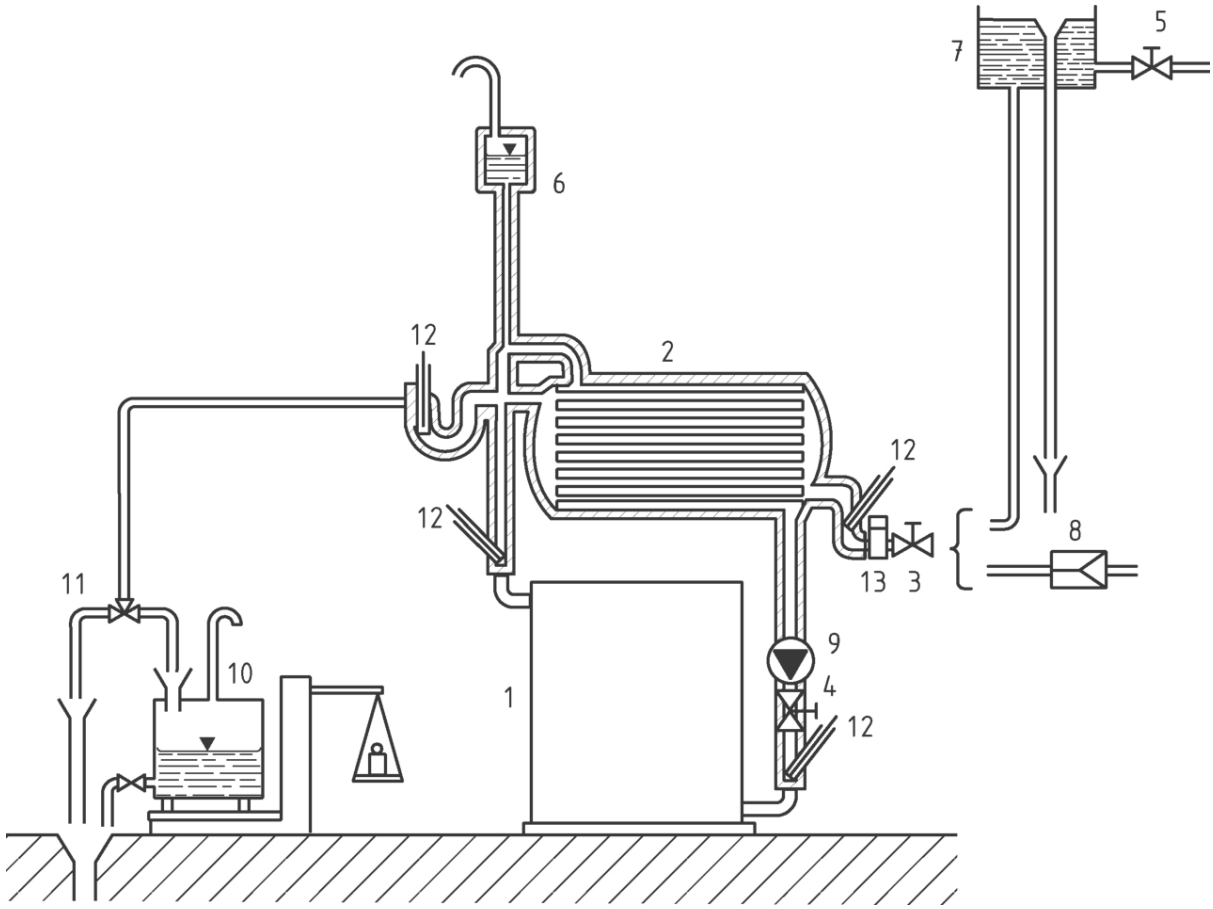
All the information of 8.1 and 8.2 is given in the language(s) and according to the practice of the country(ies) in which the boiler is intended to be installed.




**Keys**

| | | | |
|---|---|---|---|
| 1 | boiler under test | 8 | connection to a constant pressure distribution pipe |
| 2 | circulating pump | 9 | three-way tap |
| 3 | control valve I | 10 | weighing vessel |
| 4 | control valve II | 11 | water meter |
| 5 | control valve III | 12 | temperature measurements |
| 6 | compensating tank | 13 | cooler |
| 7 | constant head tank or | | |

**Figure 1 — Test rig with direct recirculation**

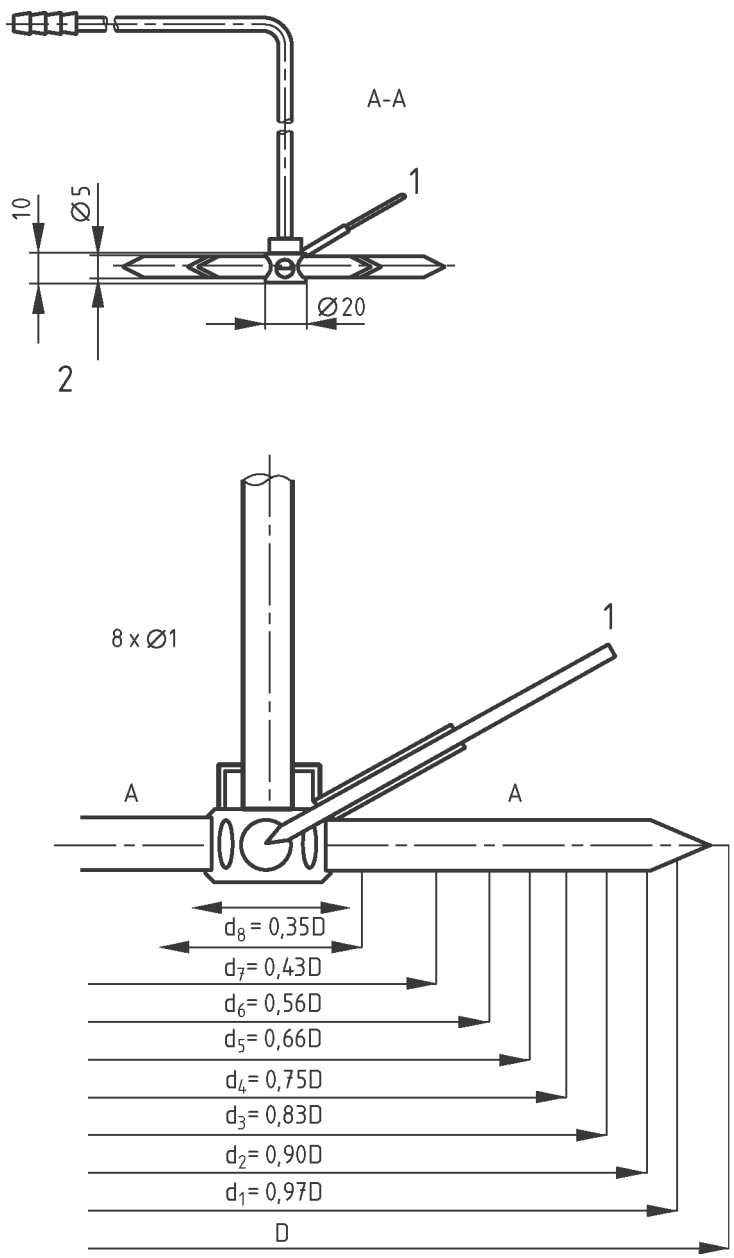



**Keys**

| | | | |
|---|---|---|---|
| 1 | boiler under test | 7 | constant head tank or |
| 2 | heat exchanger | 8 | connection to a constant pressure distribution pipe |
| 3 | control valve I | 9 | circulating pump |
| 4 | control valve II | 10 | weighing vessel |
| 5 | control valve III | 11 | three way tap |
| 6 | expansion vessel (not in the circulating system) | 12 | temperature measurements |
| | | 13 | water temperature |

