BS EN 15420:2010

BSI Standards Publication

Gas-fired central heating boilers — Type C boilers of nominal heat input exceeding 70 kW, but not exceeding 1 000 kW

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National foreword

This British Standard is the UK implementation of EN 15420:2010.

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 this committee can be obtained on request to its secretary.

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

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Gas-fired central heating boilers - Type C boilers of nominal heat input exceeding 70 kW, but not exceeding 1 000 kW

Chaudières de chauffage central utilisant les combustibles gazeux - Chaudières de type C dont le débit calorifique nominal est supérieur à 70 kW mais inférieur ou égal à 1 000 kW

Heizkessel für gasförmige Brennstoffe - Heizkessel der Bauart C mit einer Nennwärmebelastung größer als 70 kW aber gleich oder kleiner als 1 000 kW

This European Standard was approved by CEN on 23 October 2010.

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Foreword

This document (EN 15420:2010) 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of an identical text or by endorsement, at the latest by June 2011, and conflicting national standards shall be withdrawn at the latest by June 2011.

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

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 document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directives 90/396/EEC and 92/42/EEC.

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 standard.

This standard covers only type testing.

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

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 O 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, Bulgaria, Croatia, 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 document 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 document applies to boilers of type C, as listed in 4.2:

— that use one or more combustible gases of the three gas families at the pressures stated in Tables 14 and 15;

— that have a nominal heat input (on the basis of net calorific value) exceeding 70 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;

— which can give rise to condensation under certain circumstances.

The document applies to boilers designed for sealed water systems or for open water systems.

The document 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;

— of the condensing type;

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

— type C21, C41, C51, C61, C7 and C81 boilers;

— fitted with a forced draught burner in accordance with EN 676;

— producing hot water for domestic purposes.

This document only covers type testing.

2 Normative references

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

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

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

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

EN 483, *Gas-fired central heating boilers — Type C boilers of nominal heat input not exceeding 70 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 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 60335-1:1992, *Safety of household and similar electrical appliances — Part 1: General requirements (IEC 60335-1:2001, modified)*

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

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 3166-1:2006)*

EN ISO 4063, *Welding and allied processes — Nomenclature of processes and reference numbers (ISO 4063:2009)*

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

ISO 857, *Welding, brazing and soldering processes — Vocabulary — Bilingual edition*

ISO 2553, *Welded, brazed and soldered joints — Symbolic representation on drawings*

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

CR 1472, *General guidance for the marking of gas appliances*

3 Terms and definitions

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

3.1 Combustible gases

3.1.1
test gases
gases that are intended for the verification of the operational characteristics of appliances using combustible gases and that consist of reference gases and limit gases

3.1.2
reference gases
test gases with which appliances operate under nominal conditions, when they are supplied at the corresponding normal pressure

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
reference conditions
conditions corresponding to 15 °C 1 013,25 mbar, unless otherwise specified

3.1.5
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

3.1.6
calorific value
quantity of heat produced by the complete combustion, at a constant pressure equal to 1 013,25 mbar, of a 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

NOTE A distinction is made between:

a) The gross calorific value: the water produced by combustion is assumed to be condensed

Symbol: H_s

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

Symbol: H_i

c) Unit:

1) 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.

3.1.7
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, that is said to be gross or net according to whether the calorific value used is the gross or net calorific value

Symbols: gross Wobbe index: W_s

net Wobbe index: W_i

NOTE 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.

3.1.8
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)

3.1.9
test pressures
gas pressures used to verify the operational characteristics of appliances using combustible gases and consisting of normal and limit pressures

[EN 437:2003, 3.5]

3.1.10
normal pressure
pressure under which the appliances operate in nominal conditions when they are supplied with the corresponding reference gas

Symbol: p_n

3.1.11
limit pressures
pressures representative of the extreme variations in the appliance supply conditions

Symbols: maximum pressure: p_{max}

minimum pressure: p_{min}

3.1.12
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:

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

— the lower pressure corresponds to gases of high Wobbe index

3.2 Constituent parts of the boiler

3.2.1 Gas supply

3.2.1.1
gas inlet connection
part of the boiler intended to be connected to the gas supply

3.2.1.2
gas circuit
assembly of parts of the boiler that carry or contain the combustible gas between the boiler gas inlet connection and the point at which air is admitted

3.2.1.3
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

3.2.1.4
injector
component that admits gas into the burner

3.2.1.5
gas rate adjuster
component allowing the gas rate of the burner to be brought to a predetermined value according to the supply conditions

NOTE The action of operating this component is called "adjustment of the gas rate".

3.2.1.6
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

3.2.1.7
primary aeration adjuster
device enabling the primary aeration of a burner to be set to the desired value according to the supply conditions

3.2.1.8
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)

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

3.2.1.9
putting an adjuster or a control out of service
action intended to put an adjuster or control (rate, pressure, etc.) out of service

3.2.1.10 Burners

3.2.1.10.1
main burner
burner that is intended to assure the thermal function of the boiler and is generally called "the burner"

3.2.1.10.2
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

3.2.1.10.3
ignition device
means (flame, electrical ignition device or other device) used to ignite the gas at the ignition burner or at the main burner

3.2.1.10.4
manual ignition device
device by means of which the burner is ignited following manual intervention

3.2.1.10.5
automatic ignition device
automatic device which ignites the ignition burner or the main burner directly

3.2.1.10.6
ignition burner
burner intended to ignite a main burner

3.2.1.10.7
permanent ignition burner
ignition burner that operates continuously throughout the whole period that the boiler is in use

3.2.1.10.8
intermittent ignition burner
ignition burner that is ignited before and extinguished at the same time as the main burner

3.2.1.10.9
alternating ignition burner
ignition burner which is extinguished as soon as ignition of the main burner is effected, and which re-ignites at the main burner flame just before the latter goes out

3.2.1.10.10
interrupted ignition burner
ignition burner which operates only during the ignition sequence

3.2.2 Air supply and combustion products evacuation

3.2.2.1
combustion circuit
circuit including the air supply duct, the combustion chamber, the heat exchanger, the combustion products evacuation duct and either the fitting piece or the connection to the terminal, if any

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

3.2.2.4
flue outlet
part of the boiler through which the combustion products are evacuated to the flue system

3.2.2.5
air supply and combustion products evacuation ducts
means for transporting combustion air to the burner and combustion products to the terminal or fitting piece

NOTE It is necessary to distinguish between:

— completely surrounded ducts: the combustion products evacuation duct is surrounded by combustion air throughout its length;

— separate ducts: the combustion products evacuation duct and the combustion air supply duct are neither concentric nor completely surrounded ducts.

3.2.2.6
terminal
device fitted to the outside of the building, to which are connected:

— the air supply and combustion products evacuation ducts for type C1 and C3 boilers (one or two devices);

— the air supply duct on the one hand and the combustion products evacuation duct on the other hand for type C5 boilers (two devices);

— the air supply duct for type C8 boilers (one device)

3.2.2.7
terminal guard
device that protects the terminal from mechanical damage from outside influences

3.2.2.8
fitting piece
device which allows the fitting of:

— the air supply and combustion products evacuation ducts to a single shared duct for type C2 boilers;

— the air supply and combustion products evacuation ducts to two ducts of a shared duct system for type C4 boilers;

— type C6 boilers to a system for air supply and combustion products evacuation that is approved and marketed independently from the boiler;

— the combustion products evacuation duct to a chimney that is part of the building for type C8 boilers

NOTE The fitting piece may be part of the boiler or of the air supply and/or combustion products evacuation system.

3.2.2.9
damper
device placed in the air inlet duct or the flue products outlet duct to control the volume flow

3.2.3 Adjusting, control and safety devices

3.2.3.1
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

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

NOTE This means is considered as an "adjusting device".

3.2.3.3
volume governor
device which maintains a rate between fixed limits, independent of upstream and downstream pressures, within a range of given values

3.2.3.4
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

3.2.3.5
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

3.2.3.6
control thermostat
device enabling the water temperature to be kept automatically, within a given range, at a predetermined value

3.2.3.7
adjustable control thermostat
control thermostat that permits the operator to obtain setting temperatures between a minimum and a maximum value

3.2.3.8
safety temperature limiter
device that causes safety shutdown and non-volatile lockout so as to prevent the water temperature exceeding a preset limit

3.2.3.9
temperature sensing element
sensor
component that detects the temperature of the environment to be supervised or controlled

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3.2.3.10
control knob
component intended to be moved by hand in order to act on a boiler control (tap, thermostat, etc.)

3.2.3.11
flame detector
device which detects and signals the presence of a flame and which 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.

3.2.3.12
flame signal
signal given by the flame detector, normally when its sensor senses a flame

3.2.3.13
flame simulation
condition which occurs when a flame signal is given by the flame detector although in reality there is no flame

3.2.3.14
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, and that follows a predetermined sequence of actions and operates in conjunction with the flame detector

3.2.3.15
automatic burner control system
system that comprises a programming unit and all the elements of a flame detector, and all the functions of which may be assembled in one or more housings

3.2.3.16
start signal
signal causing the boiler to leave its start position and the predetermined programme of the programming unit to commence

3.2.3.17
programme
sequence of control operations determined by the programming unit involving switching on, supervising and switching off the burner

3.2.3.18
automatic shut-off valve
device that automatically opens, closes or varies a rate on a signal from the control circuit and/or the safety circuit

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
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

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3.2.3.21
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

3.2.3.22
closure member
movable part of the valve or the thermoelectric device that opens, varies or shuts off the gas way

3.2.3.23
breather hole
orifice that allows atmospheric pressure to be maintained in a compartment of variable volume

3.2.3.24
diaphragm
flexible component that operates the valve by means of forces resulting from a pressure difference

3.2.3.25
external soundness
soundness, with respect to the atmosphere, of an enclosure containing gas

3.2.3.26
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

3.2.3.27
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

3.2.3.28
gas/air ratio control
device intended to cause safety shutdown in the event of abnormal conditions of air admission or of combustion products evacuation

3.3 Operation of the boiler

3.3.1 Gas rates

3.3.1.1
volume flow rate
volume of gas consumed by the appliance in unit time during continuous operation

Symbols: V (under test conditions)

V_r (under reference conditions)

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

3.3.1.2
mass flow rate
mass of gas consumed by the appliance in unit time during continuous operation

Symbols: M (under test conditions)

M_r (under reference conditions)

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

3.3.1.3
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)

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

Symbol: Q_n

Unit: kilowatt (kW)

3.3.1.5
ignition rate
average heat input during the ignition safety time

Symbol: Q_{ign}

Unit: kilowatt (kW)

3.3.2 Outputs

3.3.2.1
useful output
quantity of heat transmitted to the heat carrier in unit time

Symbol: P

Unit: kilowatt (kW)

3.3.2.2
nominal output
useful output stated by the manufacturer

Symbol: P_n

Unit: kilowatt (kW)

3.3.3 Efficiency

3.3.3.1
useful efficiency
ratio of the useful output to the heat input

Symbol: η_u

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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.

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Unit: percent (%)

3.3.4 Gas combustion

3.3.4.1
complete combustion
combustion with no more than traces of combustible constituents (hydrogen, hydrocarbons, carbon monoxide, carbon, etc.) in the combustion products

3.3.4.2
incomplete combustion
combustion at which at least one combustible constituent is present in significant proportions in the combustion products

3.3.4.3
flame stability
characteristic of flames which remain on the burner ports or in the flame retention zone

3.3.4.4
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

3.3.4.5
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

3.3.4.9
condensate
liquid formed from the combustion products during the condensation process

3.3.5 Times

3.3.5.1
ignition opening time (T_{IA})
thermoelectric flame supervision device

time that elapses between ignition of the supervised flame and the moment when the closure element is held open by the flame signal

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3.3.5.2
extinction delay time (T_{IE})
thermoelectric flame supervision device

time that elapses between the disappearance of the flame and the interruption of the gas supply

3.3.5.3
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

3.3.5.4
maximum ignition safety time ($T_{SA,max}$)
ignition safety time measured under the least favourable conditions of ambient temperature and variation in supply voltage

3.3.5.5
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

3.3.5.6
closing time
time interval between the interruption of the auxiliary energy or the voltage and the achievement of the closed position

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 recycling

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

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
complete 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

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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 fuel/air mixture which could remain there

NOTE 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.

3.4 Auxiliary energy

3.4.1 electric auxiliary energy

electric energy consumed by the system components such as pump, fan, valves, heating elements and control unit required for the heat generator's designed operation

3.5 Country of destination

3.5.1 direct country of destination

country for which the boiler has been certified and which is specified by the manufacturer as the intended country of destination. At the time of putting the boiler on the market and/or of installation, the boiler shall be capable of operating, without adjustment or modification, with one of the gases distributed in the country concerned, at the appropriate supply pressure. More than one country can be specified if the boiler, in its current state of adjustment, can be used in each of these countries

3.5.2 indirect country of destination

country for which the boiler has been certified, but for which, in its present state of adjustment, it is not suitable. Subsequent modification or adjustment is essential in order that it can be used safely and correctly in this country

4 Classification of boilers

4.1 Gases and categories

Gases are classified into families, groups and ranges in accordance with EN 437.

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Boilers are classified into categories in accordance with EN 437.

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

4.2 Mode of air supply and evacuation of the combustion products

4.2.1 Type C Boilers

A boiler in which the combustion circuit (air supply, combustion chamber, heat exchanger and evacuation of the products of combustion) is sealed with respect to the room (or space) in which the boiler is installed.

The air supply and the combustion products evacuation ducts and the terminal or the fitting piece that is used to connect the boiler to a chimney or duct system are part of the boiler unless otherwise stated. They admit fresh air from outside of the building to the burner as well as discharge the products of combustion to the outside.

Boilers are classified into several types according to the mode of evacuation of the combustion products and supply of the combustion air (see examples attached in informative Annex D)[2)].

The types are defined by two subscripts:[3)]

— The first subscript number is based upon the possible installation of the boiler with respect to the mode of air supply and evacuation of the combustion products. (See 4.2.2.)

— The second subscript number is based upon the presence and position of an integral fan in the boiler. (See 4.2.3.)

4.2.2 Type of installation of the boiler

4.2.2.1 Type C_1

A type C boiler that is designed for connection via its ducts to a horizontal terminal, which at the same time admits fresh air to the burner and discharges the products of combustion to the outside through orifices that are either concentric or close enough to come under similar wind conditions.

4.2.2.2 Type C_2

A type C boiler connected via its two ducts to a common duct system serving more than one appliance. This system consists of a single duct, which supplies the combustion air and evacuates the products of combustion.

4.2.2.3 Type C_3

A type C boiler that is designed for connection via its ducts to a vertical terminal, which at the same time admits fresh air to the burner and discharges the products of combustion to the outside through orifices that are either concentric or close enough to come under similar wind conditions.

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2) The classification used in this standard is based upon the classification of CR 1749, *European scheme for the classification of gas appliances according to the method of evacuation of the products of combustion (Types)*.

3) Boilers in which the combustion circuit is under positive pressure and surrounded by the combustion air circuit may require identification by an additional subscript, in accordance with national regulations, if they are intended to be installed in non-ventilated areas.

4.2.2.4 Type C_4

A type C boiler connected via its two ducts to a common duct system 5 serving more than one appliance. This common duct system consists of two ducts connected to a terminal, which at the same time admits fresh air to the burner and discharges the products of combustion to the outside through orifices that are either concentric or close enough to come under similar wind conditions.

4.2.2.5 Type C_5

A type C boiler connected via its separate ducts to separate terminals for the supply of combustion air and the evacuation of the products of combustion. These ducts may terminate in zones of different pressure.

4.2.2.6 Type C_6

A type C boiler which is intended to be connected to a separately approved and marketed system for the supply of combustion air and discharge of the combustion products.

4.2.2.7 Type C_8

A type C boiler connected via one of its ducts to a single or common duct system. This duct system consists of a single natural draught duct (i.e. not incorporating a fan) that evacuates the products of combustion. The appliance is connected via a second of its ducts to a terminal, which supplies air to the appliance from outside the building.