**Figure 2 — Test rig with heat exchanger**

Dimensions in millimetres

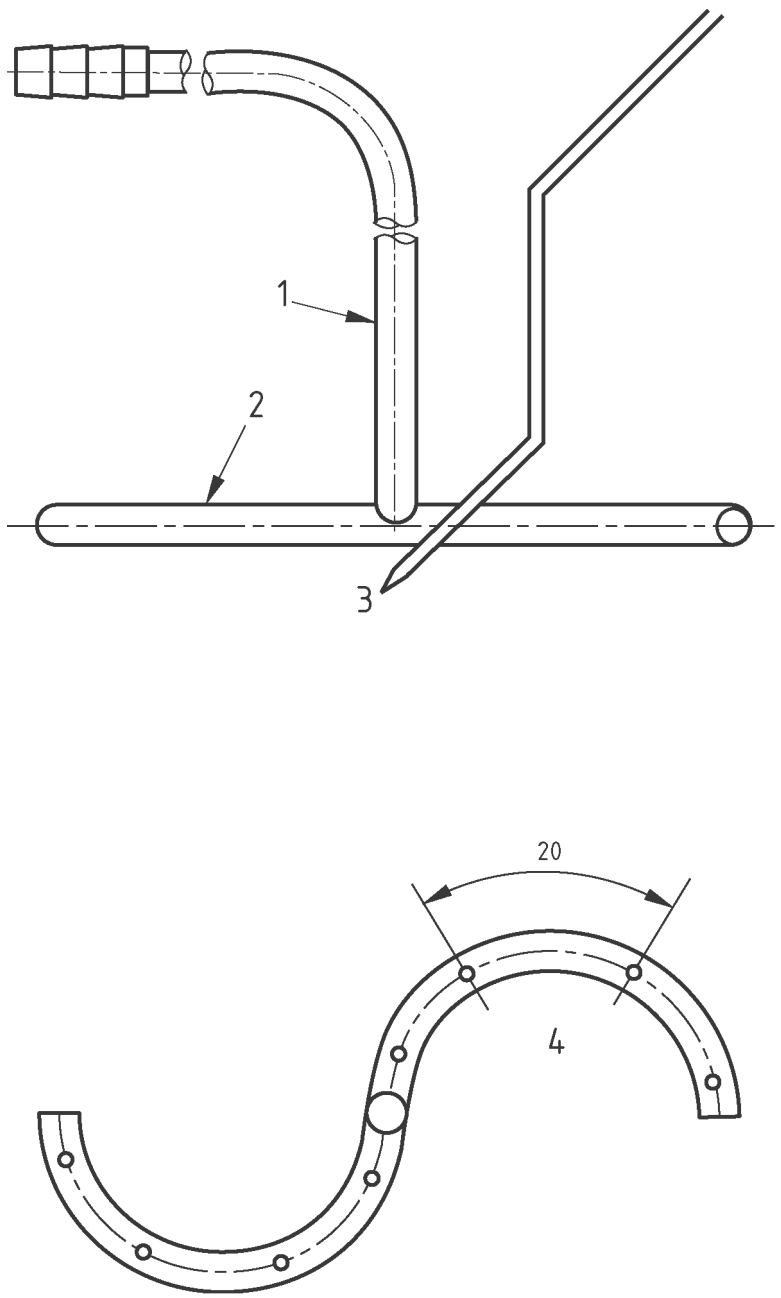



**Keys**

1 thermocouple
2 sampling probe
D diameter of flue

**Figure 3 — Sampling probe for flue diameters greater than DN 100**

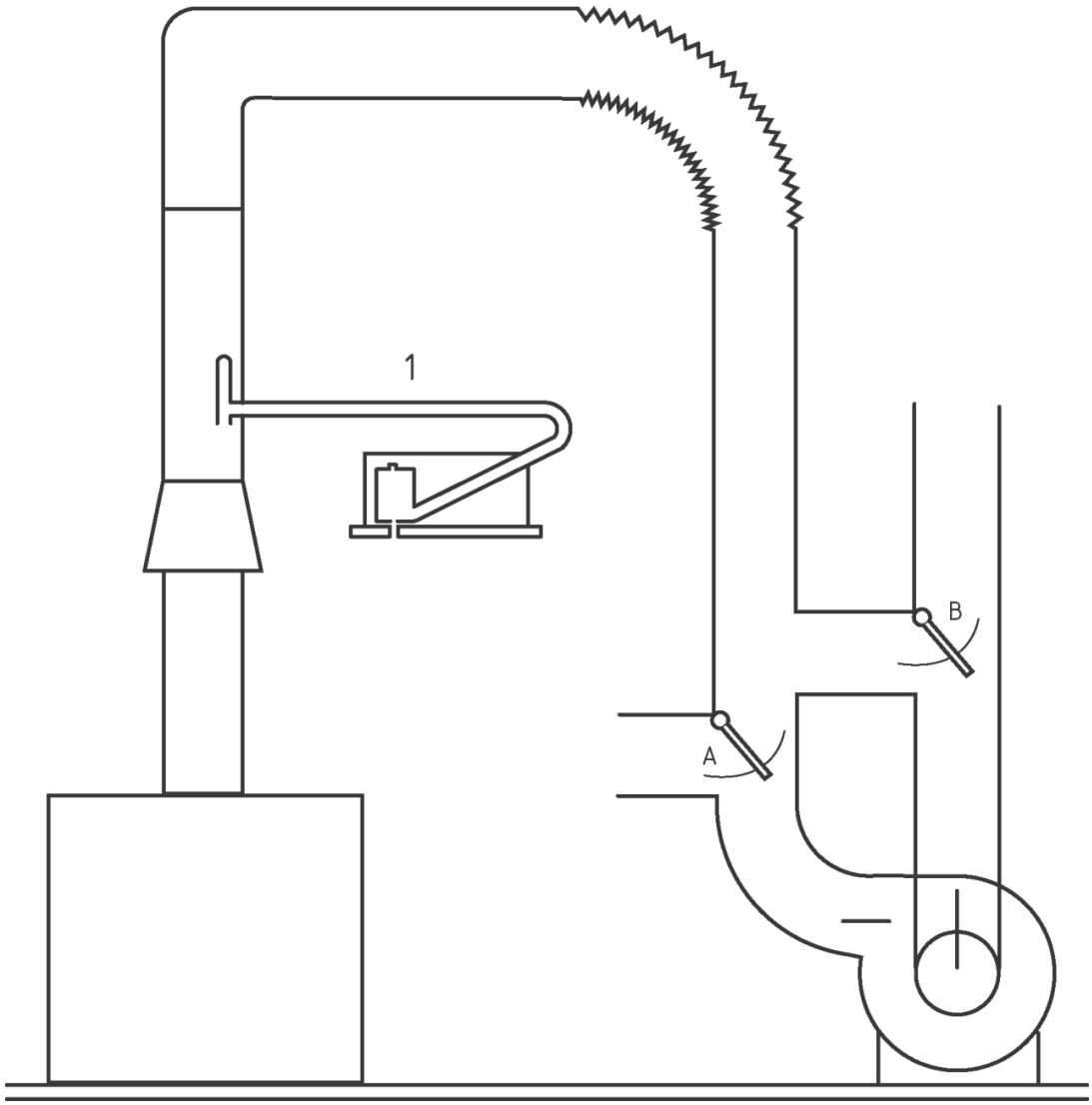
Dimensions in millimetres




**Keys**

1 copper tube Ø 6
2 copper tube Ø 4/3
3 thermocouple
4 openings 8 x Ø 1

**Figure 4 — Sampling probe for flue diameters not greater than DN 100**



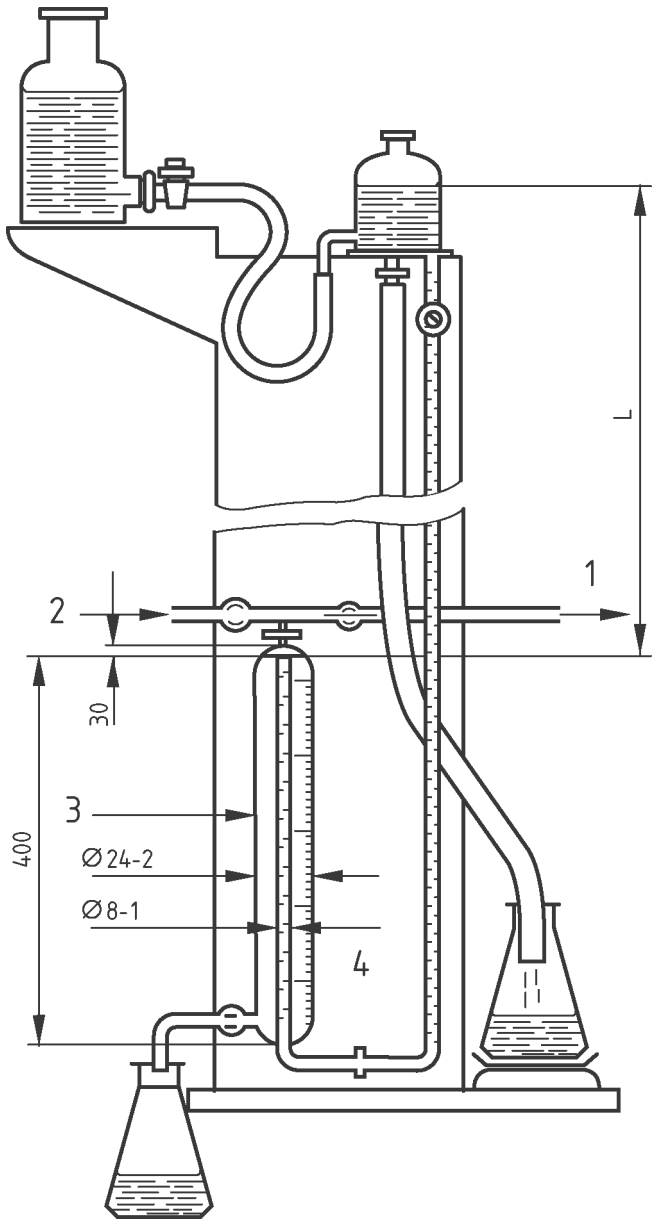

**Key**

1 velocity measurement by means of a pilot tube

A and B diverter valves to obtain either updraught or downdraught

**Figure 5 — Test of a boiler under special draught conditions**

Dimensions in millimetres

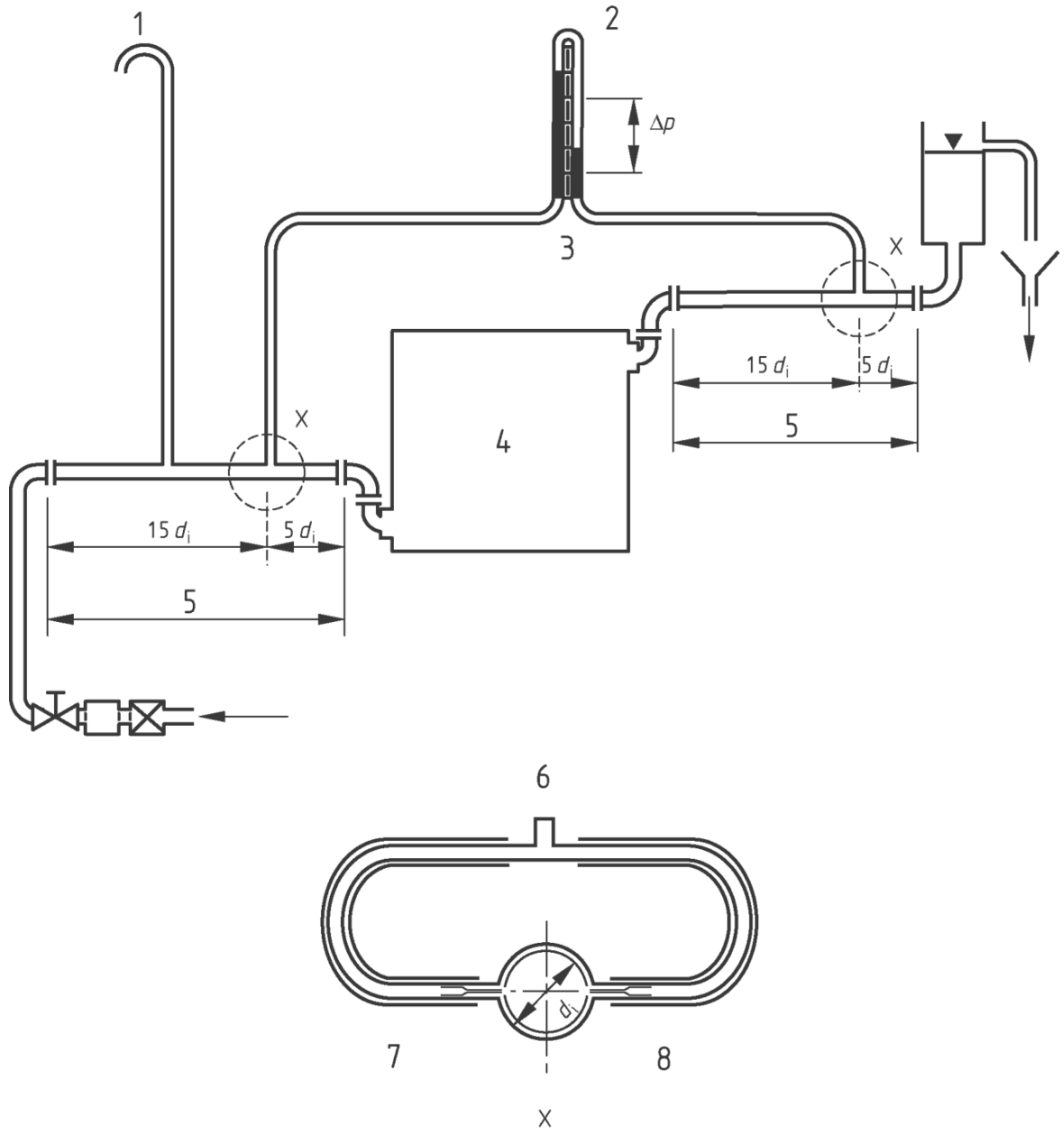



**Keys**

1 appliance under test
2 compressed air