4.2.3 Presence and position of a fan

A second subscript number of each specific variation indicates the absence or presence of an integral fan for the supply of combustion air and/or for the evacuation of the products of combustion. Where such a fan is present, the numbers 2 or 3 are given. These two numbers are used solely to identify the location of this fan:

— a type C boiler that does not incorporate a fan is identified by the second subscript number "1" (e.g. C_{11});

— a type C boiler that does incorporate a fan downstream of the combustion chamber/heat exchanger is identified by the second subscript number "2" (e.g. C_{12});

— a type C boiler that does incorporate a fan upstream of the combustion chamber/heat exchanger is identified by the second subscript number "3" (e.g. C_{13}).

4.3 Classification according to operating conditions[4)]

4.3.1 Standard boiler

A boiler for which the average temperature of the water can be restricted by design.

4.3.2 Low-temperature boiler

A boiler which can work continuously with a water supply temperature of 35 °C to 40 °C, possibly producing condensation in certain circumstances, including condensing boilers using liquid fuel[5)].

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

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4.3.3 Gas condensing boiler[6)]

A boiler designed to condense permanently a large part of the water vapour contained in the combustion gases.

4.4 Modular boiler

A 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, 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.

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, all the boiler components, including air inlet and combustion outlet ducts, shall be appropriate for their intended purpose and shall withstand the mechanical, chemical and thermal conditions to which they will foreseeably be subjected.

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5) Boilers using liquid fuels are not covered by this standard.

6) Specific requirements and test methods for condensing boilers with heat inputs exceeding 70 kW are covered in the scope of EN 15417.

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 in Table 1;

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

— the 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 R_m N/mm^2	Yield point R_{oH}/R_p 0,2 N/mm^2	Breaking elongation A_{long} at $L_o = 5\ d_o$ %	Breaking elongation A_{transv} at $L_o = 5\ d_o$ %	C	P	S	Si	Mn	Cr	Mo	Ni	Ti	Nb/Ta
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	> 150 N/mm²
Brinell hardness	160 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 R_m N/mm²	Temperature range °C
Al 99,5	≥ 75	< 300
AlMg2Mn0,8	≥ 275	< 250

Table 4 — Copper or copper alloy parts

	Tensile strength R_m N/mm²	Temperature range °C
SF – Cu	≥ 200	< 250
CuNi30Fe	≥ 310	< 350

5.3.2.3 Thicknesses

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

Table 5 — Minimum thicknesses for rolled parts

	Carbon steels, aluminium mm		Protected steels, stainless steels, copper mm	
Boiler nominal heat input	> 70 kW to 300 kW	> 300 kW to 1 000 kW	> 70 kW to 300 kW	> 300 kW to 1 000 kW
Walls of the combustion chamber in contact with fire and water and flat walls of convection heating surfaces	4	6	2	4
Walls in contact only with water and rigidly formed (e.g. corrugated) convection heating surfaces outside the combustion chamber	3	5	2	2
Pipes used in the convection part of the heat exchanger	2,9	2,9	1	1

Table 6 — Nominal thicknesses of boiler sections of cast materials

	Flake graphite cast iron, aluminium		Spheroidal graphite (annealed ferritic) cast iron, copper	
Boiler nominal heat input	> 70 kW to 300 kW	> 300 kW to 1 000 kW	> 70 kW to 300 kW	> 300 kW to 1 000 kW
	4,5 mm	5,5 mm	4,0 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.

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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 ISO 2553; the reference numbers of welding processes are in accordance with ISO 857 and EN ISO 4063, as appropriate.

Table 7 — Weld joints and welding processes

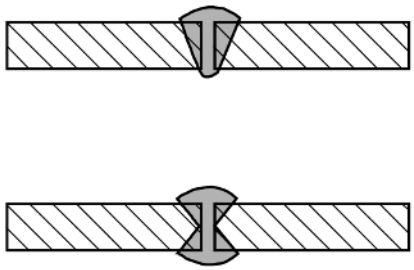
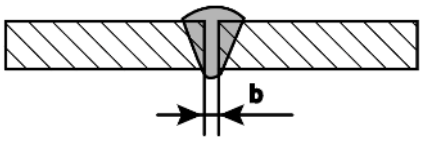
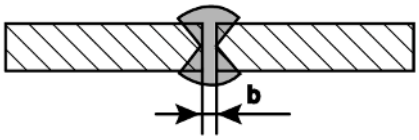
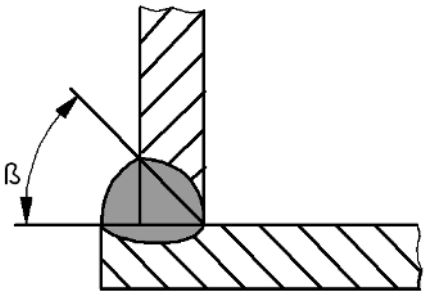
No	Weld joint type	Material Thickness t mm	Welding process [a]	Remarks
1.1	Square butt weld 	≤ 6 (8)	135 12 131 (111)	Permissible up to t = 8 mm on use of deep penetration electrodes or welding on both sides
1.2	Square butt weld 	≥ 6 up to 12	12	Root gap b = 2 mm to 4 mm with stiffener, powder holder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

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Table 7 *(continued)*

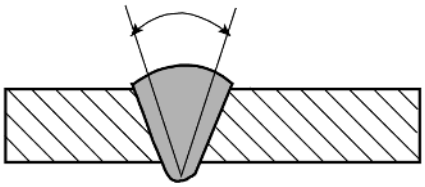
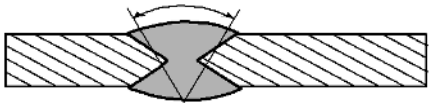
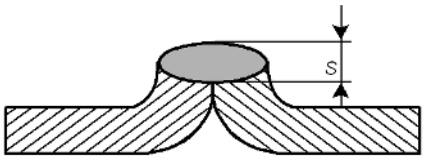
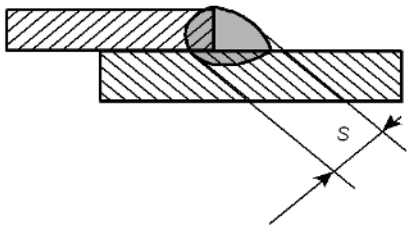
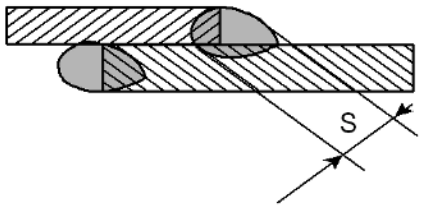
1.5	Single-V butt weld 	to 12	135 12	Seam preparation V-seam 30° to 50° depending on thickness of material.
1.6	Double-V butt weld 	> 12	135 12	Seam preparation double V-seam 30° to 50° depending on material thickness
1.7	Butt weld between plates with raised edges 	≤ 6	135 141 131 (111)	Only permissible in exceptional cases for parts welded in. Moreover, the welds have to be kept largely free from bending stresses. Not suitable for directly fired wall parts $s = 0{,}8 \times t$
1.8	Overlap welding 	≥ 6	135 12	Welds of these type are to be kept largely free from bending stresses. Not suitable for directly fired wall parts $s = t$
1.9	Overlap welding (continued) 	≤ 6	135 12 (111)	Not suitable for directly fired wall parts $s = t$

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Table 7 *(continued)*

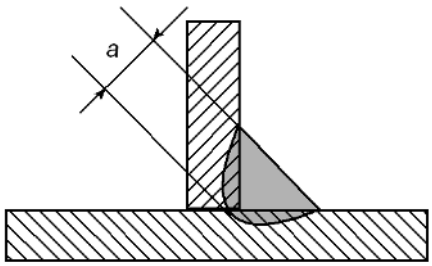
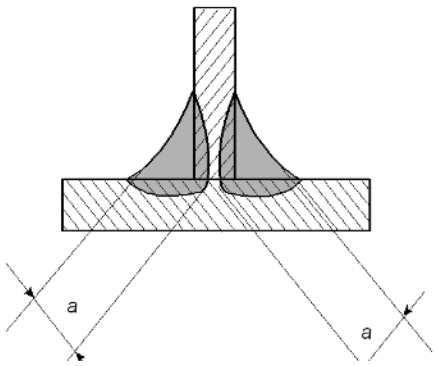
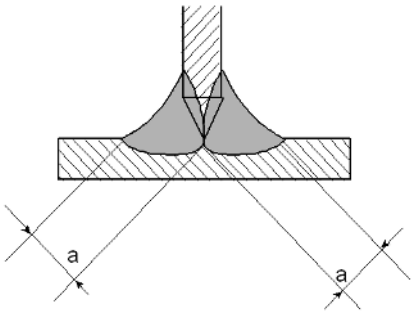
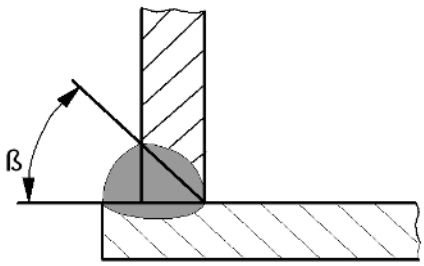
2	Fillet weld 	≤ 6	135 12 (111)	Welds of these types are to be kept largely free from bending stresses $a = t$
2.1	Double fillet weld 	≤ 12	135 12 (111)	$a = t$
		> 12	135 12 (111)	$a = \frac{2}{3}t$
2.2	Double-bevel butt weld 	≤ 12	135 12 (111)	$a = t$
		> 12	135 12 (111)	$a = \frac{2}{3}t$
2.3	Single bevel butt weld 	≤ 12	135 12 (111)	For (111) $\beta = 60°$ For 135, 12 $\beta = 45°$ to 50°
		> 12	135 12	

Table 7 *(continued)*

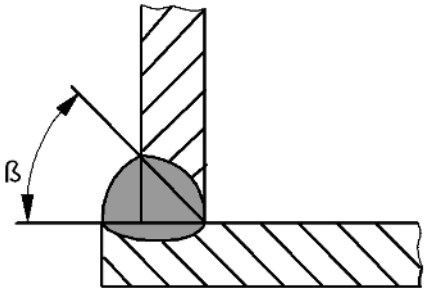
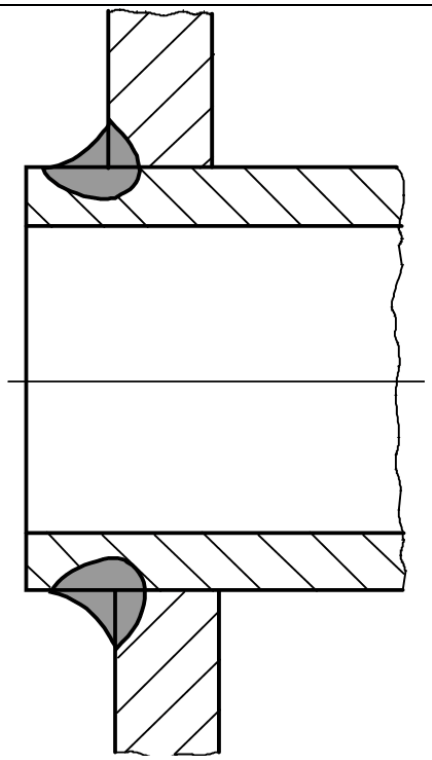
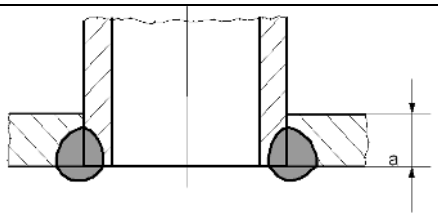
2.4	Single bevel butt weld 	≤ 12	135 12 (111)	For (111) $\beta = 60°$ For 135, 12 $\beta = 45°$ to $50°$
2.5		≤ 12	135 (111)	Tube ends shall not project beyond fillet weld if it is subjected to heat radiation
2.6		≤ 6	135 (111)	Welding in of tube under high thermal stress $a \geq t$

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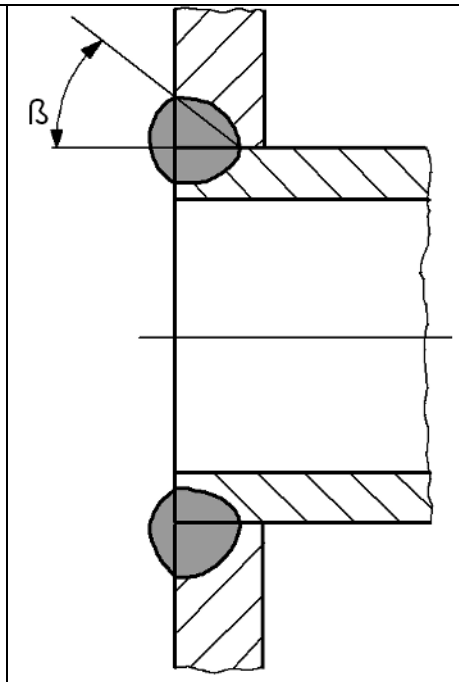
Table 7 *(continued)*

2.7			135 (111)	Welding in of tube under high thermal stress For (111) $\beta = 60°$ For 135 $\beta = 45°$ to 50°

[a] Reference numbers of welding processes in accordance with ISO 857 and EN ISO 4063:

Reference no.	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 Combustion products evacuation duct

5.4.1 Stability under mechanical loading

The duct shall be capable of withstanding horizontal and vertical loads. The following aspects shall be considered:

— compressive strength --- tensile strength;

— where applicable, resistance to lateral load for a reference wind velocity pressure of 1,5 kN/m^2.

5.4.2 Stability under exposure to heat

The stability of the walls of the duct shall be ensured during and after exposure to heat occurring under all operating conditions of the boiler.

5.4.3 Corrosion resistance

The duct shall keep its essential characteristics in the presence of the corrosion load corresponding to all operating conditions of the boiler.

5.4.4 Resistance to condensate and moisture under normal operating conditions

The duct shall keep its essential characteristics in the presence of condensate and moisture under normal operating conditions.

5.5 Design

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

Low temperature boilers are considered to be designed to give rise to condensation.

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

— affect the operational safety;

— drop outside the appliance.

This requirement does not apply to the flow of condensate which is produced at the outlet of the combustion products evacuation duct.

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.

5.5.2 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 are those of EN 483).

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.

5.6 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.

For boilers connected to an air supply system and/or combustion products evacuation system that forms part of the construction of the building, it shall be possible to carry out servicing of the boiler without dismantling the permanent connections to the duct.

The soundness of the combustion circuit shall be maintained after reassembly and, if necessary, in accordance with the manufacturer’s instructions, after replacement of the seal(s) following cleaning and servicing operations.

5.7 Connections to the gas and water pipes

5.7.1 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.

5.7.2 Connections to the gas pipe

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

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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.

5.7.3 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.

5.8 Soundness

5.8.1 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.

5.8.2 Soundness of the combustion circuit

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

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

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

The ducts, bends, if any, and the terminal or fitting piece shall fit together correctly and shall form a stable assembly. Parts intended to be dismantled for periodic servicing shall be designed and arranged so that soundness is guaranteed after re-assembly.

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

5.9 Supply of combustion air and the evacuation of the combustion products

5.9.1 General

All boilers shall be designed so that there is an adequate supply of combustion air during ignition and over the whole range of possible heat inputs stated by the manufacturer. A gas/air ratio control is permitted.

Unless otherwise stated, fan assisted boilers may be fitted with a means of adjustment in the combustion circuit intended to adapt the boiler to the pressure losses in the installed ducts either by restrictors or by setting the means of adjustment to predetermined positions in accordance with detailed instructions from the manufacturer.

According to the appliance type, the manufacturer shall supply any terminal and/or fitting piece, with the boiler for test.

5.9.2 Air supply and combustion products evacuation duct[7)]

The assembly of the various parts during installation shall be such that no work is necessary other than adjusting the length of the air supply and combustion products evacuation ducts (possibly by cutting them). Such adaptation shall not impair the correct operation of the boiler.

It shall be possible to connect the boiler, the air supply and combustion products evacuation ducts and the terminal or fitting piece using ordinary tools if necessary. All necessary accessories and the fitting instructions shall be supplied by the manufacturer.

The terminal outlets from separate ducts for the supply of combustion air and the evacuation of combustion products:

— shall fit inside a square of 100 cm for type C1 and C3 boilers;

— may terminate in zones of different pressure for type C5 boilers, but not on opposite walls of the building.

5.9.3 Terminal

No opening in the external surfaces of the terminal shall permit the entry of a 16 mm diameter ball applied with a force of 5 N.

Any horizontal terminal shall be designed in such a way that any condensate is discharged away from the wall.

5.9.4 Terminal guard

If the manufacturer prescribes, in the installation instructions, a protective guard for the terminal for use when the outlets for evacuation of the combustion products open on to a walkway, this device shall be supplied to the laboratory for test.

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7) In accordance with national regulations sampling points in the combustion circuit may be required.

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The dimensions of the terminal guard, when installed in accordance with the manufacturer's instructions, shall be such that the distance between any part of the guard and the terminal, except the wall plate, exceeds 50 mm. The guard shall not have any sharp edges likely to cause injury.

5.9.5 Fitting piece

For boilers of types C2, C4 and C8, the fitting piece shall be designed so that it is possible to obtain the distances specified by the manufacturer for the projection of the ends of the combustion air supply and combustion products discharge ducts into the common duct, whatever the total thickness (flue and cladding) of the common duct.

5.9.6 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.

5.9.7 Special requirements for certain components of boilers with a fan

5.9.7.1 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.

5.9.7.2 Air proving

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

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

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

This supervision of pressure is only allowed for boilers fitted with a constant speed fan during the operation of the main burner and where the combustion products evacuation duct is surrounded by combustion air throughout its length, which shall not exceed 3 m. In addition the following requirements shall be fulfilled:

— the ducts shall not have adjustable or removable restrictions;

— the pressure loss of the heat exchanger shall not exceed 0,05 mbar;

— continuous supervision of the combustion air rate or the combustion products rate: in this system, the supervision device is activated directly by the flow of combustion air or combustion products; this is also valid for boilers with more than one fan speed in which the flows associated with each fan speed are monitored by separate supervision devices;

— gas/air ratio control.

Only for boilers where the combustion products circuit is completely surrounded by the air supply circuit or for separate ducts when the leakage rates of the combustion products evacuation ducts meets the requirements of 6.2.2.4, the following two indirect supervision methods are also allowed:

— Indirect supervision (e.g. fan speed supervision) when there is an air proving device which proves the supply of combustion air at least once at each start up;

— Supervision of the minimum and maximum air or combustion products rates with two rate supervision devices.

5.9.7.3 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 7.5.5.4.2.

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.

5.9.8 Condensate discharge

A means of condensate discharge shall be provided if the condensate:

— impairs safety or correct operation;

— results in spillage from the appliance;

— causes deterioration of materials.

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

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

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

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

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

5.10 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 able to be observed 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.

5.11 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.

5.12 Electrical equipment

The electrical equipment shall comply with the requirements of EN 50165 except where reference is made to another electrical standard in 5.14.

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 possibility of ambiguity.

5.13 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.

5.14 Adjusting, control and safety devices

5.14.1 General

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

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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.

5.14.2 Adjusters and range rating devices

5.14.2.1 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.

5.14.2.2 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 "+" sign (e.g. 2E+ or 3+).

5.14.2.3 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.

5.14.3 Gas circuit

5.14.3.1 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.

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5.14.3.2 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	:	Stylised star	★
— Full rate of the burner	:	Stylised 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.

5.14.3.3 Composition of the gas circuit

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

Table 8 — Composition of the gas circuit

Heat input of the individual gas line within the gas circuit kW	Boiler without fan	Boiler with fan		
		With pre-purge	Without pre-purge but with a leakage control device 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 b), only one Class C valve is needed.				

Safety devices which require non-volatile lockout to occur shall give rise to simultaneous signal 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 H.

5.14.4 Gas pressure regulator

The gas regulator, if fitted, shall comply with EN 88-1.

Boilers using first family gases and boilers in excess of 300 kW nominal heat input using second family gases shall be fitted with a regulator. For other boilers this regulator is optional.

A regulator intended for operation with a pressure couple shall be adjusted or shall be able to be adjusted in a manner, such 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 unauthorised interference with the adjuster difficult.

5.14.5 Ignition devices

5.14.5.1 Ignition of the ignition burner

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

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Ignition devices for the ignition burner shall be designed and fitted in a 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.

5.14.5.2 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.

5.14.5.3 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.

5.14.5.4 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.

5.14.6 Flame supervision systems

5.14.6.1 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.

5.14.6.2 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).

5.14.6.3 Automatic burner control system

Automatic burner control systems shall comply with the appropriate requirements of EN 298, with the exception of requirements for degree of electrical protection, endurance, marking and instructions. 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.

5.14.7 Thermostats and water temperature limiting devices

5.14.7.1 General

Boilers shall be fitted with at least:

— an adjustable or fixed control thermostat (in accordance with 5.14.7.2), and

— a safety temperature limiter (in accordance with 5.14.7.3).

5.14.7.2 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.

5.14.7.3 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.

5.14.7.4 Sensors

Thermostats and safety temperature limiters shall have independent sensors.

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

5.14.7.5 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.

5.15 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.

5.16 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 ($9_{-0,5}^{0}$) 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.

5.17 Chemical composition of the condensate

The manufacturer shall communicate the possible 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.

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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

6.2.2.1 General

Boilers shall be sound in accordance with 6.2.2.2 or 6.2.2.3. Ducts shall be sound in accordance with 6.2.2.4, 6.2.2.5 and 6.2.2.6.

Soundness is verified before and after all the tests of this standard.

6.2.2.2 Air supply and combustion product circuit

Soundness with respect to the room where the boiler is installed is ensured if, under the test conditions of 7.2.2.2, the leakage rates do not exceed the values in Table 9.

Table 9 — Maximum admissible leakage rates

Test object	Surrounding of the combustion products circuit by the combustion air circuit	Maximum leakage rate m^3/h
Boiler with its air supply and combustion products evacuation ducts and all their joints	Completely not completely	$5Q_n/40$ $Q_n/40$
Boiler and the joint to the air supply and combustion products evacuation duct	Completely not completely	$3Q_n/40$ $0,6Q_n/40$
Combustion products evacuation ducts, not completely surrounded by combustion air, with all its joints excluding the joint tested above		$0,4Q_n/40$
Air supply duct with all its joints excluding the joint tested above		$2Q_n/40$

6.2.2.3 Combustion products evacuation duct for alternative control systems (see 5.8.7 indirect supervision methods)

The soundness of the combustion products evacuation duct for installation both inside and outside the room where the boiler is installed, permitted for alternative control systems, is ensured if, under the test conditions of 7.2.2.3, the leakage rate per surface area of the duct does not exceed 0,006 $dm^3/s{\cdot}m^2$ [8)].

8) This figure should be revised after the finalising of the relevant product standard by CEN /TC 166.

6.2.2.4 Separate combustion products evacuation duct

The soundness of a separate combustion products evacuation duct with respect to areas other than the room where the boiler is installed is ensured if, under the conditions of 7.2.2.4, the leakage rate per surface area of the duct does not exceed 0,006 $dm^3/s \cdot m^2$.

6.2.2.5 Separate and concentric air supply duct

The soundness of the air supply duct with respect to all areas other than the room where the boiler is installed, is ensured if under the test conditions of 7.2.2.5 the leakage rate per surface area of the duct does not exceed 0,5 $dm^3/s \cdot m^2$.

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; where this minimum heat input is less than 10 kW, a tolerance of 500 W is acceptable.

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 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 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 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 test panels and the floor

The temperature of the floor, on which the boiler is placed, where appropriate, and that of the panels placed at the side of and behind the boiler 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 boiler and the floor or walls when these latter are made of inflammable materials.

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

6.4.1.5 External temperature of the ducts

The temperature of the ducts in contact with or passing through the walls of the building shall not exceed the ambient temperature by more than 60 K under the test conditions of 7.4.1.5.

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However, when this temperature rise exceeds 60 K, the manufacturer shall state in the technical instructions for the installer the nature of the protection which has to be applied between the ducts and the walls in case they are constructed from inflammable materials. This protection shall be supplied to the test laboratory which shall check that, with the boiler fitted with it, the external surface temperature in contact with the wall measured under the test conditions of 7.4.1.5 does 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.

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.

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

Under the test conditions of 7.4.2.3, ignition of the ignition burner, ignition of the main burner by the ignition burner or direct ignition of the main burner, complete cross lighting of the main burner and also stability of the ignition burner when it alone is alight or of the ignition burner and main burner operation simultaneously shall be assured. Slight flame disturbance is permitted but there shall be no flame extinction.

6.4.2.3.1 Reduction of the gas rate of the ignition burner

Under the test conditions of 7.4.2.3.8 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.

6.4.2.3.2 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 7.4.2.3.9 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.

6.4.2.3.3 Reduction of the gas pressure

Under the test conditions of 7.4.2.3.10 there shall be no dangerous situation for the user or damage to the boiler.

6.4.2.3.4 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 appliances, the ignition burner flame shall remain stable under the test conditions of 7.4.2.3.11.

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 leakage control device;

— boilers up to 150 kW, fitted with two Class C valves or a Class B and a Class J valve (see 5.14.3.3);

— boilers above 150 kW and up to 300 kW, fitted with two Class B valves (see 5.14.3.3);

— boilers above 300 kW, fitted with two Class A valves (see 5.14.3.3).

The pre-purge shall:

— either correspond to a volume of at least three times the volume of the combustion chamber at an air rate of at least:

  0,4 ($Q_{\text{NOM AIR}}$),

— or correspond to a pre-purge time of at least 30 s at an air rate of: $Q_{\text{NOM AIR}}$,

— or at a longer time when:

  $0{,}4\ (Q_{\text{NOM AIR}}) < Q_{\text{AIR}} < Q_{\text{NOM AIR}}$.

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.

6.4.4 Functioning of a permanent ignition burner when the fan stops during the standby time

Under the test conditions of 7.4.4, the flame stability of the ignition burner shall be correct.

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 correct 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).

The ignition attempt shall continue at least to the moment flame is sensed. If flame sensing can be influenced by ignition, it is allowed to shorten the duration of the ignition attempt.

If ignition does not occur, 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})

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

b) 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.

c) 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 either of the following requirements:

— for $Q_n \leq 150$ kW: $$T_{SA.max} \leq \frac{5Q_n}{Q_{ign}} \text{ s}$$;

— for 150 kW < $Q_n \leq 1\,000$ kW: $$T_{SA.max} \leq \frac{5 \times 150}{Q_{ign}} \text{ s}$$

where

Q_{ign} is the ignition input.

Where several automatic ignition attempts are made, the sum of the durations of the ignition attempts shall comply with the above requirement for the $T_{SA,max}$. This does not apply for boilers with a fan where a full pre-purge occurs between each ignition attempt. 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.

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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 start gas rate

For direct ignition of the main burner the start gas 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 or 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:

a) under the test conditions of 7.5.5.2 a), the gas supply shall be shut off before the *CO* concentration exceeds 0,20 %, or;

b) under the test conditions of 7.5.5.2 b) with the boiler at thermal equilibrium, the *CO* concentration of the combustion products shall not exceed 0,10 %.

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:

a) under the test conditions of 7.5.5.3 a), the gas supply shall be shut off before the *CO* concentration exceeds 0,20 %, or

b) under the test conditions of 7.5.5.3 b) with the boiler at thermal equilibrium, the *CO* concentration of the combustion products shall not exceed 0,10 %, or

c) under the test conditions of 7.5.5.3 c), the gas supply shall be shut off before the *CO* concentration exceeds 0,20 %, or

d) under the test conditions of 7.5.5.3 d) with the boiler at thermal equilibrium, the *CO* concentration of the combustion products shall not exceed 0,10 %.

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

  — $\frac{Q}{Q_{KB}} \times CO_{mes} \leq 0{,}20\ \%$ 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.

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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 K, 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 6.5.7.3.1 and 6.5.7.3.2.

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6.5.8 Condensate discharge blockage

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:

— under the conditions of 7.5.8 test 1, when the condensate discharge is blocked, the gas supply shall be shut off before the *CO* concentration exceeds 0,20 %, or

— under the conditions of 7.5.8 test 2, 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

The *CO* concentration of the dry, air-free, products of combustion shall not exceed the values stated in 6.6.2 and 6.6.3.

6.6.2 Limit conditions

Under the test conditions of 7.6.2 the *CO* concentration shall not exceed 0,10 %.

6.6.3 Special conditions

Under the test conditions of 7.6.3.1 the *CO* concentration shall not exceed 0,20 %.

6.6.4 Sooting

Under the test conditions of 7.6.3.2 no soot deposition shall be observed although yellow tipping is acceptable.

6.6.5 Other pollutants

The manufacturer shall select the NO_x class of the boiler from Table 10. 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 10 — 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 11.

Table 11 — 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 12.

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Table 12 — Useful efficiency at part load

Boiler type	Boilers with nominal output ≤ 400 kW %	Boilers with nominal output > 400 kW output %
Standard	≥ 80 + 3 $\log_{10} P_n$ [a]	≥ 87,8 [b]
Low-temperature	≥ 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

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:

— 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 the 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 Condensation in the boiler

If condensation occurs in the flue, 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 7.11, it is checked whether formation of condensate occurs in the boiler.

If there is condensation in the boiler, the appropriate requirements of 5.3.1, 5.9.7, 5.17 and 8.2.1 shall be met.

6.12 Combustion air and flue dampers

Under the test conditions of 7.12 the damper assembly shall continue to operate correctly and there shall be no distortion of any part of the assembly.

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 O.

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 13, Table 14 and Table 15. The choice of the reference gases and limit gases is given in Table 16, according to the boiler category. For gases distributed nationally or locally, the choice of reference gases and limit gases is given in A.3.

Tables 13 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.

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Where an actually distributed gas is permitted for certain tests, this gas shall belong to the same gas family and group as the reference gas it replaces.

Table 13 — Calorific values of the third family test gases

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

Table 14 — Second family reference gas characteristics at 0 °C and 1 013,25 mbar

Gas group	Test gas	Designation	Composition by volume %	W_i MJ/m^3	H_i MJ/m^3	W_s MJ/m^3	H_s MJ/m^3	d
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 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 15 — 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 Incomplete combustion, flame lift and sooting limit gas	G 110	CH_4 = 26 H_2 =50 N_2 = 24	21,76	13,95	24,75	15,87	0,411
	Light-back limit gas	G 112	CH_4 = 17 H_2 = 59 N_2 = 24	19,48	11,81	22,36	13,56	0,367

(continued)

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

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 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 C_3H_8 = 13	49,60	41,01	54,76	45,28	0,684
	Light-back limit gas	G 222	CH_4 = 77 H2 = 23	42,87	28,53	47,87	31,86	0,443
	Flame lift limit gas	G 23	CH_4 = 92,5 N_2 = 7,5	41,11	31,46	45,66	34,95	0,586
Group L	Reference gas and light-back limit gas	G 25	CH_4 = 86 N_2 = 14	37,38	29,25	41,52	32,49	0,612
	Incomplete combustion and sooting limit gas	G 26	CH_4 = 80 C_3H_8= 7 N_2 = 13	40,52	33,36	44,83	36,91	0,678
	Flame lift limit gas	G 27	CH_4 = 82 N_2 = 18	35,17	27,89	39,06	30,98	0,629
Group E	Reference gas	G 20	CH_4 = 100	45,67	34,02	50,72	37,78	0,555
	Incomplete combustion and sooting limit gas	G 21	CH_4 = 87 C_3H_8= 13	49,60	41,01	54,76	45,28	0,684
	Light-back limit gas	G 222	CH_4 = 77 H_2 = 23	42,87	28,53	47,87	31,86	0,443
	Flame lift limit gas	G 231	CH_4 = 85 N_2 = 15	36,82	28,91	40,90	32,11	0,617

(continued)

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

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 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 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.3.