3 measuring vessel
4 graduated scale
L height of fluid equivalent to test pressure (see 7.2.1)

**Figure 6 — Device for checking the soundness of the gas circuit**

Dimensions in millimetres

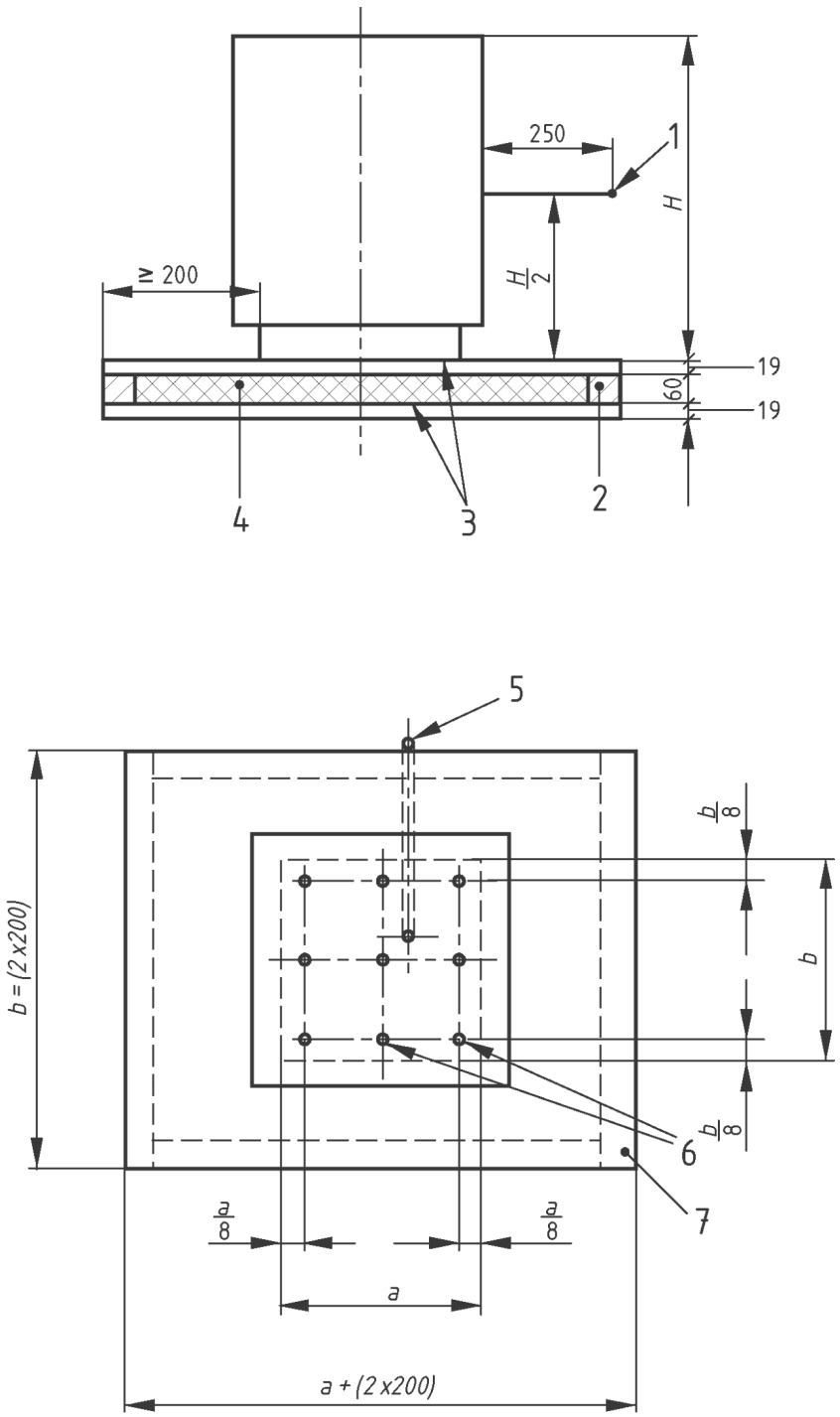



**Keys**

| | | | |
|---|---|---|---|
| 1 | vent | 5 | test pipe |
| 2 | differential manometer | 6 | section at 'X' rotated through 90° |
| 3 | flexibles | 7 | flexible pipe |
| 4 | boiler | 8 | orifice 3 Ø smoothed internally |

**Figure 7 — Determination of the hydraulic resistance**

Dimensions in millimetres

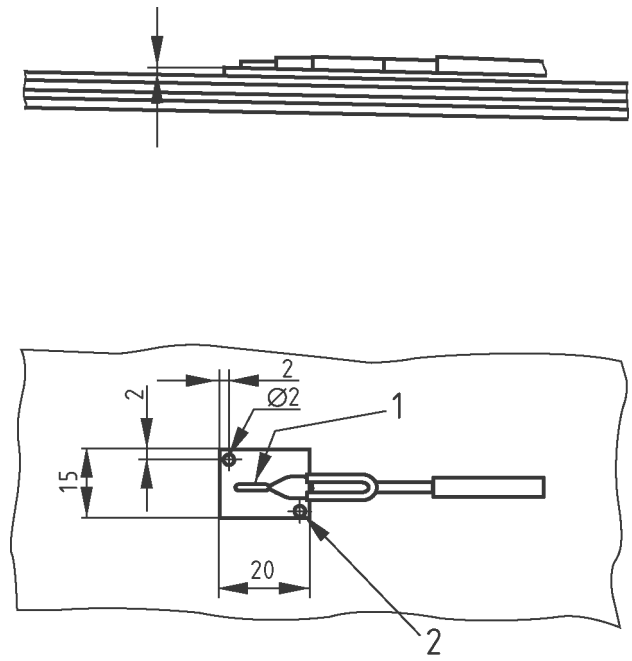



**Keys**

1 air temperature measurement point
2 squared-timber frame
3 Norway spruce with groove and spring
4 glass fibre
5 hollow tube for measurement cable
6 measurement points
7 test floor for measuring floor temperature