[b] For other groups, see A.3.

[c] See also Table 13.

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

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Table 16 — 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] G 25 [c d]	G 21 [d] G 26 [d]	G 222 [d] G 25 [d]	G 231 [d] G 27 [d]	G 21 [d] 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
$II_{2E3B/P}$ $II_{2E+3B/P}$, 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 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 Tables 17 and 18 reproduced from EN 437:2003.

Table 17 — Test pressures where no pressure couple exists

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, 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.2.

[b] Boilers of this category may be used without adjustment at specified supply pressures from 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 I2N 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 18 — 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] Boilers 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 Installation and sampling

The boiler is installed in accordance with the technical instructions 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.

Depending on the type of boiler, the manufacturer shall supply the boiler, fitted with all the accessories necessary for its installation (including its ducts), accompanied by the mounting instructions.

Wall-mounted boilers are installed on a vertical test panel of plywood, or of a material with the same thermal characteristics, in accordance with the information in the manufacturer's instructions. The plywood panel shall be (25 ± 1) mm thick and painted matt black; the panel dimensions are at least 50 mm greater than the corresponding dimensions of the boiler (see 7.4.1.4).

Except where otherwise stated, the boiler is connected to the shortest ducts with the smallest pressure loss stated by the manufacturer in his installation instructions. If necessary, an external telescopic duct may be sealed in accordance with the manufacturer's instructions. The terminal guard is not fitted.

Type C1, C3, and C5 boilers are tested with their terminals fitted. Type C1, boilers are tested with a duct suitable for a wall with a thickness of 300 mm.

Type C2, C4, and C8 boilers are tested with their fitting pieces fitted but not connected to a test duct.

Type C6 boilers are fitted with restrictors enabling the minimum and maximum duct pressure losses specified by the manufacturer to be simulated.

The sample of the combustion products is taken in the plane perpendicular to the direction of flow of the combustion products, and at a distance L from the extreme end of the combustion products duct (see examples in Figures 3 and 4):

— for circular ducts: $L = D_i$

— for rectangular ducts: $L = \frac{4S}{C}$

where

D_i is the internal diameter of the combustion products evacuation duct, in mm;

S is the cross-sectional area of this duct, in mm^2;

C is the circumference of this duct, in mm;

The sampling probe is positioned so as to obtain a representative sample of the combustion products.

7.1.2.3 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.

7.1.2.4 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.

7.1.2.5 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:

— the nominal heat input, or

— the 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:

$$M = \frac{Q_i}{H_i} \times 3{,}6$$

— or, for the volumetric rate:

$$V = \frac{Q_i}{H_i} \times \frac{1013{,}25}{p_a + p_g - p_s} \times \frac{273{,}15 + t_g}{288{,}15} \times 3{,}6$$

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 (for example, this value may be derived from minimum, nominal or maximum heat input where appropriate);

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 shall be 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 Tables 17 and 18 are corrected such that:

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

7.1.2.6 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 K.

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

7.1.2.7 Influence of thermostats

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

7.1.2.8 Electrical supply

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

7.1.2.9 Uncertainty of measurements

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

a) atmospheric pressure ± 5 mbar;

b) combustion chamber and test flue pressure ± 5 % full scale or 0,05 mbar;

c) gas pressure ± 2 % full scale;

d)	water-side pressure loss		± 5 %;
e)	water rate		± 1 %;
f)	gas rate		± 1 %;
g)	air rate		± 2 %;
h)	time		± 0,2 s up to 1 h, ± 0,1 % beyond 1 h;
i)	auxiliary electrical energy		± 2 %;
j)	temperature:		
	1) ambient	± 1 K;	
	2) heat carrier	± 2 K;	
	3) combustion products	± 5 K;	
	4) gas	± 0,5 K;	
	5) surface	± 5 K;	
k)	CO, CO_2 and O_2		± 6 % full scale;
l)	gas calorific value		± 1 %;
m)	gas density		± 0,5 %;
n)	mass		± 0,05 %;
o)	torque		± 10 %;
p)	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 dm³/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.

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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 5.14.3.2) is checked, all other closure members being open.

The pressure upstream of the boiler is set to 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 set to 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

7.2.2.1 General

The test checks all the joints declared by the manufacturer, between:

— the boiler and its ducts;

— interconnecting ducts;

— the ducts and any bends;

— the ducts and any fitting piece or terminal.

In the case that leakage also can occur along the length of the ducts, the tests are also carried out with the maximum length of ducts.

In accordance with the technical instructions, the wall connections, the joint with the terminal or the joint with the fitting piece with another system of combustion products evacuation may be made sound.

7.2.2.2 Air supply and combustion product circuit

Depending on the manufacturer's choice the test is carried out either separately on the boiler body and on the ducts or on the boiler assembled with its ducts.

The combustion circuit of the test object in accordance with Table 9 is connected to a pressure source on one side and blocked on the other side.

The test pressure difference is at least 0,5 mbar.

For boilers with a fan of which the combustion product circuit is not completely surrounded by the combustion air circuit, the test is also carried out on the part of the combustion circuit downstream of the fan, with a test pressure which is increased by the highest pressure between the combustion circuit, in the envelope of the boiler or the ducts, and the atmosphere, measured with the boiler in thermal equilibrium at nominal heat input and fitted with the longest ducts specified by the manufacturer.

It is checked that the requirements of 6.2.2.2 are met.

7.2.2.3 Combustion products evacuation duct for alternative control systems (see 5.9.7.2)

The combustion products evacuation duct is connected to a pressure source on one side and blocked on the other side.

The test pressure is 2,0 mbar.

It is checked that the requirements of 6.2.2.3 are met.

7.2.2.4 Separate combustion products evacuation duct

When tested in accordance with 7.2.2.2 but with a test pressure of 2,0 mbar, it is checked that the requirements of 6.2.2.4 are met.

7.2.2.5 Separate and concentric air supply duct

When tested in accordance with 7.2.2.2., it is checked that the requirements of 6.2.2.5 are met.

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 Nominal heat input or 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 shall not be changed for this test. Any adjusters shall be 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:

$$Q_c = H_i \times \frac{10^3}{3600} \times V \times \sqrt{\frac{1013{,}25 + p_g}{1013{,}25} \times \frac{p_a + p_g}{1013{,}25} \times \frac{288{,}15}{273{,}15 + t_g} \times \frac{d}{d_r}}$$

whence

$$Q_c = \frac{H_i \times V}{214{,}9} \times \sqrt{\frac{(1013{,}25 + p_g)(p_a + p_g)}{(273{,}15 + t_g)} \times \frac{d}{d_r}}$$

If the mass rate M is measured:

$$Q_c = H_i \times \frac{10^3}{3600} \times M \times \sqrt{\frac{1013{,}25 + p_g}{p_a + p_g}} \times \frac{273{,}15 + t_g}{288{,}15} \times \frac{d_r}{d}$$

whence

$$Q_c = \frac{H_i \times M}{61{,}1} \times \sqrt{\frac{(1013{,}25 + p_g)(273{,}15 + t_g)}{(p_a + p_g)} \times \frac{d_r}{d}}$$

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 [9];

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.

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9) 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:

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

where

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

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

7.3.3 Ignition rate

For boilers which may be ignited at a heat input lower than the nominal heat input, the mean 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 pressure 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.

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 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 test panels and the floor

7.4.1.4.1 Limiting temperature of the floor

In determining the floor temperatures, the boiler should be installed on a test floor e.g. conforming to Figure 12. The surface temperatures of the test floor are 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 13, or commercially available surface temperature sensors.

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

When the manufacturer states in the instructions that some form of protection has to be used, another test is carried out with this protection in position.

It is checked that the requirements of 6.4.1.4 are satisfied.

7.4.1.4.2 Limiting temperature of the test panels

The boiler is installed on a vertical test panel of wood.

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

This distance is measured from the closest part of the boiler. The side panel is placed on the side of the boiler exhibiting the highest temperatures.

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

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

The wooden panels shall be (25 $\pm$ 1) mm thick and it shall be painted matt black; their dimensions are at least 5 cm greater than the corresponding dimensions of the boiler.

Temperature sensors are incorporated into the panels at the centre of 10 cm squares and penetrate the panels from the outside so that the hot junctions are situated 3 mm from the surface facing the boiler.

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

When the manufacturer states in the instructions that some form of protection has to be used, another test is carried out with this protection in position.

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

It is checked that the requirements of 6.4.1.4 are satisfied.

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7.4.1.5 External temperature of the ducts

With the protection, if any, fitted in accordance with the manufacturer's instructions, the temperature of the wall is measured after the boiler has operated for 30 min.

It is checked that the requirement of 6.4.1.5 is 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 General

The boiler is supplied with one of the reference gases or a distributed gas if the boiler is in excess of 300 kW input for its category at the nominal heat input and the minimum heat input given by the controls, if such operation is intended by the manufacturer.

The tests are carried out with the shortest and longest air supply and combustion products evacuation ducts, or with corresponding pressure losses, unless otherwise stated.

7.4.2.3.2 Type C1 and C3 boilers

The boiler is installed in accordance with the information in the technical instructions, with accessories supplied by the manufacturer, on the applicable test apparatus of Figures 5 or 8 for type C1 boilers and Figures 7 or 6 for type C3 boilers.

During the test, the largest projected area of the air/flue terminal in the airflow shall not be more than 20 % of the wind tunnel outlet. If the dimensions are such that this condition cannot be fulfilled, tests may be conducted on a scale model of the terminal according to the method described in Annex N. In this case, the maximum suction between outlet and inlet under the influence of wind at the start flow velocity and the maximum recirculation percentages are measured. The tests are conducted according to the tests for type C6 boilers described in 7.4.2.3.6 and 7.6.1.3.5 but with the measured values of suction and recirculation as applied values.

7.4.2.3.2.1 First test series

The terminal is subjected successively to winds of three different speeds (1 m/s, 2,5 m/s and 12,5 m/s) and with directions in three planes as given in Figures 5 to 8 depending on the boiler type and the situation.

For each of the three planes of incidence:

— the three combinations of wind speed and angle of incidence are found giving the lowest CO_2 concentrations (for evaluating 6.4.2.3);

— the three combinations for which the highest *CO* concentrations are measured, in the dry air-free combustion products (for evaluating 6.6.1.3).

7.4.2.3.2.2 Second test series

— The boiler is in thermal equilibrium.

— For each of the nine combinations that produce the lowest CO_2 concentrations, noted in the first test series, it is checked that the requirements of 6.4.2.3 are met.

7.4.2.3.2.3 Third test series

If the manufacturer makes provision for a terminal guard, this is fitted in accordance with the instructions, and the nine tests in the first series that gave the highest *CO* concentrations in the dry air-free combustion products are repeated. The measured values are noted to be used for the calculation in 7.6.1.3.1.

7.4.2.3.3 Type C2 boilers

The boiler is installed in accordance with the manufacturer's instructions on the test apparatus of Annex M and Figure 9.

The test apparatus is adjusted to give successively the following conditions:

— an upflow of average speed 2 m/s, a CO_2 concentration of 1,6 % and a temperature within the range 60 °C to 80 °C;

— an upflow of average speed 3 m/s, a CO_2 concentration of 0,75 % and a temperature within the range 40 °C to 60 °C.

The tests are carried out with the boiler at ambient temperature and at thermal equilibrium.

It is checked that the requirements of 6.4.2.3 are met.

7.4.2.3.4 Type C4 boilers

The boiler is installed with the shortest ducts specified by the manufacturer. A suction of 0,5 mbar is applied to the combustion products evacuation duct.

It is checked that the requirements of 6.4.2.3 are met.

7.4.2.3.5 Type C5 boilers

The boiler is installed with the shortest ducts specified by the manufacturer. A suction of 2,0 mbar is applied to the combustion products evacuation duct.

It is checked that the requirements of 6.4.2.3 are met.

7.4.2.3.6 Type C6 boilers

The boiler is installed with ducts that are specified and supplied by the manufacturer. A suction of 0,5 mbar is applied to the combustion products outlet.

It is checked that the requirements of 6.4.2.3 are met.

7.4.2.3.7 Type C8 boilers

The boiler is installed with the shortest ducts specified by the manufacturer.

The combustion air terminal is subjected to wind with a speed of 12,5 m/s, in the directions given in Figures 5 to 8, depending on the situation.

It is checked that the requirements of 6.4.2.3 are met.

7.4.2.3.8 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 6.4.2.3.1.

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.

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

7.4.2.3.9 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 if the boiler is in excess of 300 kW input, at nominal heat input.

Under these conditions, it is checked that the requirements of 6.4.2.3.2 are satisfied.

7.4.2.3.10 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 6.4.2.3.3 is checked.

7.4.2.3.11 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 6.4.2.3.4 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.

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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.

7.4.4 Functioning of a permanent ignition burner when the fan stops during standby time

The boiler is installed in accordance with 7.1.2.

The ignition burner is adjusted using the reference gases at the normal pressure in accordance with the manufacturer's instructions.

The test is carried out with the fan stopped, in still air, at the maximum pressure using the incomplete combustion and sooting limit gas. With the boiler at ambient temperature, the ignition burner is ignited and kept in operation for 1 h.

It is checked that the requirement of 6.4.4 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.

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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 devices

7.5.3.1 General

The tests of 7.5.3 are first carried out with the reference gas or an actually distributed gas if the boiler is in excess of 300 kW input, 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 reference gases or distributed gases if the boiler is in excess of 300 kW input, of 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).

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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 reference gases or distributed gases if the boiler is in excess of 300 kW input, of 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, it ceases by the action of the safety device.

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 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 reference gases of 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.

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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.

It is checked that the requirement of 6.5.4.1 is satisfied.

7.5.4.2 Main burner start gas 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.

It is checked that the requirements of 6.5.4.2 are satisfied.

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 boiler is fitted with the longest combustion air supply and combustion products evacuation ducts stated by the manufacturer. The tests may be carried out without the terminal or fitting piece.

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. Measurements are taken at thermal equilibrium. The *CO* and CO_2 concentrations are measured continuously.

By choice of the manufacturer, one of the following tests is conducted:

— The voltage at the fan terminals is progressively reduced. It is checked that the requirements of 6.5.5.2 a) are met.

— With the boiler at ambient temperature, the minimum voltage at the fan terminals which enables the burner to ignite, is established. Under this condition, the boiler is operated until thermal equilibrium is reached. It is checked that the requirements of 6.5.5.2 b) are met.

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.

By choice of the manufacturer, one of the following tests is conducted:

— The combustion products evacuation duct or air inlet is progressively blocked. The means of carrying out the blockage shall not give rise to recirculation of the products of combustion. It is checked that the requirements of 6.5.5.3 a) are met.

— With the boiler at ambient temperature, the maximum blockage of the combustion products evacuation duct or air inlet which enables the boiler to ignite, is established. The means of carrying out the blockage shall not give rise to recirculation of the products of combustion. Under this condition, the boiler is operated until thermal equilibrium is reached. It is checked that the requirements of 6.5.5.3 b) are met.

— The voltage at the fan terminals is progressively reduced. It is checked that the requirements of 6.5.5.3 c) are met.

— With the boiler at ambient temperature, the minimum voltage at the fan terminals which enables the burner to ignite, is established. Under this condition, the boiler is operated until thermal equilibrium is reached. It is checked that the requirements of 6.5.5.3 d) are met.

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. It is checked that the requirements of 6.5.5.4.2 are met.

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— With the boiler cold, the combustion products evacuation duct is re-opened gradually. The blockage at which the burner ignites is determined. 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 requirements of 6.5.6.3 are 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.

Sixty percent 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.

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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 requirements of 6.5.7.3.1 are 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[10)]. It is checked that the requirements of 6.5.7.3.3 are fulfilled.

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10) 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 Condensate discharge blockage

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 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.

Test 1, 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 6.5.8 are met.

Test 2, 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 the condensate is stopped. The *CO* concentration is measured. It is checked that the requirements of 6.5.8 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 tests are carried out with the longest air supply and combustion products evacuation ducts fitted, or with the corresponding pressure losses, unless otherwise stated.

The boiler is successively supplied with all the reference gases for the category to which it belongs and adjusted to the nominal heat input.

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

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

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

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

where

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

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

$(CO)_M$ and $(CO_2)_M$ are the measured concentrations in the samples taken during the combustion test, both expressed in percent.

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

Table 19 — $(CO_2)_N$ concentration of the combustion products

Designation of the gas	G 20	G 21	G 23	G 25	G 26	G 27	G 30	G 31
$(CO_2)_N$	11,7	12,2	11,6	11,5	11,9	11,5	14,0	13,7
Designation of the gas	G 110	G 120	G 130			G 150	G 231	G 271
$(CO_2)_N$	7,6	8,35	13,7			11,7	11,5	11,2

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

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

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 test conditions is given in informative Annex G.

7.6.2 Limit conditions

The boiler is first tested with the reference gas or gases for the boiler category and adjusted as follows:

NOTE For boilers > 300 kW, it is permissible to use distributed gas of group H, E, or L and of the third family.

— for an ungoverned 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 governed 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 ungoverned boilers with a gas rate adjuster.

It is checked that the requirements of 6.6.2 are satisfied.

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7.6.3 Special conditions

7.6.3.1 Incomplete combustion

After the test with the reference 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 three cases mentioned above, is first supplied with the reference 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[11)] or does incorporate gas/air ratio controls.

Without changing the adjustment of the boiler or the supply pressure, the reference gas is replaced by the corresponding incomplete combustion gas.

It is checked that the requirements of 6.6.3.1 are satisfied.

Alternatively, for boilers over 300 kW, it is permissible to carry out the incomplete combustion tests above using a distributed gas for the group for which the boiler is adjusted, in which case the following procedures should be adopted:

— for an ungoverned 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 governed 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 ungoverned boilers with a gas rate adjuster.

It is checked that the requirements of 6.6.3.1 are satisfied.

7.6.3.2 Sooting

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 7.6.3.1 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 6.6.4 is satisfied.

For boilers over 300 kW, in the place of the above test, the manufacturer may provide evidence that the requirement of 6.6.4 is satisfied.

11) If the boiler is intended to be installed solely on a gas installation with a governed meter, the 1,05 factor may be applied.

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7.6.3.3 Combustion test with flame lift limit gas

The adjustment is modified as follows:

— for boilers without regulators or with gas/air ratio controls, the pressure at the boiler inlet is reduced to the minimum pressure given in 7.1.1.4;

— 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 requirement of 6.6.3 are met.

For boilers over 300 kW, in the place of the above test, the manufacturer may provide evidence that the requirement of 6.6.3 is satisfied.

7.6.3.4 Type C1 and C3 boilers

The test is carried out as stated in the first and third test series in 7.4.2.3.2, if appropriate.

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

It is checked that the requirements of 6.6.3 are met.

For boilers > 300 kW it is permissible to use distributed gas(es) for its category(ies) at normal pressure.

7.6.3.5 Type C2 Boilers

Under the test conditions of 7.4.2.3.3, it is checked that the requirements 6.6.3 are met.

For boilers > 300 kW it is permissible to use distributed gas(es) for its category(ies) at normal pressure.

7.6.3.6 Type C4

Under the test conditions of 7.4.2.3.4, it is checked that the requirements 6.6.3 are met.

For boilers > 300 kW it is permissible to use distributed gas(es) for its category(ies) at normal pressure.

7.6.3.7 Type C5

Under the test conditions of 7.4.2.3.5, it is checked that the requirements 6.6.3 are met.

For boilers > 300 kW it is permissible to use distributed gas(es) for its category(ies) at normal pressure.

7.6.3.8 Type C6

In accordance with 4.2.2.6 these boilers are intended to be connected to a separately approved and marketed system for the supply of combustion air and discharge of the combustion products to which reference is made in Annex N.

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Type C6 boilers are fitted with a restriction to simulate the minimum pressure loss stated by the manufacturer.

The air supply is fitted with a mixing device which permits adjustment of the recirculation of the products of combustion. The mixing device is adjusted such that 10 % of the combustion products are re-circulated to the air supply.

It is checked that the requirements of 6.6.3 are met.

A supplementary test is carried out by adjusting the restriction such that the air proving device just fails to operate.

If the boiler is fitted with an air proving device that does not interrupt the gas rate before the *CO* concentration exceeds 0,20 %, the test is done with a blockage that generates a *CO* concentration of 0,10 % at equilibrium.

For appliances with gas/air ratio controls the supplementary test is done at the minimum adjustable heat input.

Under these test conditions, it is checked that the requirements of 6.6.3 are met.

For boilers > 300 kW it is permissible to use distributed gas(es) for its category(ies) at normal pressure.

7.6.3.9 Type C8

Under the test conditions of 7.4.2.3.8 it is checked that the requirements of 6.6.3 are met.

For boilers > 300 kW it is permissible to use distributed gas(es) for its category(ies) at normal pressure.

7.6.3.10 Voltage variation

For fan assisted boilers, it is checked that the requirements of 6.6.3 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 gas(es) for its category(ies) at the normal pressure

For boilers > 300 kW it is permissible to use the distributed gas(es) for its category(ies) at the normal pressure.

7.6.4 Other pollutants

7.6.4.1 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.

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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:

$$T_r = (0{,}4 \times Q_{pi}) + 20$$

where

T_r is the return water temperature, expressed in degrees Celsius (°C);

Q_{pi} 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 to details given in CR 1404. No wet meters are used.

The reference conditions for the combustion air are:

— temperature: 20 °C;

— 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 Table 10 of 6.7, depending on the NO_x class chosen.

For the calculation of conversions of NO_x, see Annex L.

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7.6.4.2 Weighting

7.6.4.2.1 General

The weighting of the measured NO_x values shall be as described in 7.6.4.2.2 to 7.6.4.2.5, on the basis of the values in Table 20.

Table 20 — 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.

7.6.4.2.2 On/off boilers

The NO_x concentration is measured (and possibly corrected as specified in 7.6.4.1) at the nominal heat input, Q_n.

7.6.4.2.3 Boilers with several rates

The NO_x concentration is measured (and possibly corrected as specified in 7.6.4.1) at the partial heat input corresponding to each of the rates and weighted in accordance with Table 20.

If necessary, the weighting factor specified in Table 20 is recalculated for each rate as specified below.

If the heat inputs of two rates are between the partial heat inputs specified in Table 20, it will be necessary to apportion the weighting factor between the heat inputs of the higher and lower rates, as follows:

$$F_{p,\text{high rate}} = F_{pi} \times \frac{Q_{pi} - Q_{\text{low rate}}}{Q_{\text{high rate}} - Q_{\text{low rate}}} \times \frac{Q_{\text{high rate}}}{Q_{pi}}$$

$$F_{p,\text{low rate}} = F_{pi} - F_{p,\text{high rate}}$$

If the heat inputs of two rates cover more than one partial heat input specified in Table 20, 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, ($NO_{x,\text{ mes rate}}$), multiplied by their weighting factor, calculated as specified above:

$$NO_{x,pond} = \Sigma\,(NO_{x,mes(rate)} \times F_{p,rate})$$

(See calculation example in Annex K).

7.6.4.2.4 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 7.6.4.1) at the partial heat inputs specified in Table 20.

The NO_x value is weighted as specified below:

$$NO_{x,pond} = 0,15 \times NO_{x,mes\,(70)} + 0,25 \times NO_{x,mes\,(60)} + 0,30 \times NO_{x,mes\,(40)} + 0,30 \times NO_{x,mes\,(20)}$$

7.6.4.2.5 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 7.6.4.1) at the minimum modulating rate and at the partial heat inputs Q_{pi}, specified in Table 20, which are greater than the minimum modulation rate.

The weighting factors for the partial heat inputs in Table 20, 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:

$$NO_{x,pond} = (NO_{x,mes\,Q_{min}} \times \Sigma\, F_{pi}(Q \le Q_{min})) + \Sigma\,(NO_{x,mes} \times F_{pi})$$

Symbols used in 7.6.4.2:

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): $NO_{x,mes}$,Q_{min};
- 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.

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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 tared 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:

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

where

η_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, which ensures a total uncertainty in the efficiency measurement of ± 2 %.

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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 14 (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 21.

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 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 heat input, or the maximum and minimum adjustable heat inputs 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.

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Table 21 — 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_n	t_2 = 600	η_2	$\eta_u = \eta_2$
2	Full rate	$Q_1 = Q_{na}$	$t_1 = \frac{180\,Q_1 - 600\,Q_3}{Q_1 - Q_3}$	η_1	$\eta_u = \frac{\frac{\eta_1}{100} Q_1 t_1 + (0{,}8\,Q_3 - P_s)\,t_3}{Q_1 t_1 + Q_3 t_3} \times 100$
	Controlled off	Q_3 = permanent ignition	t_3 = 600 - t_1	P_s	
3	Reduced rate	Q_{21} > 0,3 Q_n	$t_{21} = \frac{180\,Q_{21} - 600\,Q_3}{Q_{21} - Q_3}$	η_{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	t_3 = 600 - t_{21}	P_s	
4	Full rate	$Q_1 = Q_{na}$	$t_1 = \frac{180\,Q_1 - 600\,Q_{22}}{Q_1 - Q_{22}}$	η_1	$\eta_u = \frac{\frac{\eta_1}{100} Q_1 t_1 + \frac{\eta_{22}}{100} Q_{22} t_{22}}{Q_1 t_1 + Q_{22} t_{22}} \times 100$
	Reduced rate	Q_{22} < 0,3 Q_n	t_{22} = 600 - t_1	η_{22}	
5	Reduced rate 1	Q_{21} > 0,3 Q_n	$t_{21} = \frac{180\,Q_{21} - 600\,Q_{22}}{Q_{21} - Q_{22}}$	η_{21}	$\eta_u = \frac{\frac{\eta_{21}}{100}\,Q_{21}\,t_{21} + \frac{\eta_{22}}{100}\,Q_{22}\,t_{22}}{Q_{21}\,t_{21} + Q_{22}\,t_{22}} \times 100$
	Reduced rate 2	Q_{22} < 0,3 Q_n	t_{22} = 600 - t_{21}	η_{22}	
6	Full rate	$Q_1 = Q_{na}$	t_1 = measured value (see Annex J)	η_1	$\eta_u = \frac{\frac{\eta_1}{100}\,Q_1\,t_1 + \frac{\eta_2}{100}\,Q_2\,t_2 + (0{,}8\,Q_3 - P_s)\,t_3}{Q_1\,t_1 + Q_2\,t_2 + Q_3\,t_3}$ x 100
	Reduced rate	Q_2	$t_2 = \frac{(180 - t_1)\,Q_1 - (600 - t_1)\,Q_3}{Q_2 - Q_3}$	η_2	
	Controlled off	Q_3 = permanent ignition	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 22 — Flow and return temperatures

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

The measured value η_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 23 — Flow and return 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 η_2.

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

The measured values are designated by:

— η_{21}, for the larger heat input;

— η_{22}, for the smaller heat input.

7.7.2.3.1.3 Standby losses

The test installation is described in Figure 15.

The circuits joining the different parts of the installation shall be 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 shall be determined at the beginning to be able to take account of them (see Annex I).

The boiler is fitted with a largest diameter test flue as stated 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 shall not 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 equal to 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 24 are used.

Table 24 — Symbols and quantities needed to calculate the efficiency at part load

Operational phases of the main burner	Heat input kW	Operation times	Measured values [a]
			Efficiency (%)
Full rate	Q_1	t_1	η_1
Reduced rate	Q_2	t_2	η_2
Reduced rate > 0,3 Q_1	Q_{21}	t_{21}	η_{21}
Reduced rate < 0,3 Q_1	Q_{22}	t_{22}	η_{22}
Controlled off	Q_3	t_3	Standby losses P_s (kW)

[a] At 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 21:

— 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 21.

7.8 Criteria for condensation in the flue

7.8.1 Determination of flue losses

Under the test conditions of 7.7.1, using a flue or ducts specified by the manufacturer, 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:

$$q_c = (a + \frac{b}{CO_2}) \times \frac{t_c - t_a}{100}$$

where

q_c are the flue losses of the heat input, in percent;

a and b are the coefficients given in Table 25;

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 25 — 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 of 7.7.1, the temperature of the combustion products is measured 150 mm before the discharge of the combustion products from the maximum length of flue specified by the manufacturer. 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 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 × PMS) bar.

It is checked that the requirement of 6.9.2 is satisfied.

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7.9.3 Boilers of cast iron and cast materials

7.9.3.1 Boiler body

The test pressure is (2 × 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 11. 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 Condensation in the 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.

7.12 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.

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— **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 6.12 are satisfied.

8 Marking and instructions

8.1 Marking of the boiler

8.1.1 General

CR 1472[12)] 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:

a) the name of the manufacturer[13)] or his identification symbol;

b) the serial number or year of manufacture;

c) the trade name of the boiler;

d) if necessary, the CE Marking with:

   1) the identifying number of the boiler;

   2) the last two numbers of the year when the CE Marking was granted;

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

Austria	AT	Greece	GR
Belgium	BE	Ireland	IE
Switzerland	CH	Iceland	IS
Czech Republic	CZ	Italy	IT

12) "General guidance for the marking of gas appliances".

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

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
Latvia	LV	Lithuania	LT
Malta	MT	Poland	PL
Romania	RO	Slovakia	SK
Slovenia	SI	Bulgaria	BG

f) the 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;

g) the gas supply pressure in millibar, if several normal pressures can be used for the same gas group; they are indicated by their numerical value and the unit "mbar";

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

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

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

k) the electrical supply;

l) the nature given by the symbol "~" or "=";

m) the nominal voltage of the electrical supply in volts given by the numerical value followed by the unit "V",

n) the power consumption in watts given by the numerical value followed by the unit "W";

o) the NO_x class of the boiler.

The indelibility of markings is checked by a test carried out in accordance with EN 60335-1:1992, 7.14.

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 24.

This information may be carried on the data plate.

Table 26 — 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 - b 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.

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

b) the maximum water temperature in degrees Celsius;

c) the servicing necessary and the recommended service interval;

d) the method recommended for cleaning the boiler;

e) references to certain standards and/or particular regulations where necessary for the correct installation and use of the boiler;

f) a wiring diagram with the connection terminals (including those for external controls);

g) an indication of the controls which can be used;

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

i) the obligation to earth boilers incorporating electrical equipment;

j) for sealed water systems, instructions concerning the installation of a pressurized 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 operations required to convert from one gas to another and indication that the adjustments and modifications shall only be carried out by a competent person and information that the adjuster shall be sealed after the adjustment;

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

p) information on:

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

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

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) information on the requirements to be observed in respect of the air supply and ventilation of the room in which the boiler is installed;

s) 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;

t) where it is determined that condensation occurs in the boiler (measured under the conditions of 7.11), 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.