**Figure 8 — Test configuration for determining floor temperature**

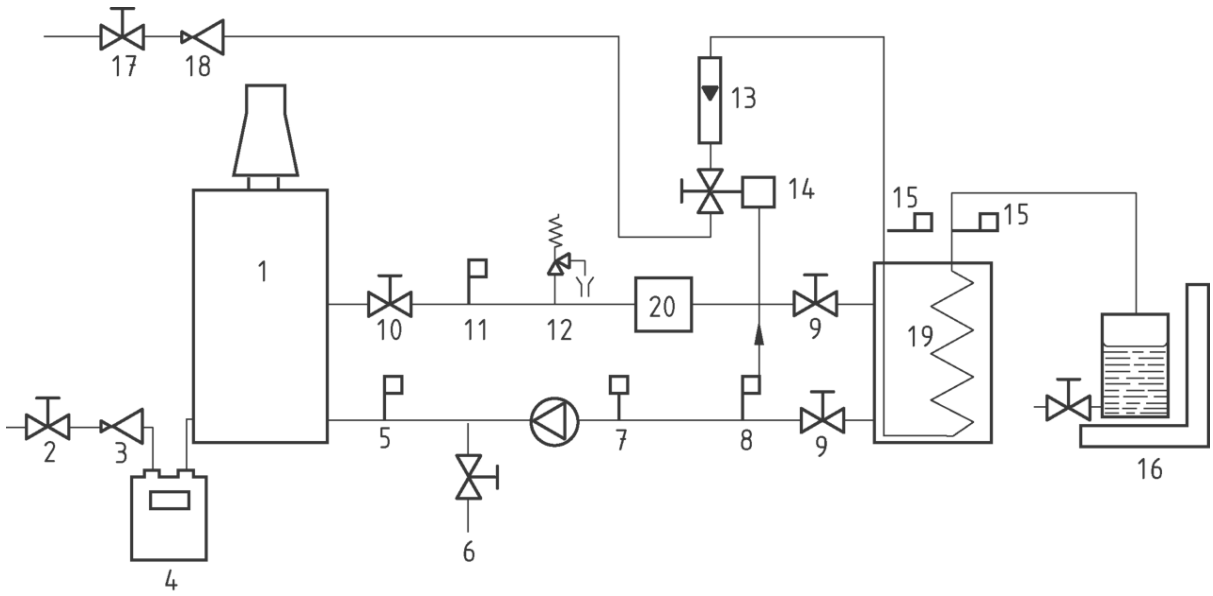
Dimensions in millimetres




**Keys**

1 thermocouple brazed to copper plate 2 holes for fitting copper plate

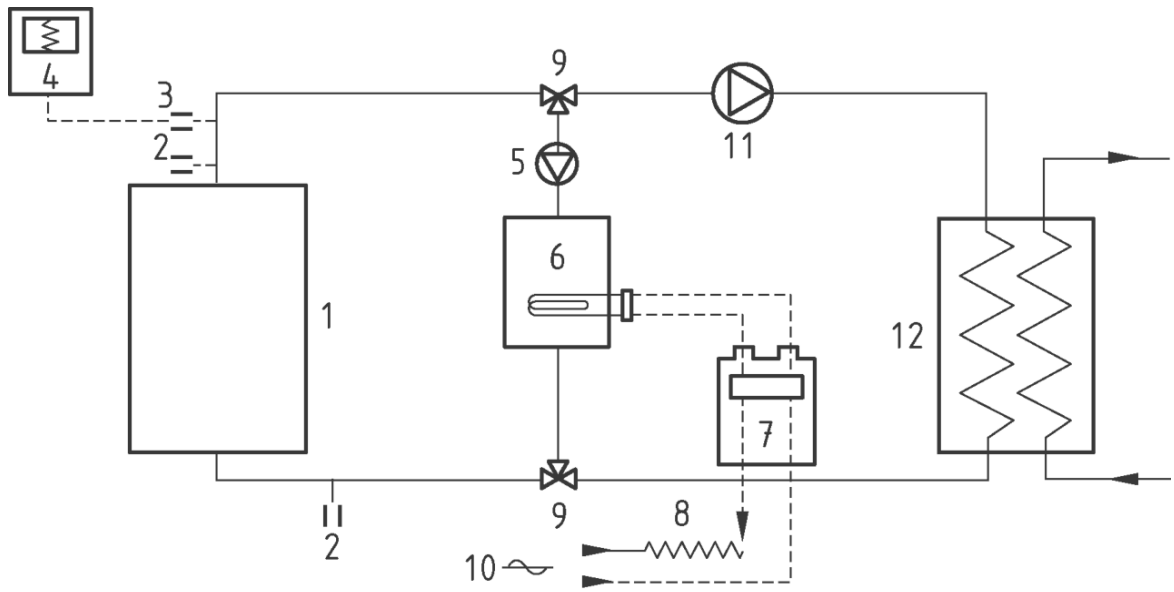
**Figure 9 — Thermocouple configuration for measuring surface temperatures on test floor**




**Keys**

| | | | |
|---|---|---|---|
| 1 | boiler under test | 14 | control valve |
| 2/17 | shut-off valve | 9/10 | shut-off valve |
| 3/18 | gas regulator | 12 | control and relief valve |
| 4 | gas meter | 13 | rotameter |
| 5/8/11/15 | thermometer | 16 | balance |
| 6 | drain tap | 19 | heat exchanger |
| 7 | expansion vessel | 20 | heat buffer |

**Figure 10 — Test rig for determination of part-load efficiency**




**Keys**

| | | | |
|---|---|---|---|
| 1 | boiler under test | 6 | auxiliary electric boiler |
| 2 | temperature probes | 7 | device for measuring the electric power |
| 3 | low inertia thermocouple | 8 | voltage regulator |
| 4 | recorder | 9 | 1/4 Turn valves |
| 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 | 10 | electrical supply |
| | | 11 | additional pump (if necessary) |
| | | 12 | cooling system on principle of exchange or mixing |

**Figure 11 — Test installation to determine the heat emissions of the boiler when the burner is off**

# Annex A
(informative)

# National situations

## A.1 General

In each country that this European Standard concerns, gas-fired boilers may only be marketed if they comply with the particular national supply conditions.

For the information of the manufacturer, and in order to determine at the time of testing the boiler which of the alternatives are applicable, the various national situations are summarized in Tables A.1.1, A.1.2, A.3 and A.4, extracted from EN 437:2003.

Gas connections, in common use in the various countries, are given in A.5.

## A.2 Categories marketed in the various countries

To determine if a gas appliance can be designed for several gas families, gas categories or gas pressures, the national supply conditions given in Tables A.1.1 and A.1.2 should be referred to.

**Table A.1.1 — Single categories marketed**

| Country code | $I_{2H}$ | $I_{2L}$ | $I_{2E}$ | $I_{2E+}$ | $I_{2N}$ | $I_{2R}$ [a] | $I_{3B/P}$ | $I_{3+}$ | $I_{3P}$ [a] | $I_{3B}$ [a] | $I_{3R}$ [a] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | X | | | | | | X | | X | | |
| BE | | | | X | X | | | X | X | X | |
| CH | X | | | | | | X | X | X | | |
| CZ | X | | | | | | X | X | X | | |
| DE | | | X | | X [a c] | X [c] | X | | X | | X |
| DK | X | | | | | | X | | | | |
| ES | X | | | | X [a] | X | | X | X | X | X |
| FI | X | | | | | | X | | | | |
| FR | X [b] | X [b] | | X | X [a] | X | X [a] | X | X | X | X |
| GB | X | | | | | X | X [d] | X | X | X | X |
| GR | X | | | | X [a] | X | X | X | X | X | X |
| IE | X | | | | | | | X | X | X | |
| IS(?) | | | | | | | | | | | |
| IT | X | | | | | | X | X | X | | X |
| LU(?) | | | X | | | | | | | | |
| NL | X [b] | X | | | | | X | | X | | |
| NO | X | | | | | X | X | | | | X |
| PT | X | | | | X [a] | X | | X | X | X | X |
| SE | X | | | | | | X | | | | |

[a] Categories applicable only to certain types of appliance, specified in the individual appliance standards.

[b] Categories applicable only to certain types of appliance, submitted to the on site EC verification procedure; [Annex II, article 6 of the Gas Appliance Directive (90/396/CEE)].

[c] See B.5 of EN 437:2003.

[d] Category applicable only to appliances installed in caravans and motor caravans.

The symbol (?) placed alongside the name of the countries means that the country concerned has not indicated its choice of category.

**Table A.1.2 — Double categories marketed**

| Country code | $II_{1a2H}$ | $II_{2H3B/P}$ | $II_{2H3+}$ | $II_{2H3P}$ [a] | $II_{2L3B/P}$ | $II_{2L3P}$ [a] | $II_{2E3B/P}$ | $II_{2E+3B/P}$ | $II_{2E+3+}$ | $II_{2E+3P}$ [a] | $II_{2R3R}$ [a] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | | X | | X | | | | | | | |
| BE | | | | | | | | | X [a] | X | |
| CH | | X | X | X | | | | | | | |
| CZ | | X | X | X | | | | | | | |
| DE | | | | | | | X | | | | X |
| DK | X | X | | | | | | | | | |
| ES | | | X [c] | X | | | | | | | X |
| FI | | X | | | | | | | | | |
| FR | | | | X [b] | | X [b] | | X [a] | X | X | X |
| GB | | | X | X | | | | | | | |
| GR | | X | X | X | | | | | | | X |
| IE | | | X | X | | | | | | | |
| IS(?) | | | | | | | | | | | |
| IT | X | X | X | X | | | | | | | |
| LU(?) | | | | | | | | | | | |
| NL | | | | | X | X | | | | | |
| NO | | X | | | | | | | | | X |
| PT | | | X | X | | | | | | | X |
| SE | X | X | | | | | | | | | |

[a] Categories applicable only to certain types of appliance, specified in the individual standards.

[b] Categories applicable only to certain types of appliance, submitted to the on site EC verification procedure; [Annex II, article 6 of the Gas Appliance Directive (90/396/EEC)].

[c] Appliances of this category set for group H gases of the second family may use air and commercial propane gas mixtures where the gross Wobbe index (at 15 °C and 1 013,25 mbar) is between 46 MJ/m$^3$ and 51,5 MJ/m$^3$, at the same supply pressure, without additional tests.