8.2.2 For installation of the combustion circuit

These instructions shall carry the following information:

a) information about the type of installation for which the boiler is approved; National Regulations must be consulted regarding types and positions of terminals prior to installation;

b) the instruction that the boiler has to be installed with the necessary accessories (e.g. ducts, terminal, fitting piece) supplied with the boiler or give the specification of the necessary accessories that shall be fitted;

c) the instruction for the installation of parts intended to be fitted to the boiler;

d) the maximum number of bends to be used and the maximum length and, if necessary, the minimum length of the air supply and combustion products evacuation ducts;

e) the particular characteristics of the terminal guard, where provision for this is made, and information on its installation relative to the terminal;

f) for type C1 boilers:

1) The information if and how the terminal shall be placed on the wall and/or on the roof (see 7.4.2.3.2);

2) the instruction that the terminal outlets from separate ducts shall fit inside a square of 100 cm;

g) for type C2 boilers the characteristics of the shared duct systems to which the boiler can be connected;

h) for type C3 boilers – the instruction that the terminal outlets from separate ducts shall fit inside a square of 100 cm and that the distance between the planes of the two orifices shall be less than 100 cm;

i) for type C4 boilers:

1) the minimum and maximum pressure loss permitted in the air supply and combustion products evacuation ducts, or the minimum and maximum length of these ducts;

2) the combustion products temperature and mass rate at the maximum and minimum heat input with the maximum length of ducts, if necessary;

3) the characteristics of the shared duct systems to which the boiler can be connected;

j) for type C5 boilers the instruction that the terminal for the supply of combustion air and for the evacuation of combustion products shall not be installed on opposite walls of the building;

k) for type C6 boilers:

1) the minimum and maximum pressure loss permitted in the air supply and combustion products evacuation ducts, or the minimum and maximum length of these ducts;

2) the combustion products temperature and mass rate at the maximum and minimum heat input;

3) the instruction that the boiler shall only be installed with a terminal that complies with the requirements of EN 1856-1 (see Annex N);

4) the method of calculating the pressure loss in the air supply and combustion products evacuation ducts, starting from the values of the temperature and mass rate of the combustion products in relation to the CO_2 concentration;

l) for type C8 boilers - the characteristics of the chimney to which it is permissible to connect the boiler.

8.2.3 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:

— point out that a competent person should be called on to install the boiler and adjust it if necessary;

— explain the procedure for starting up and shutting off the boiler;

— 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;

— if necessary, explain the precautions to be taken against frost;

— warn against incorrect use;

— draw the attention of the user to the requirements concerning air supply for ventilation of the room in which the boiler is installed;

— if necessary, draw the user's attention to the risks of burning associated with direct contact with the viewing window or its immediate environment.

8.2.4 Conversion instructions

Parts intended for conversion to another gas family, another group, another range and/or another supply pressure, shall be accompanied by conversion instructions intended for the competent person.

The instructions shall:

— specify the parts necessary to carry out the conversion and their means of identification;

— clearly specify the operations necessary to change the parts and make the correct adjustment, where appropriate;

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

— 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:

— the gas group or range;

— the gas type;

— the gas supply pressure and/or the pressure couple;

— the adjusted heat input, where appropriate.

8.3 Presentation

All the information of 8.1 and 8.2 is given in the language(s) and according to the practice of the country(ies) in which the boiler is intended to be installed.

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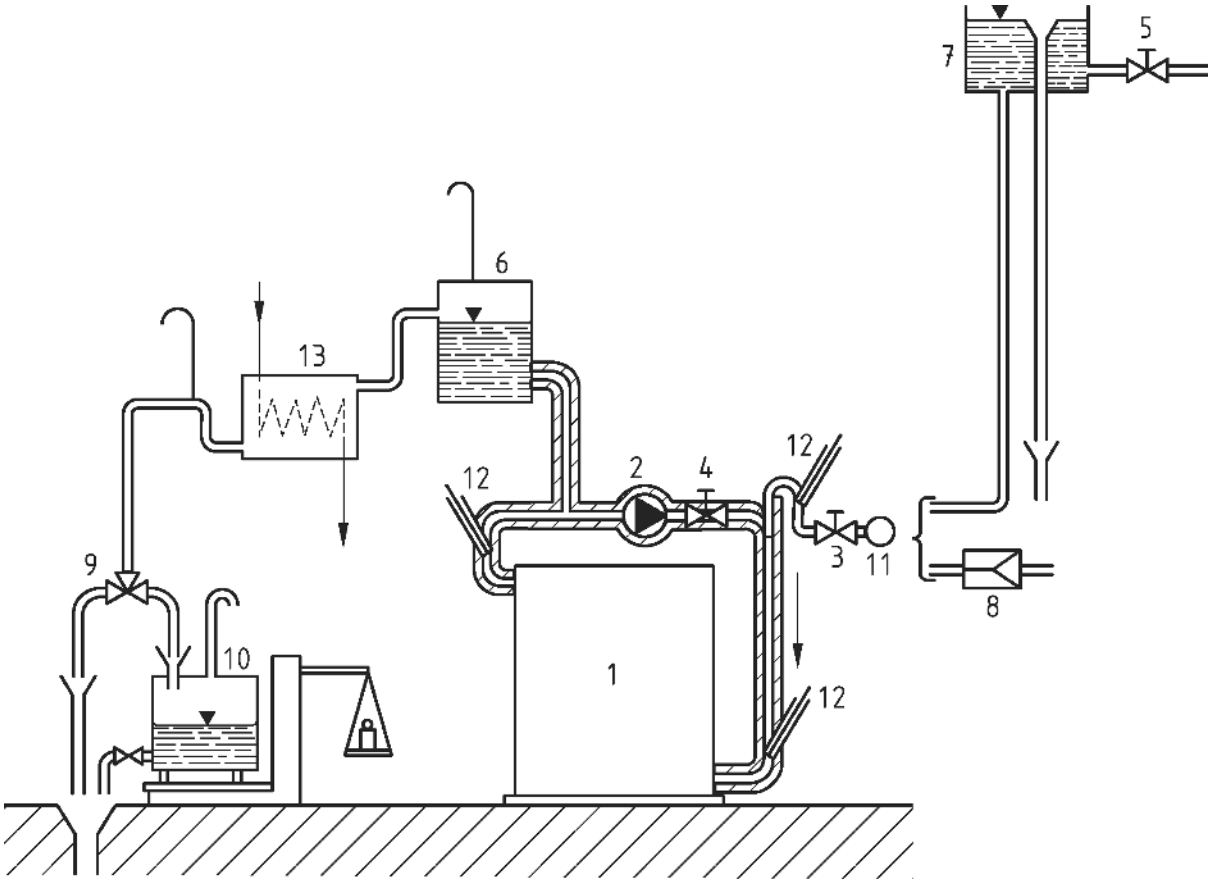
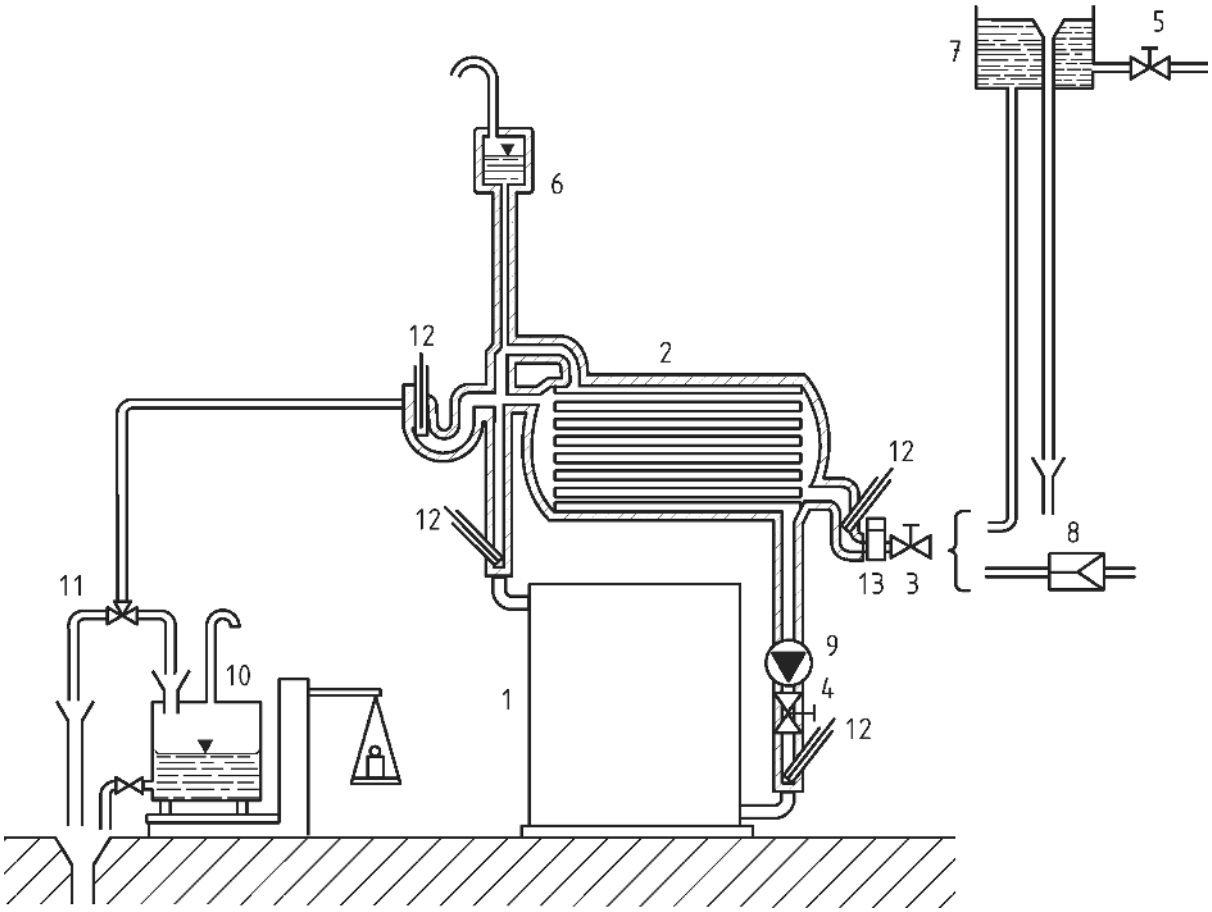


Key

1	boiler under test	8	connection to a constant pressure distribution pipe
2	circulating pump		
3	control valve I	9	three-way tap
4	control valve II	10	weighing vessel
5	control valve III	11	water meter
6	compensating tank	12	temperature measurements
7	constant head tank or	13	cooler

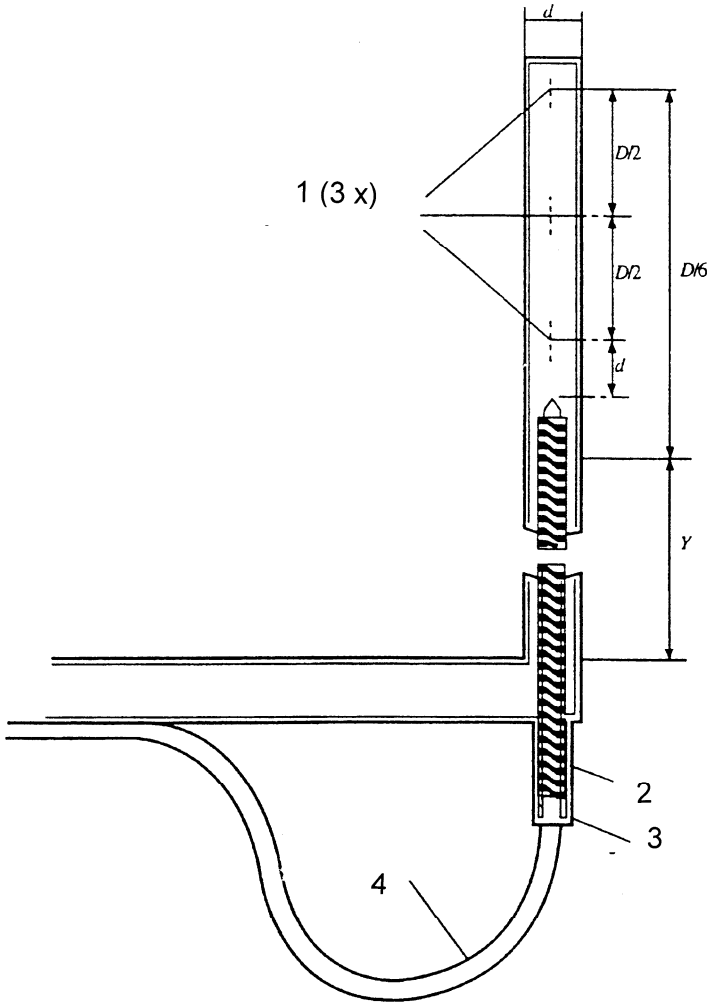
Figure 1 — Test rig with direct recirculation



Key

1 boiler under test
2 heat exchanger
3 control valve I
4 control valve II
5 control valve III
6 expansion vessel (not in the circulating system)
7 constant head or
8 connection to a constant pressure distribution pipe
9 circulating pump
10 weighing vessel
11 three-way tap
12 temperature measurements
13 water meter

Figure 2 — Test rig with heat exchanger



Key

1	sampling points (3 ×)	3	insulating cement
2	ceramic tube with two ducts	4	chromel/alumel thermouple wires

NOTE 1 The dimensions of a 6 mm diameter probe (suitable for a flue of diameter D greater than 75 mm) are as follows:

—	external diameter of the probe (d)	6 mm;
—	wall thickness	0,6 mm;
—	diameter of the three sampling holes (x)	1,0 mm
—	two channel ceramic tube	3 mm diameter with channels of 0,5 mm diameter;
—	thermocouple wire	0,2 mm diameter.

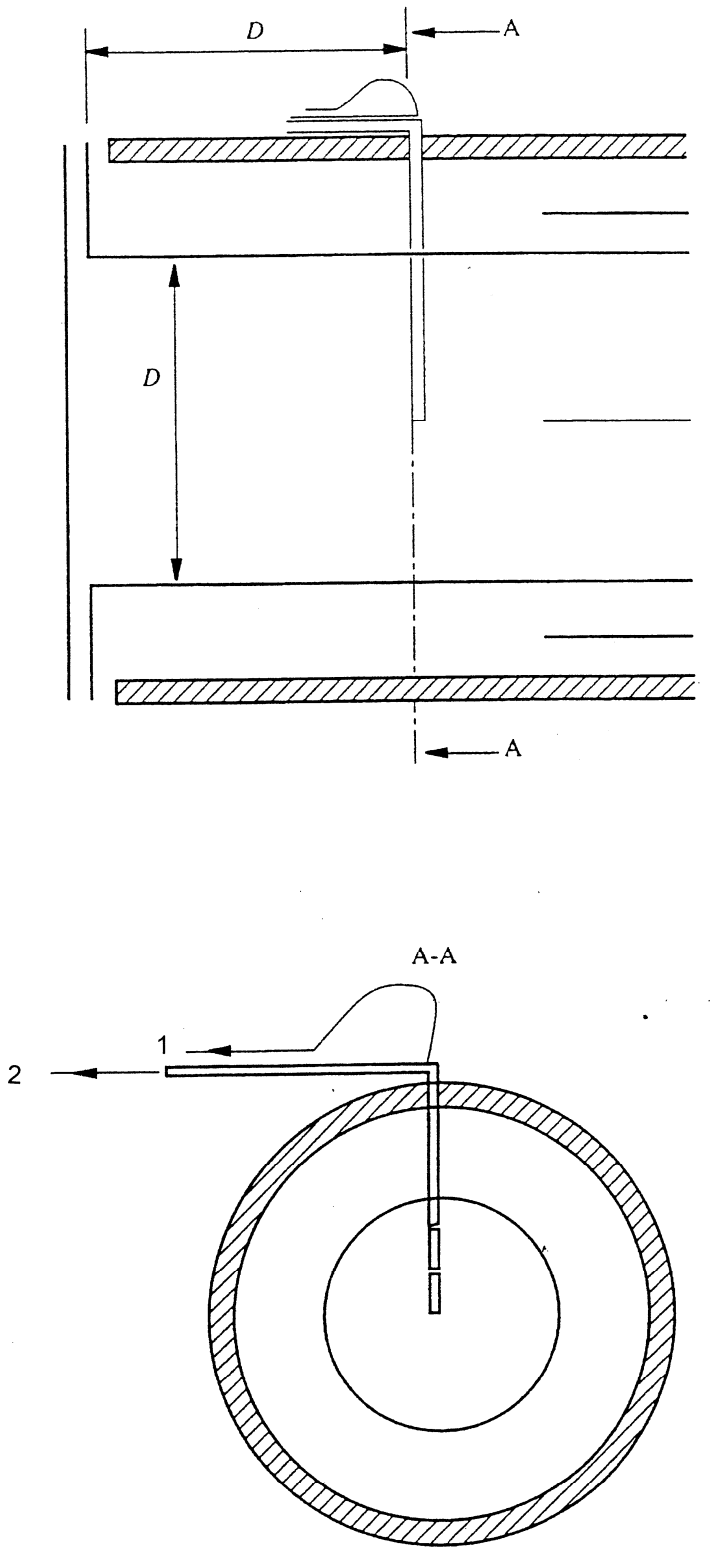
The dimensions (d) and (x) of a probe suitable for a flue of diameter less than 75 mm shall be such that:

— the cross-section of the probe shall be less than 5 % of the cross-section of the flue,
— the total surface area of the three sampling holes is less than three quarters of the cross-section of the probe.