The symbol (?) placed alongside the name of the countries means that the country concerned has not indicated its choice of category.

## A.3 Special categories marketed nationally or locally

The national or local conditions of gas distribution (gas composition and supply pressures) lead to the definition of the special appliance categories that are marketed nationally or locally in certain countries. These categories for each country together with the corresponding test gases are given in EN 437.

## A.4 Gas groups distributed locally

The gas groups distributed locally, or during a transition period, are given in Table A.3.

**Table A.3 — Locally distributed gas groups**

| Country code | Gas groups | | | | |
|---|---|---|---|---|---|
| | 1b | 1c | 2Es | 2Ei | 2LL |
| DE | | | | | X |
| FR | | X | X | X | |
| SE | X | | | | |

The gas properties, gas groups, reference and limit gases and the supply pressures are given in EN 437.

## A.5 Boiler supply pressures

Table A.4 specifies the national situations concerning the supply pressures of boilers marketed in the various countries.

**Table A.4 — Normal supply pressures**

| Gas | G 110 | G 20 | G 25 | | G 20+G 25 | G 30 | | G 31 | | | G 30 + G 31 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pressure (mbar) Country code | 8 | 20 | 20 | 25 | couple 20/25 | 30 28-30 | 50 | 30 | 37 | 50 | couple 28-30/37 | couple 50/67 | couple 112/148 [b] |
| AT | | X | | | | | X | | | X | | | |
| BE | | | | | X | X | X [d] | | X | | X | | |
| CH | | X | | | | | X [b] | | X | X [b] | X | | |
| CZ | | X | | | | X | X [c] | X | X | X [d] | X | | |
| DE | | X | X | | | | X | | | X | | | |
| DK | X | X | | | | X | | X | | | | | |
| ES | | X | | | | X | | | X | X [b] | X | | |
| FI | | X | | | | X | | X | | | | | |
| FR | | | | | X | X | X [b] | | X | X [b] | X | | X |
| GB | | X [a] | | | | X | | | X | X [b] | X | | |
| GR | | X | | | | X | X | X | X | | X | | |
| IE | | X | | | | X | | | X | | X | | |
| IS(?) | | | | | | | | | | | | | |
| IT | X | X | | | | X | | X | X | | X | | |
| LU | | X | | | | | | | | | | | |
| NL | | | | X | | X | | X | | X | | | |
| NO | | X | | | | X | | X | | | | | |
| PT | | X | | | | X | | | X | | X | X | |
| SE | X | X | | | | X | | X | | | | | |

[a] For certain non-domestic appliances: 17,5 mbar.

[a] Only for certain types of non-domestic appliance.

[a] For certain types of industrial appliances.

[a] For certain types of appliances.

The symbol (?) placed alongside the name of the country means that the country concerned has not indicated its choice of category.

## A.6 Gas connections in common use in the various countries

Table A.5 shows the national situations concerning the various types of gas connections specified in 5.6.2.

**Table A.5 — Gas connections**

| | Category $I_3$ | | | | | | Other categories | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Threaded connections | | Plain connec-tions | Compres-sion joints | Other connec-tions in 5.6.2 | Flanges | Threaded connections | | Plain connec-tions | Compres-sion joints | Flanges |
| Country code | ISO 7-1 [a] | EN ISO 228-1 | EN 1057 | | | EN 1092 | ISO 7-1 [a] | EN ISO 228-1 | EN 1057 | | EN 1092 |
| AT | Yes | Yes | | Yes | Yes | | Yes | Yes | | | |
| BE | Yes | | | Yes | Yes | | Yes | | | | |
| CH | Yes | Yes | Yes | | Yes | Yes | Yes | Yes | | | |
| CZ | | | | | | | | | | | |
| DE | | | | | Yes | | Yes | | | | |
| DK | | | | | Yes | | Yes | | | | |
| ES | | Yes | Yes | | Yes | | | Yes | Yes | | |
| FI | Yes | Yes | | | Yes | | Yes | Yes | | | |
| FR | Yes | Yes | | | | | Yes | Yes | | | |
| GB | Yes | | Yes | Yes | | | Yes | | Yes | Yes | |
| GR | | | | | | | | | | | |
| IE | | | | | | | | | | | |
| IS | | | | | | | | | | | |
| IT | Yes | Yes | | | Yes | | Yes | Yes | | | |
| LU | | | | | | | | | | | |
| NL | Yes | | | | | Yes | Yes | | | | |
| NO | | | | | | | | | | | |
| PT | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| SE | | | | | | | | | | | |

[a] Tapered male threads and parallel female threads.

# Annex B
(informative)

# Special national conditions

Special national condition: National characteristic or practice that cannot be changed even over a long period, e.g. climatic conditions, electrical earthing conditions. If it affects harmonization, it forms part of the European Standard or Harmonization Document.

For the countries in which the relevant conditions apply these provisions are normative, for other countries they are informative.

**Austria**
Boilers of categories $I_{3P}$ and $II_{2H3P}$ marketed in Austria shall have successfully undergone a test for combustion with the incomplete combustion limit gas G 30 at the normal pressure of 50 mbar following adjustment of the nominal heat input with G 31 at 50 mbar.

**Belgium**
Boilers of category $I_{2E+}$, $I_{2E(R)B}$, $I_{2E(S)B}$ and $I_{2N}$ marketed in Belgium shall have successfully undergone a test for ignition, cross-lighting and flame stability with the limit gas G 231 at reduced pressure of 15 mbar.

**Germany**
Boilers of category $I_{2N}$ and $I_{2R}$ shall have successfully undergone a test with the flame lift limit G 271 at a pressure of 25 mbar.

**Italy**
Boilers of categories $I_{3B/P}$, $II_{2H3B/P}$ and $III_{1a2H3B/P}$ without pressure regulators marketed in Italy shall have successfully undergone a test for flame stability with the limit gas G 31 at a pressure of 45 mbar.

**All countries**
Boilers of categories $I_{2R}$, $I_{3R}$ and $II_{2R3R}$ shall be marked according to the national choices for the reference gas and the nominal pressure related to the country of destination as indicated in the tables B. 6, B. 7 and B. 8 of EN 437:2003.

# Annex C
(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 compying 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 Ordinance on Air Pollution Control (Luftreinhalte-Verordnung, LRV) of 1985-12-16 (state on 2004-08-03) is applicable instead of the requirements of 6.6 and 6.7 regarding energy efficiency (flue-gas heat loss or indirect efficiency, stand-by loss) and emissions of CO and $NO_x$.

# Annex D
(informative)

# Practical method of calibrating the test rig to enable the heat loss *D*p to be determined

Substitute for the boiler (see Figure 1) a well-insulated water container of small volume (about 250 ml) containing an electric immersion heater. Fill the circulating system and start the pump running at its normal setting. The immersion heater should be connected to mains supply via a continuously variable transformer and a Watt-hour meter. Adjust the transformer so that the temperature of the circulating water reaches equilibrium (this may take 4 h 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 E
(informative)

# Main symbols and abbreviations used within this European Standard

Table E.1 shows the main symbols and abbreviations used within this European Standard.

**Table E.1 — Symbols and abbreviations**

| | | |
|---|---|---|
| Net calorific value | | $H_i$ |
| Gross calorific value | | $H_s$ |
| Density | | $d$ |
| Wobbe index | net | $W_i$ |
| | gross | $W_s$ |
| Normal pressure | | $p_n$ |
| Minimum pressure | | $p_{min}$ |
| Maximum pressure | | $p_{max}$ |
| Maximum water pressure | | PMS |
| Volumetric rate under test conditions | | $V$ |
| Volumetric rate under reference conditions | | $V_r$ |
| Mass rate under test conditions | | $M$ |
| Mass rate under reference conditions | | $M_r$ |
| Heat input | | $Q$ |
| Nominal heat input | | $Q_n$ |
| Ignition rate | | $Q_{ign}$ |
| Air rate | | $Q_{AIR}$ |
| Air rate at nominal heat input | | $Q_{n\ AIR}$ |
| Useful output | | $P$ |
| Nominal output | | $P_n$ |
| Useful efficiency | | $\eta_u$ |
| Ignition opening time | | $T_{IA}$ |
| Ignition safety time | | $T_{SA}$ |
| Maximum ignition safety time | | $T_{SA,max}$ |
| Extinction delay time | | $T_{IE}$ |
| Extinction safety time | | $T_{SE}$ |

# Annex F
(informative)

# Compilations of test conditions used within this European Standard

Tables F.1, F.2 and F.3 show the compilations of test conditions used within this European Standard.

**Table F.1 — First family**

| **Test** | | **Test gas** | **Pressure/heat input** [a] | **Clause ref.** |
|---|---|---|---|---|
| Initial adjustment with reference gas | | G 110 | $p_n$ | **7.3.1** & **7.3.2** |
| Ignition, cross-lighting with reference gas | | G 110 | 0,7 $p_n$ | **7.4.2.2** test 1 |
| Light-back with limit gas | | G 112 | $p_{min}$ | **7.4.2.2** test 2 |
| Flame lift with limit gas | | G 110 | $p_{min}$ | **7.4.2.2** test 3 |
| | | G 110 | $p_{max}$ | **7.4.2.2** test 4 |
| Combustion | | G 110 | 1,07 $Q$ | **7.6.1.2 (a)** |
| | Nominal voltage | G 110 | 1,05 $Q$ | **7.6.1.2 (b)** |
| | | G 110 | 0,95 $Q$ | **7.6.1.4** |
| | Wind conditions | G 110 | $Q$ | **7.6.1.3.1** |
| | 0,85 to 1,10 times the nominal voltage | G 110 | $p_n$ | **7.6.1.3.2** |

[a] $Q$ is either the nominal heat input or the minimum heat input achieved by adjustment or by normal operation of the control, as appropriate.