NOTE 2 The dimension Y is chosen depending on the diameter of the air inlet duct and its insulation.

Material: stainless steel.

Figure 3 — Example of probe for measuring the temperature of the combustion products

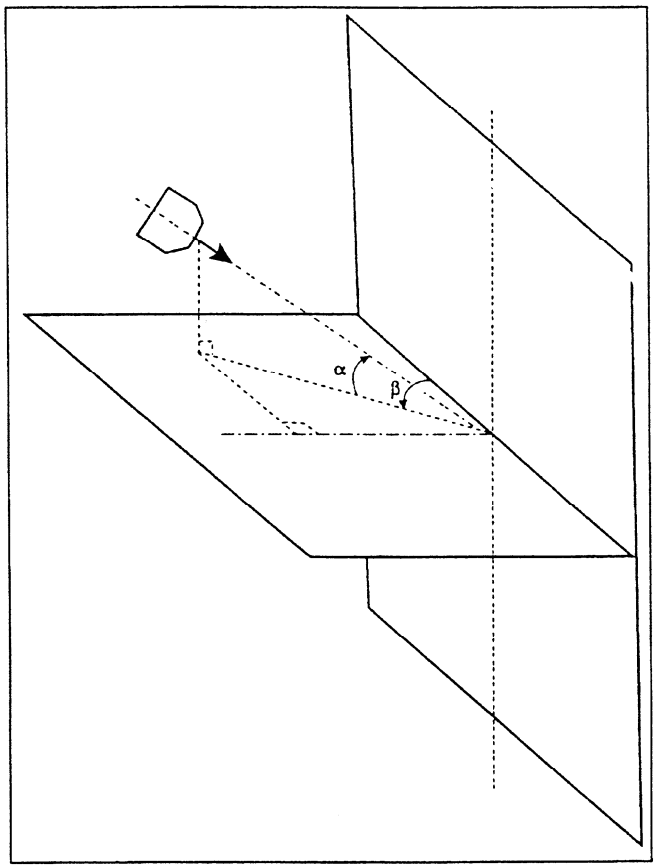


Key

1 to the temperature reader

2 to the sampling pump

Figure 4 — Position of the sample probe for type C boilers



α = 0° (horizontal winds), + 30° and 30°.

β = (glancing winds), 15°, 30°, 45°, 60°, 75°, 90°, (perpendicular to the test wall). For appliances fitted with a non symmetrical terminal, the examination is continued for the following values: 105°, 120°, 135°, 150°, 165°, 180°.

Angle β may be varied either by modification of the position of the wind generator (fixed wall) or by rotation of the test wall about a central vertical axis.

The test wall consists of a strong vertical wall of at least 2,5 m $\times$ 2,5 m, with a removable panel at its centre. The device for supplying combustion air and discharging combustion products is mounted so that its geometric centre is at the centre of 0 of the test wall, and its projection from the wall is as recommended by the manufacturer.

The characteristics of the wind generator and the distance from the test wall at which it is placed are chosen such that the following criteria are met at the level of the test wall, after the central panel has been removed:

— during the test, the largest projected area of the air/flue terminal in the airflow shall not be more than 20 % of the wind tunnel outlet;
— wind speeds of 1 m/s, 2,5 m/s and 12,5 m/s with an accuracy of 10 % can be obtained;
— the wind stream is essentially parallel and has no residual rotational movement; if the central removable panel is not large enough to allow checking of these criteria, they are checked without the wall and measured at a distance corresponding to the distance existing in practice between the test wall and the wind generator discharge nozzle.

Figure 5 — Test rig for type C boilers fitted with a horizontal terminal installed on a vertical wall

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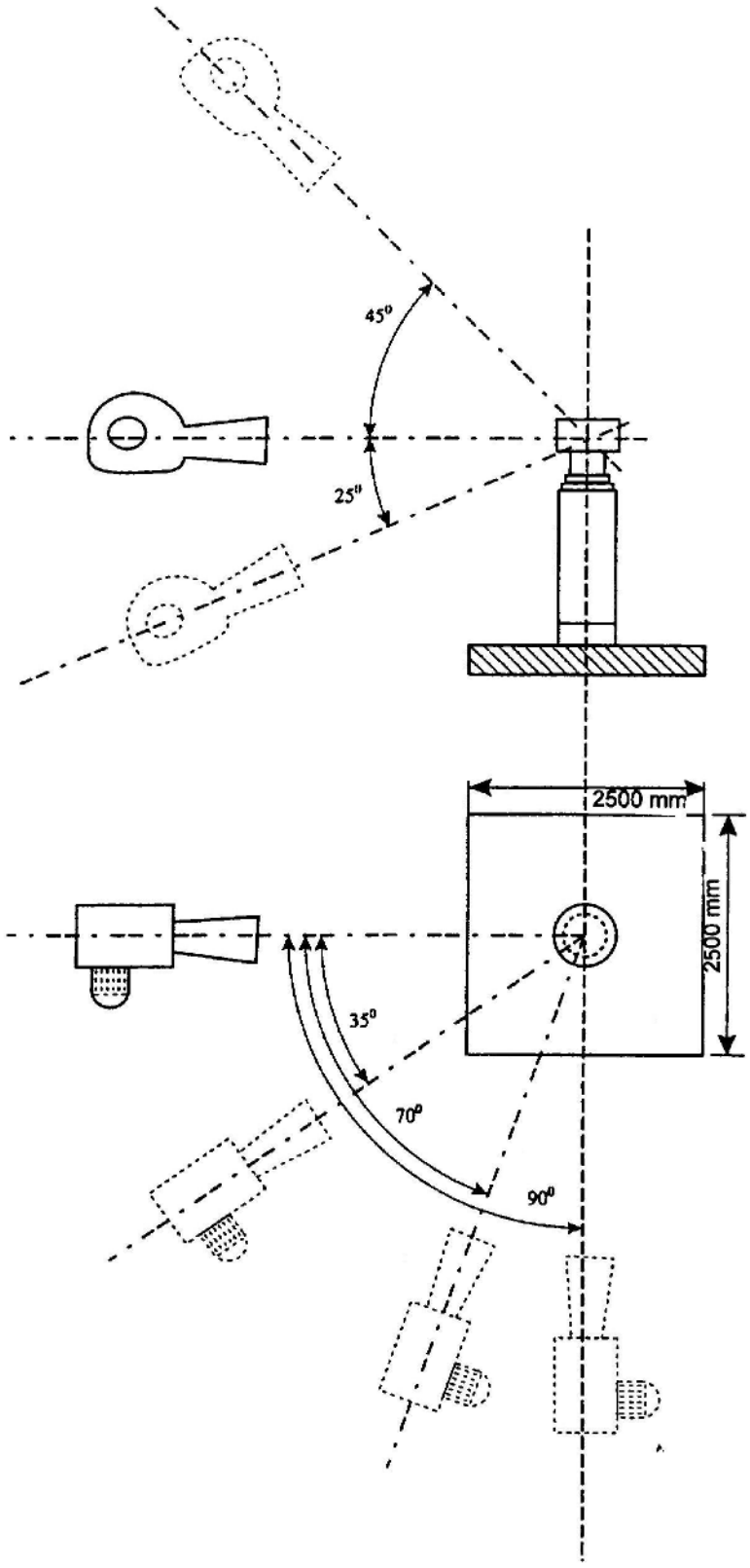

Figure 6 — Test rig for type C boilers fitted with a vertical terminal on a flat roof

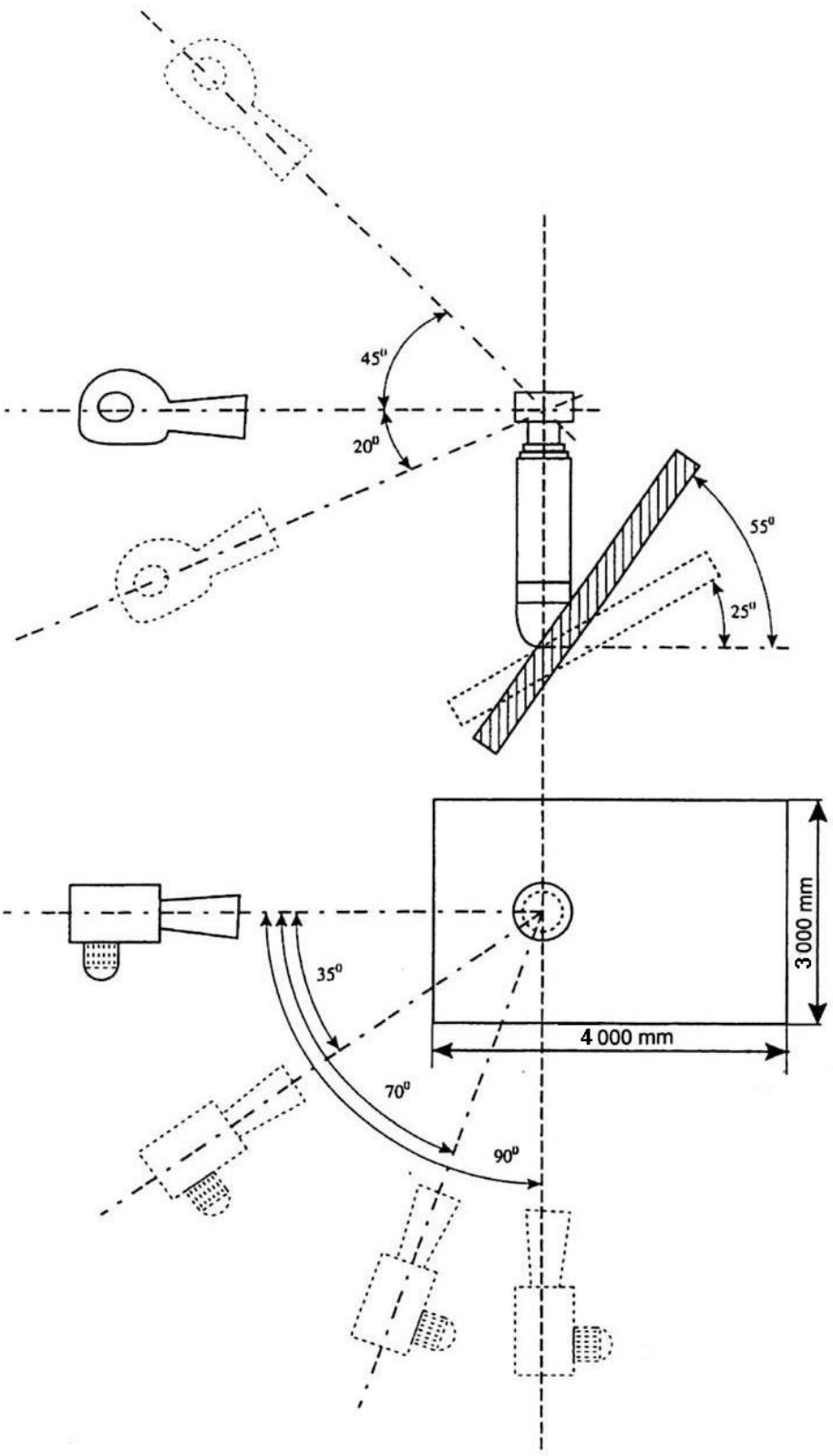

Figure 7 — Test rig for type C boilers fitted with a vertical terminal on a pitched roof

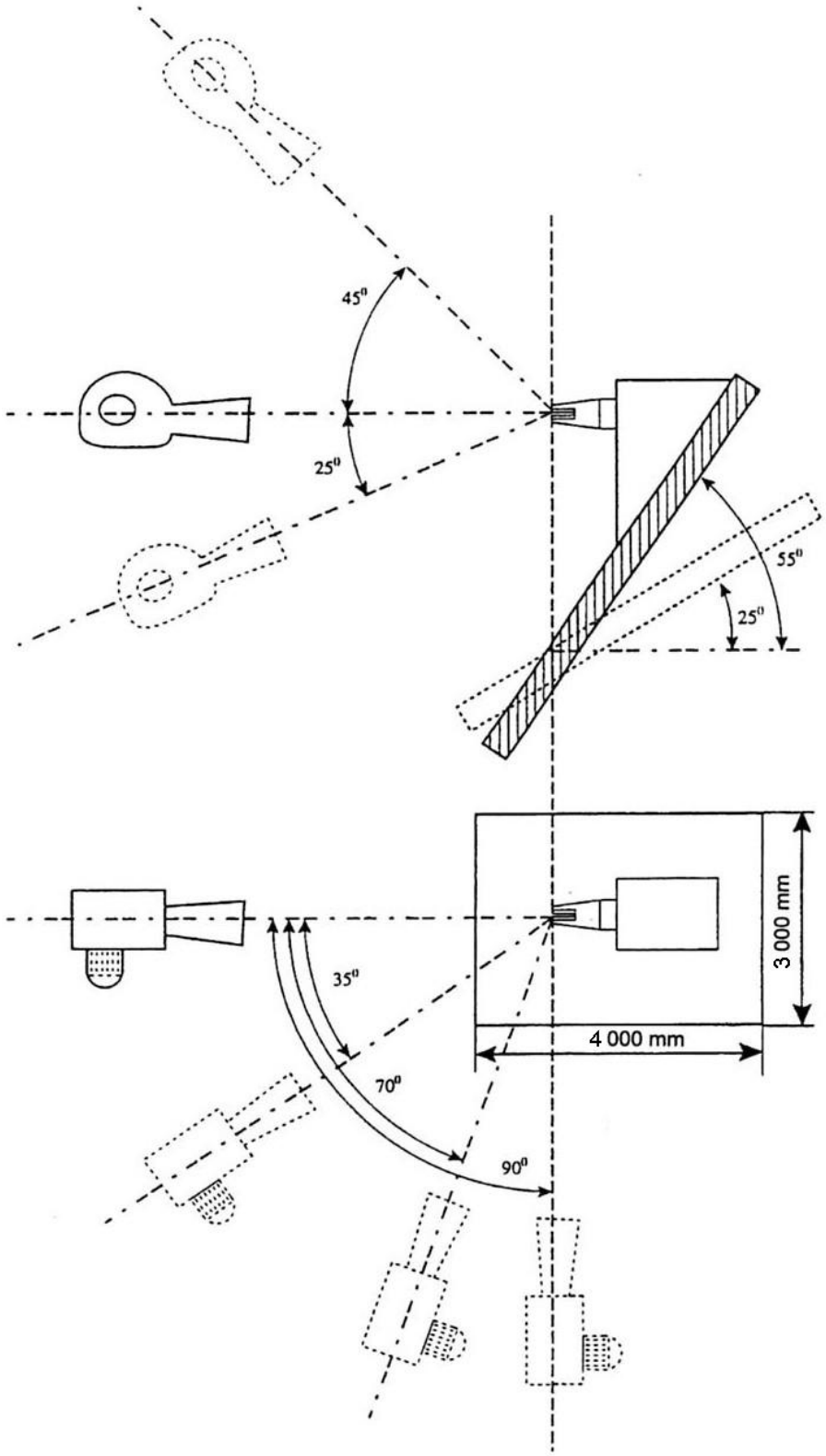

Figure 8 — Test rig for type C boilers fitted with a horizontal terminal on a roof