NOTE Some of the above tests can be carried out using distributed gases but may have different pressure/heat inputs. Refer to the relevant clauses of the main text for details.

**Table F.2 — Second family**

| Test | | Test gas groups | | | Pressure/heat input [a] | | Clause Ref. |
|---|---|---|---|---|---|---|---|
| | | E | H | L | Without governor [b] | With governor | |
| Initial adjustment with reference gas | | G 20 | G 20 | G 25 | $p_n$ | $p_n$ | 7.3.1 & 7.3.2 |
| Ignition, cross-lighting with reference gas | | G 20 | G 20 | G 25 | 0,7 $p_n$ | 0,7 $p_n$ | 7.4.2.2 test 1 |
| Light-back with limit gas | | G 222 | G 222 | G 25 | $p_{min}$ | $p_{min}$ | 7.4.2.2 test 2 |
| Flame lift with limit gas | | G 231 | G 23 | G 27 | $p_{min}$<br>$p_{max}$ | $p_{min}$<br>$p_{max}$ | 7.4.2.2 test 3<br>7.4.2.2 test 4 |
| Combustion | Nominal voltage | G 20 | G 20 | G 25 | 1,10 $Q$ [c] | 1,05 $Q$ | 7.6.1.2 (a) |
| | | G 21 | G 21 | G 26 | 1,075 $Q$ [d] | 1,05 $Q$ | 7.6.1.2 (b) |
| | | G 231 | G 23 | G 27 | $p_{min}$ [e] | 0,95 $Q$ | 7.6.1.4 |
| | Wind conditions | G 20 | G 20 | G 25 | $Q$ | $Q$ | 7.6.1.3.1 |
| | 0,85 to 1,10 times the nominal voltage | G 20 | G 20 | G 25 | $p_n$ | $p_n$ | 7.6.1.3.2 |

[a] $Q$ is either the nominal heat input or the minimum heat input achieved by adjustment or by normal operation of the control, as appropriate.

[b] Or with gas/air ratio controls.

[c] $p_{max}$ for gas/air ratio controls.

[d] 1,05 $Q$ if the boiler is intended to be installed exclusively with a governed meter or $Q_{max}$ for gas/air ratio controls.

[e] $Q_{min}$ for gas/air ratio controls.

NOTE Some of the above tests can be carried out using distributed gases but may have different pressure/heat inputs. Refer to the relevant clauses of the main text for details.

**Table F.3 — Third family**

| Test | | Test gas groups | | Pressure/heat input [a] | | Clause ref. |
|---|---|---|---|---|---|---|
| | | Butane/ Propane | Propane | Without governor [b] | With governor | |
| Initial adjustment with reference gas | | G 30 | G 31 | $p_n$ | $p_n$ | 7.3.1 & 7.3.2 |
| Ignition, cross-lighting with reference gas | | G 30 | G 31 | 0,7 $p_n$ | 0,7 $p_n$ | 7.4.2.2 test 1 |
| Light-back with limit gas | | G 32 | G 32 | $p_{min}$ | $p_{min}$ | 7.4.2.2 test 2 |
| Flame lift with limit gas | | G 31 | G 31 | $p_{min}$<br>$p_{max}$ | $p_{min}$<br>$p_{max}$ | 7.4.2.2 test 3<br>7.4.2.2 test 4 |
| Combustion | Nominal voltage | G 30 | G 31 | 1,10 $Q$ [c] | 1,05 $Q$ | 7.6.1.2 (a) |
| | | G 30 | G 31 | 1,075 $Q$ [d] | 1,05 $Q$ | 7.6.1.2 (b) |
| | | G 31 | G 31 | $p_{min}$ [e] | 0,95 $Q$ | 7.6.1.4 |
| | Wind conditions | G 30 | G 31 | $Q$ | $Q$ | 7.6.1.3.1 |
| | 0,85 to 1,10 times the nominal voltage | G 30 | G 31 | $p_n$ | $p_n$ | 7.6.1.3.2 |

[a] $Q$ is either the nominal heat input or the minimum heat input achieved by adjustment or by normal operation of the control, as appropriate.

[b] Or with gas/air ratio controls.

[c] $p_{max}$ for gas/air ratio controls.

[d] 1,05 $Q$ if the boiler is intended to be installed exclusively with a governed meter or $Q_{max}$ for gas/air ratio controls.

[e] $Q_{min}$ for gas/air ratio controls.

NOTE Some of the above tests can be carried out using distributed gases but may have different pressure/heat inputs. Refer to the relevant clauses of the main text for details.

# Annex G
(informative)

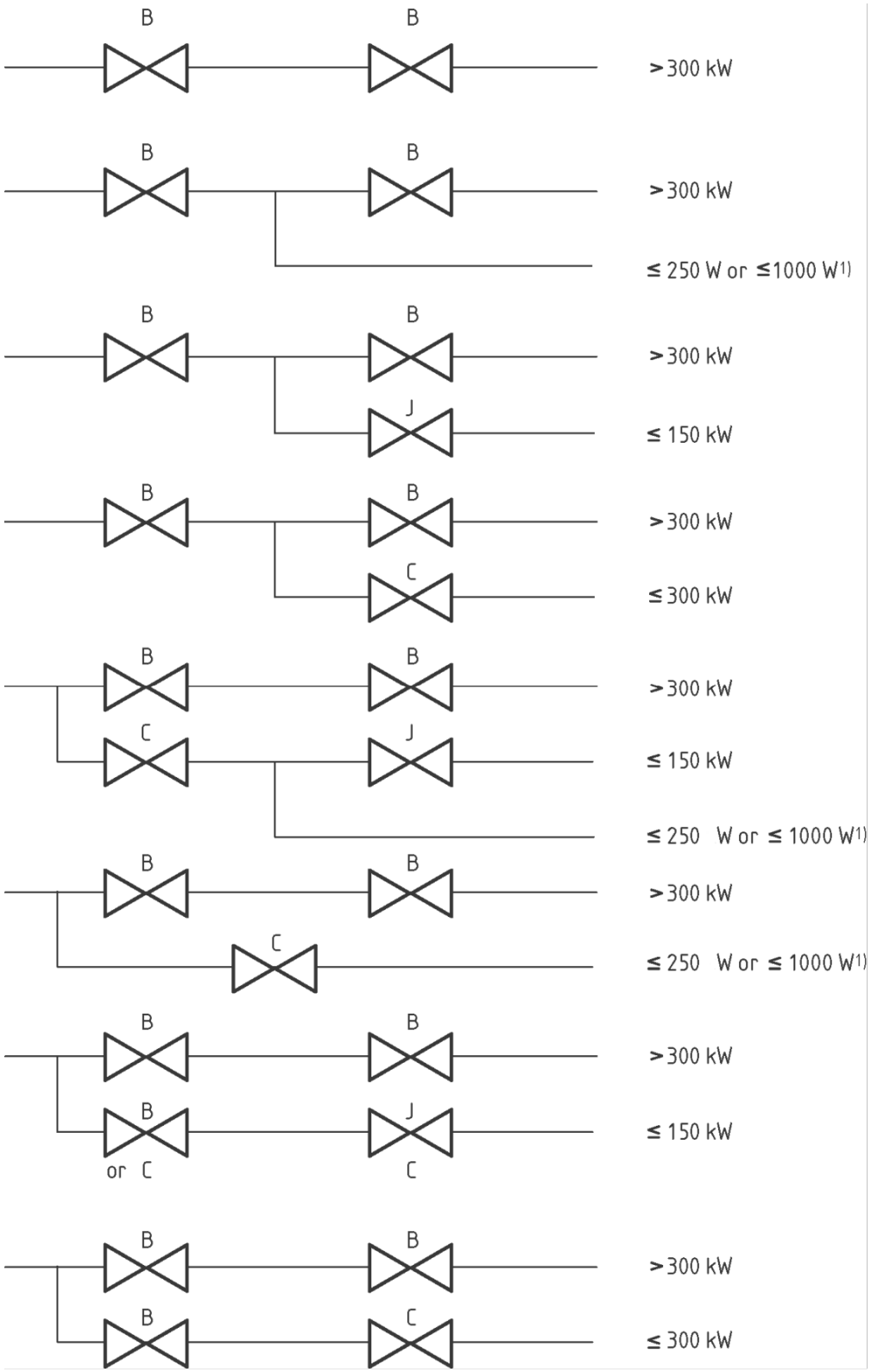
# Valving

## G.1 General

For valve arrangements on boilers with automatic ignition which have ignition burner heat inputs between 250 W and 1 000 W, the second paragraph of 6.5.3.3.1 is applicable.

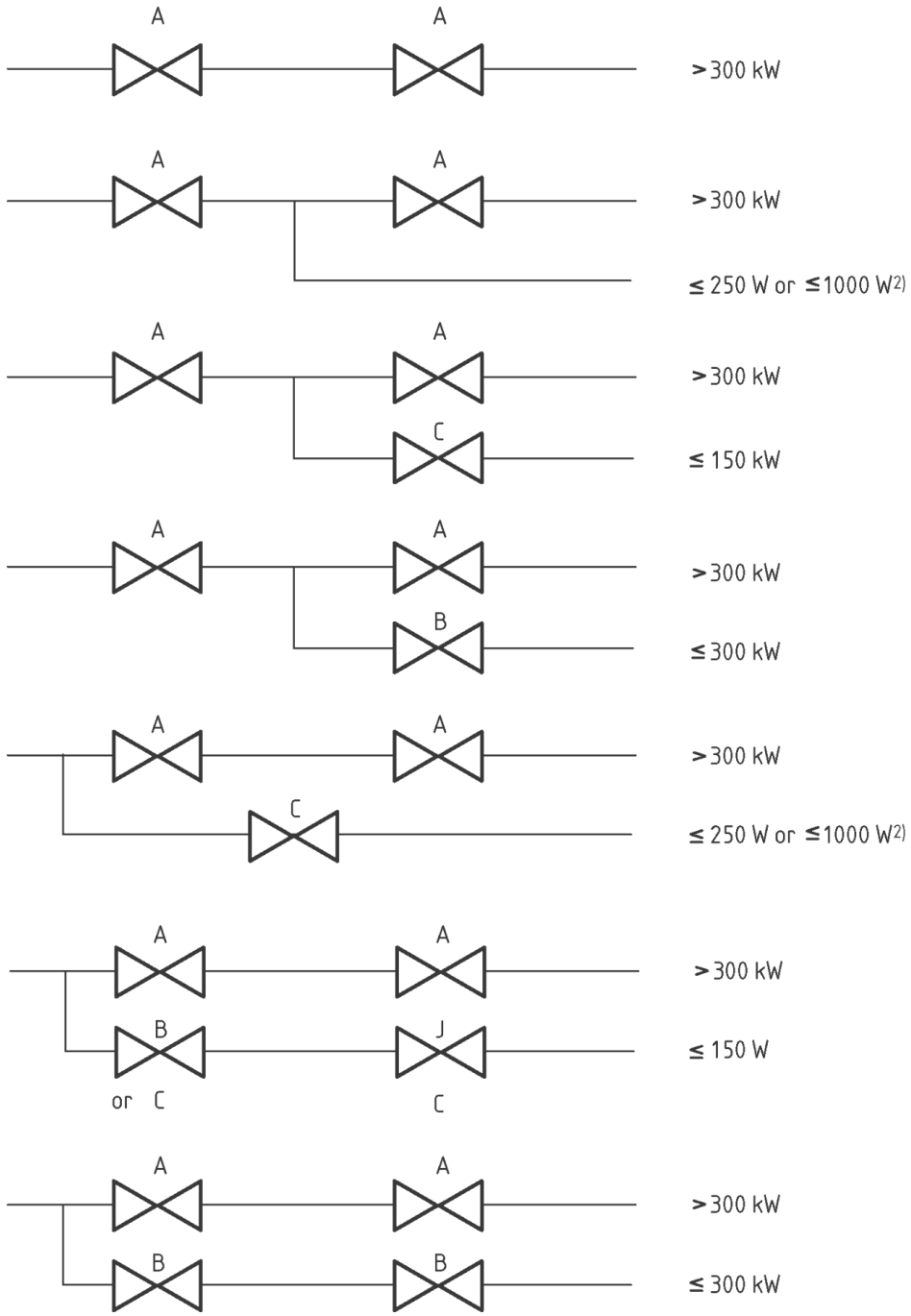
## G.2 Heat Inputs exceeding 300 kW but not exceeding 1 000 kW

### G.2.1 Boilers with permanent ignition burner or alternating ignition burner or leakage control device or with pre-purge




1) See special conditions in paragraph 2 of 6.5.3.3.1 if the ≤ 1 000 W value is to apply.

### G.2.2 Boilers without permanent ignition burner or alternating ignition burner, without a leakage control device and without pre-purge




2) See special conditions in paragraph 2 of 6.5.3.3.1 if the ≤ 1000 W value is to apply.

# Annex H
(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

The boiler is fitted to the test rig in Figure 13 and the flow and return pipes are connected directly.

The 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:

— without electrical contribution from the boiler (6);

— with an electrical contribution from the boiler (6), so as to obtain a value of($T$ - $T_A$) of (40 ± 5) K;

— with an electrical contribution from the boiler (6), so as to obtain a value of($T$ - $T_A$) of (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.

The 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 I
(informative)

# Means of determining the ignition time at full rate

The boiler is installed as indicated in Figure 11. The water circuit consists of an insulated circuit incorporating a reservoir.

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

The gas circuit is fitted with a gas rate meter or a manometer $p_1$ measuring the pressure upstream of the injector.

The initial water temperature being (47 ± 1) °C, 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:

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

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

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

where:

$Q_n$ is the heat input corresponding to the full rate, in kW;

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

$p_n$ is the pressure corresponding to the full rate, in mbar;

$p_{red}$ is the pressure corresponding to the reduced rate, in mbar.

# Annex J
(informative)

# Example of calculation of the weighting factors for a boiler with several rates

Rates of the boiler:

— 100 %

— 50 %

— 30 %.

**Table J.1**

| $Q_{pi}$ | 70 | 60 | 40 | 20 |
|---|---|---|---|---|
| $F_{pi}$ | 0,15 | 0,25 | 0,3 | 0,3 |

## J.1 Apportioning of $Q_{pi}$ = 20 %

$Q_{min}$ is 30 %, which is larger than 20 %, so the $F_{pi}$ of 20 % is added to the $F_{pi}$ of 30 %:

$F_{pi}(30\ \%) = 0,3$

## J.2 Apportioning of $Q_{pi}$ = 40 %

$Q_{pi}$ = 40 % has to be apportioned between $Q_{pi}$ = 30 % (low rate) and $Q_{pi}$ = 50 % (high rate):

— high rate:

$$F_{pi}(50\%) = F_{pi}(40\%) \times \frac{Q(40\%) - Q(30\%)}{Q(50\%) - Q(30\%)} \times \frac{Q(50\%)}{Q(40\%)} \Leftrightarrow$$

$$F_{pi}(50\%) = 0,3 \times \frac{40 - 30}{50 - 30} \times \frac{50}{40} = 0,1875$$

— low rate:

$F_{pi}(30\ \%) = F_{pi}(40\ \%) - F_{pi}(50\ \%) = 0,3 - 0,187\ 5 = 0,112\ 5$

## J.3 Apportioning of $Q_{pi}$ = 60 %

$Q_{pi}$ = 60 % has to be apportioned between $Q_{pi}$ = 50 % (low rate) and $Q_{pi}$ = 100 % (high rate):

— high rate:

$$F_{pi}(100\%) = F_{pi}(60\%) \times \frac{Q(60\,\%) - Q(50\,\%)}{Q(100\,\%) - Q(50\,\%)} \times \frac{Q(100\,\%)}{Q(60\,\%)} \Leftrightarrow$$

$$F_{pi}(100\,\%) = 0{,}25 \times \frac{60 - 50}{100 - 50} \times \frac{100}{60} = 0{,}0833$$

— low rate:

$F_{pi}(50\,\%) = F_{pi}(60\,\%) - F_{pi}(100\,\%) = 0{,}25 - 0{,}083\,3 = 0{,}166\,7$

## J.4 Apportioning of $Q_{pi}$ = 70 %.

$Q_{pi}$ = 70 % has to be apportioned between $Q_{pi}$ = 50 % (low rate) and $Q_{pi}$ = 100 % (high rate):

— high rate:

$$F_{pi}(100\%) = F_{pi}(70\,\%) \times \frac{Q(70\,\%) - Q(50\,\%)}{Q(100\,\%) - Q(50\,\%)} \times \frac{Q(100\,\%)}{Q(70\,\%)} \Leftrightarrow$$

$$F_{pi}(100\,\%) = 0{,}15 \times \frac{70 - 50}{100 - 50} \times \frac{100}{70} = 0{,}0857$$

— low rate:

$F_{pi}(50\,\%) = F_{pi}(70\,\%) - F_{pi}(100\,\%) = 0{,}15 - 0{,}085\,7 = 0{,}064\,3$

## J.5 Total apportioning

**Table J.2**

| Rate | 20 % | 40 % | 60 % | 70 % | Total |
|---|---|---|---|---|---|
| 30 %: | 0,30 + | 0,1125 | | | = 0,412 5 |
| 50 %: | | 0,187 5 + | 0,166 7 + | 0,064 3 | = 0,418 5 |
| 100 %: | | | 0,083 3 + | 0,085 7 | = 0,169 0 |
| Total: | 0,30 + | 0,30 + | 0,25 + | 0,15 | = 1 |

The weighting formula is:

$$NO_{x,pond} = 0{,}4125 \cdot NO_{x,mes(30\,\%)} + 0{,}4185 \cdot NO_{x,mes(50\,\%)} + 0{,}169 \cdot NO_{x,mes(100\,\%)}$$

# Annex K
(informative)

# Calculation of conversions of $NO_x$

Tables K.1, K.2 and K.3 show the calculation of conversions of $NO_x$.

**Table K.1 — Conversion of the emission value of $NO_x$ for first family gases**

| **1 ppm = 2,054 mg/m³** | | **G 110** | |
|---|---|---|---|
| **(1 ppm = 1 cm³/m³)** | | mg/kWh | mg/MJ |
| $O_2$ = 0 % | 1 ppm = | 1,714 | 0,476 |
| | 1 mg/m³ = | 0,834 | 0,232 |
| $O_2$ = 3 % | 1 ppm = | 2,000 | 0,556 |
| | 1 mg/m³ = | 0,974 | 0,270 |

**Table K.2 — Conversion of the emission value of $NO_x$ for second family gases**

| **1 ppm = 2,054 mg/m³** | | **G 20** | | **G 25** | |
|---|---|---|---|---|---|
| **(1 ppm = 1 cm³/m³)** | | mg/kWh | mg/MJ | mg/kWh | mg/MJ |
| O2 = 0 % | 1 ppm = | 1,764 | 0,490 | 1,797 | 0,499 |
| | 1 mg/m³ = | 0,859 | 0,239 | 0,875 | 0,243 |
| O2 = 3 % | 1 ppm = | 2,059 | 0,572 | 2,098 | 0,583 |
| | 1 mg/m³ = | 1,002 | 0,278 | 1,021 | 0,284 |

**Table K.3 — Conversion of the emission value of $NO_x$ for third family gases**

| **1 ppm = 2,054 mg/m³** | | **G 30** | | **G 31** | |
|---|---|---|---|---|---|
| **(1 ppm = 1 cm³/m³)** | | mg/kWh | mg/MJ | mg/kWh | mg/MJ |
| $O_2$ = 0 % | 1 ppm = | 1,792 | 0,498 | 1,778 | 0,494 |
| | 1 mg/m³ = | 0,872 | 0,242 | 0,866 | 0,240 |
| $O_2$ = 3 % | 1 ppm = | 2,091 | 0,581 | 2,075 | 0,576 |
| | 1 mg/m³ = | 1,018 | 0,283 | 1,010 | 0,281 |

# Annex L
(informative)

# Use of test gases

## L.1 Boilers within a range

For boilers within the scope of this European Standard which form part of a range of boilers, the input of which extends below 300 kW, the following procedure may be adopted:

The results of tests carried out on boilers within the range, with inputs less than or equal to 300 kW can be assumed to be valid for the boilers in the range that have inputs in excess of 300 kW, provided that:

— the burner is similar in design and construction;

— the burner flame port loading at maximum nominal input is within ± 5 % of that of the tested boiler(s) with input(s) equal to or less than 300 kW;

— the combustion performance (% $CO_2$ and % CO) is within ± 5 % of that of the tested boiler(s) with input(s) equal to or less than 300 kW, when using the reference or distributed gas at maximum nominal input.

## L.2 Guidance on the use of test gases

Tests using only the reference or distributed gas can be carried out as follows:

— the maximum nominal burner input pressure is adjusted to increase the gas rate by 9 %. Under this condition, the flame stability is observed and the carbon monoxide concentration in the flue gas is measured. The flame should be stable and the CO concentration should not exceed 0,20 % under this condition. Under the same input conditions, it is checked that no hazard occurs during ignition;

— the maximum nominal burner input pressure is reduced to decrease the gas rate by 9 %. Ignition and cross lighting are checked to ensure that no hazard exists. It is checked that flames do not issue out of the combustion chamber and that there is no light back at the burner injector(s).

# Annex ZA
(informative)

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

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of EU Directive 90/396/EEC “Approximation of the laws of Member States concerning gas appliances” and EU Directive 92/42/EEC “Efficiency requirements for new hot water boilers fired with liquid or gaseous fuels”.

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

The following clauses of this European Standard are likely to support requirements of the EU Directive 90/396/EEC “Approximation of the laws of Member States concerning gas appliances” and 92/42/EEC “Efficiency requirements for new hot water boiler fired with liquid or gaseous fuels”.

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

**Table ZA.1 — Identification form on the compliance of EN 13836 with the essential requirements of the EU Directive 90/396/EEC on the approximation of the laws of Member States concerning gas appliances**

| Essential requirement | Object | Clauses in the standard |
|---|---|---|
| 1 | ANNEX 1 OF THE DIRECTIVE<br>GENERAL CONDITIONS | |
| 1.1 | Safe design and construction | 1, 5, 6 |
| 1.2 | Marking and instructions<br>Installation instructions<br>User's instructions<br>Warnings on the appliance<br>on the packaging<br>Official language | 8<br>8.2.1<br>8.2.2<br>8.1.5<br>8.1.4, 8.1.5<br>8.2.4 |
| 1.2.1 | Information in the installation instructions<br>Gas type<br>Gas supply pressure<br>Combustion air rate<br>Danger unburned gas<br>Discharge of combustion products | <br>8.2.1<br>8.2.1<br>8.2.1<br>Not applicable<br>8.2.1 |
| 1.2.2 | Contents of the user's instructions | 8.2.2 |
| 1.2.3 | Warnings on the appliance and on the packaging | 8.1.4, 8.1.5 |
| 1.3 | Equipment | Not applicable |

| Essential requirement | Object | Clauses in the standard |
|---|---|---|
| 2 | Materials | |
| 2.1 | Characteristics | 5.3.1, 5.3.2 |
| 2.2 | Guarantee | Foreword, 1 |
| 3 | Design and construction | |
| 3.1 | General | |
| 3.1.1 | Resistance to constraints (safety of construction) | 5.3 |
| 3.1.2 | Condensation | 5.4.1 |
| 3.1.3 | Risk of explosion | 5.7.1 |
| 3.1.4 | Water/air penetration | 5.7.1 |
| 3.1.5 | Normal fluctuation of auxiliary energy | 5.12, 5.13.1, 5.4, 6.5.1 |
| 3.1.6 | Abnormal fluctuation of auxiliary energy | 5.12, 5.13.1, 6.5.1 |
| 3.1.7 | Hazards of electrical origin | 5.11 |
| 3.1.8 | Pressurised parts | 6.9, 6.10 |
| 3.1.9 | Failure of the safety devices | |
| | — flame supervision device | 5.13.6 |
| | — automatic burner control system | 5.13.6.3 |
| | — thermostat/overheat protection | 5.13.7.1, 5. 13.7.4, 8.2.1 |
| | — gas circuit | 5.13.3.3, 6.4.2.3.4 |
| | — air proving ($B_2$) | 5.8.3, 5.13.8, 6.5.5, 6.5.8 |
| | — automatic shut-off valves | 5.13.1, 5.13.3 |
| | — regulators | 5.13.4 |
| 3.1.10 | Safety, adjustment | 5.13.1 |
| 3.1.11 | Protection of parts set by the manufacturer | 5.13.2.1 |
| 3.1.12 | Clear marking of taps | 5.13.3.2 |
| 3.2 | Unburnt gas release | |
| 3.2.1 | Risk of leakage | 5.7.1, 6.2.1 |
| 3.2.2 | Risk of gas accumulation in the appliance | |
| | — Ignition | 5.13.5.1, 5.13.5.4, 6.5.2, 6.5.4.1, 6.5.3.2.1, 6.5.3.3.1 |

| Essential requirement | Object | Clauses in the standard |
|---|---|---|
| | — Re-ignition | 5.13.6.3, 6.5.3.4.1 |
| | — Flame extinction | 5.13.6.2, 6.5.3.2.2, 6.5.3.3.2 |
| 3.2.3 | Risk of gas accumulation in rooms | 5.13.6.1 |
| | Rooms with sufficient ventilation | Not applicable |
| 3.3 | Ignition | |
| | — Ignition and re-ignition | 6.4.2.1 |
| | — Cross-lighting | 6.4.2.1 |
| 3.4.1 | Flame stability | 6.4.2 |
| | Unacceptable concentrations harmful to health | 6.6.1 |
| 3.4.2 | No accidental release of combustion products | 5.7.2, 6.2.2 |
| | Release of combustion products into the room | Foreword, 6.5.5 |
| 3.4.3 | or appliances connected to a flue under abnormal draught conditions | 8.1.5, 8.2.1 |
| 3.4.4 | CO concentration | Not applicable |
| 3.5 | Rational use of energy | 6.7, 7.7<br>see Table ZA.2 |
| 3.6 | Temperatures | |
| 3.6.1 | Floor and adjacent walls | 6.4.1.3, 6.4.1.4 |
| 3.6.2 | Knobs | 6.4.1.2 |
| 3.6.3 | Temperatures of external surfaces | 6.4.1.3 |
| 3.7 | Sanitary water | Not applicable |
| | ANNEX II | Foreword, 1 |
| | ANNEX III<br>CE-marking<br>Appliance or its data plate<br>— CE marking<br>— manufacturer's name or identification symbol<br>— trade name<br>— electrical supply<br>— appliance category<br>— installation information | 8.1.2 |

**Table ZA.2 — Identification form on the compliance of EN 13836 with the essential requirements of the EU Directive 92/42/EEC on Efficiency requirements for new hot water boilers fired with liquid or gaseous fuels**

| Relevant articles of the Directive | Object | Clauses in the standard |
|---|---|---|
| 1 | Field of application | 1 |
| 2 | Definitions | 3 |
| 3 | Exclusions | 1 |
| 5.1 | Efficiency requirements | 6.7.1, 6.7.2 |
| 5.2 | Verification methods | 7.7.1, 7.7.2 |

# Bibliography

[1] EN 303-7, *Heating boilers — Part 7: Gas-fired central heating boilers equipped with a forced draught burner of nominal heat output not exceeding 1000 kW*

[2] EN 676, *Automatic forced draught burners for gaseous fuels*

[3] EN ISO 4063, *Welding and allied processes — Nomenclature of processes and reference numbers (ISO 4063:1998)*

[4] CR 1404, *Determination of emissions from appliances burning gaseous fuels during type testing*

[5] CR 1472, *General guidance for the marking of gas appliances*

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

[7] ISO 857-1, *Welding and allied processes — Vocabulary — Part 1: Metal welding process*

[8] EN 22553, *Welded, brazed and soldered joints — Symbolic representation on drawings (ISO 2553:1992)*

[9] EN 15417, *Gas-fired central heating boilers – Specific requirements for condensing boilers with a nominal heat input greater than 70 kW but not exceeding 1000 kW*

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