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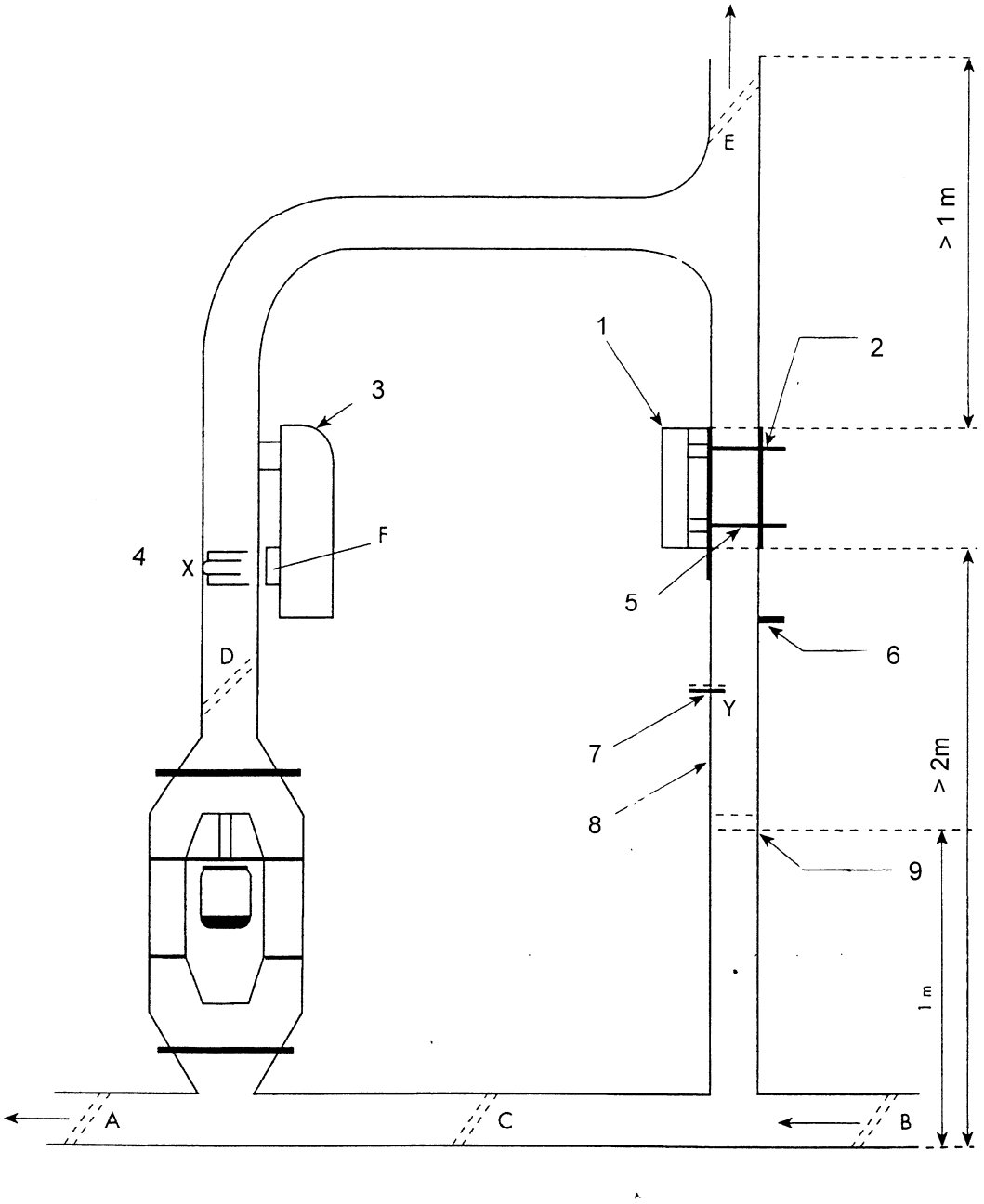


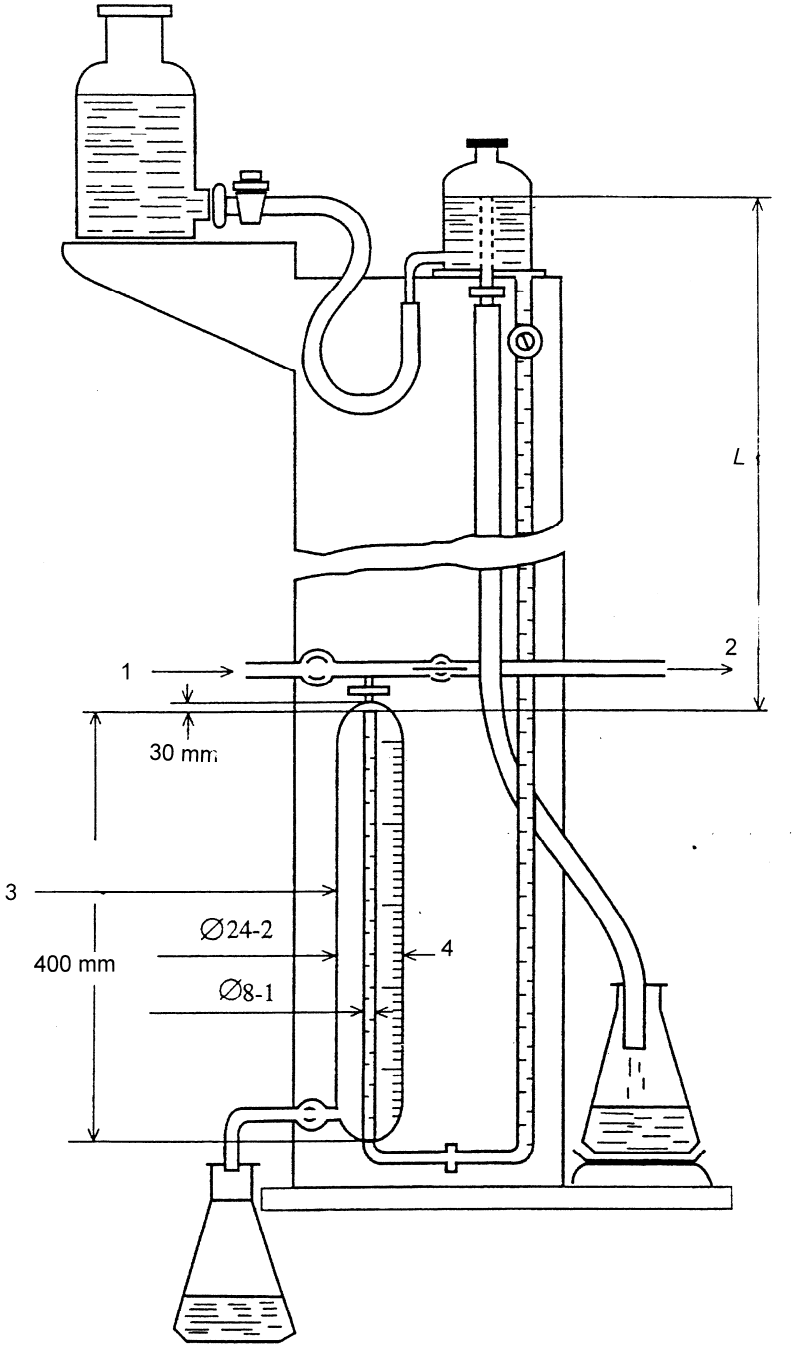
Key

1 appliance under test
2 to *CO* and CO_2 analysers
3 water heater
4 heat exchanger
5 connection to *CO* and CO_2 analysers for upflow vitiation tests
6 pressure probe
7 temperature probe
8 duct of rectangular section 1 250 × Q mm^2
9 recording anemometers (2×; interchangeable)

For details of the function of dampers A to F and explanation of X and Y refer to Annex M.

Figure 9 — Test on a type C2 boiler mounted on the duct

Dimensions in millimetres

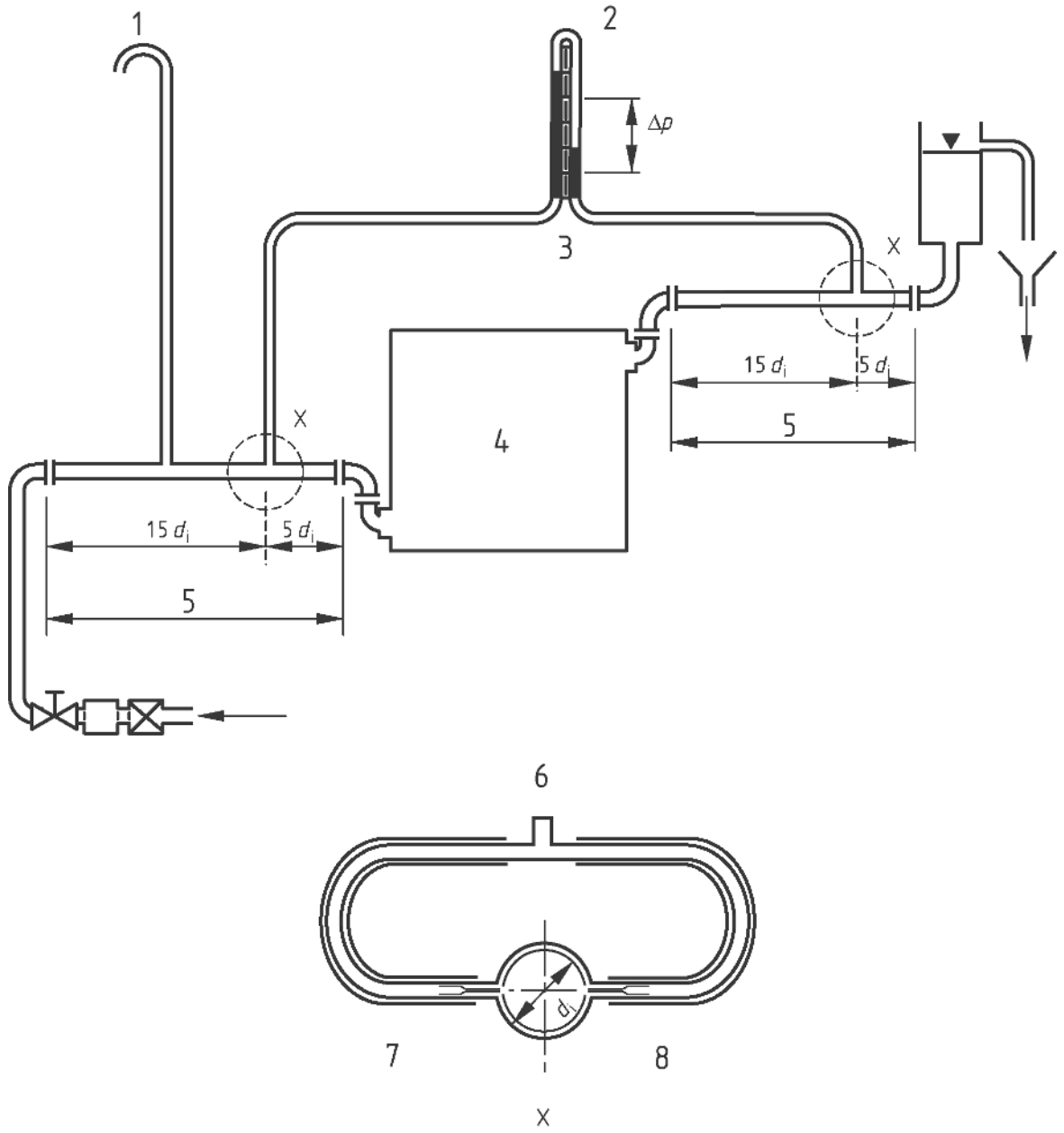


Key

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 10 — Device for checking the soundness of the gas circuit

Dimensions in millimetres

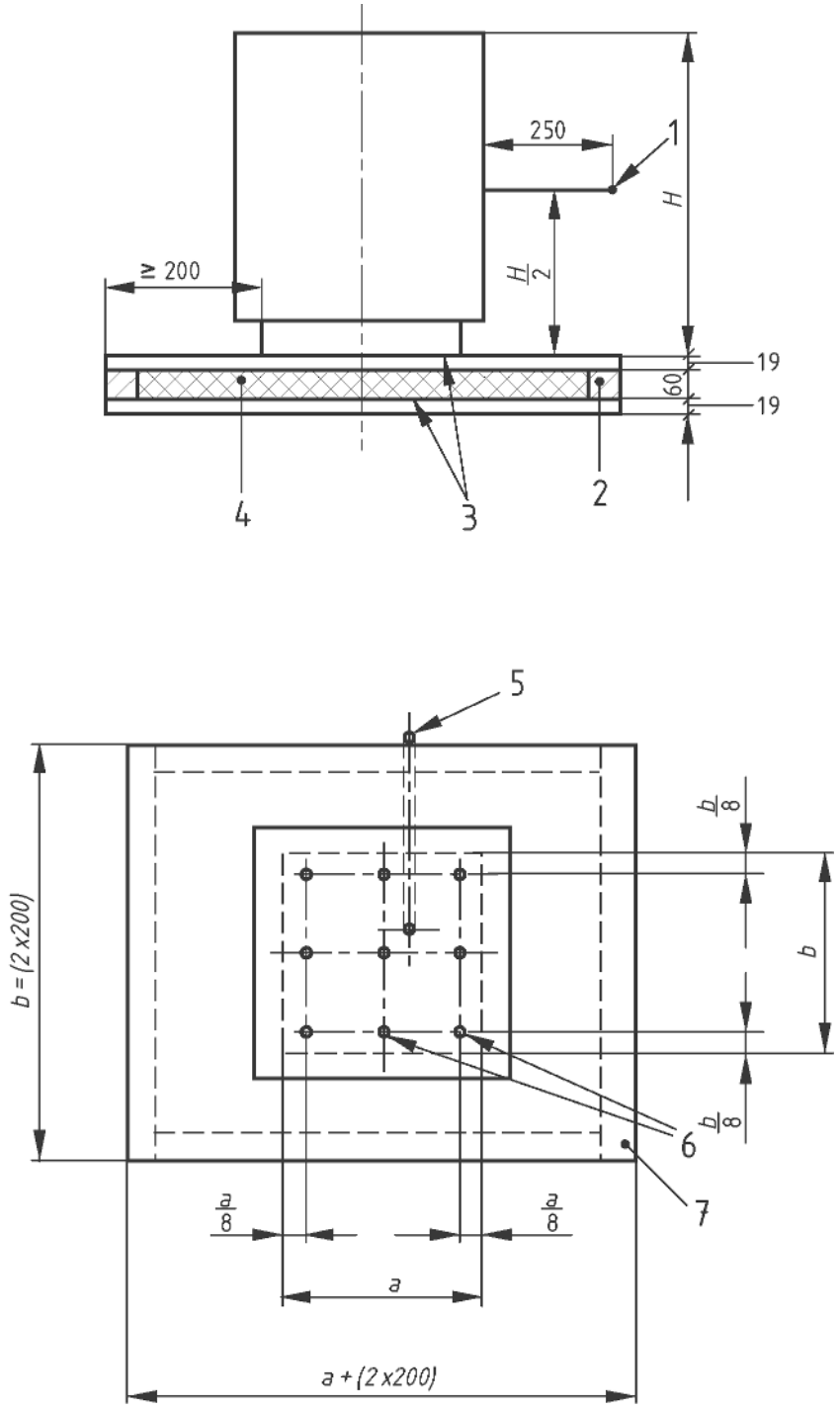


Key

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 11 — Determination of the hydraulic resistance

Dimensions in millimetres

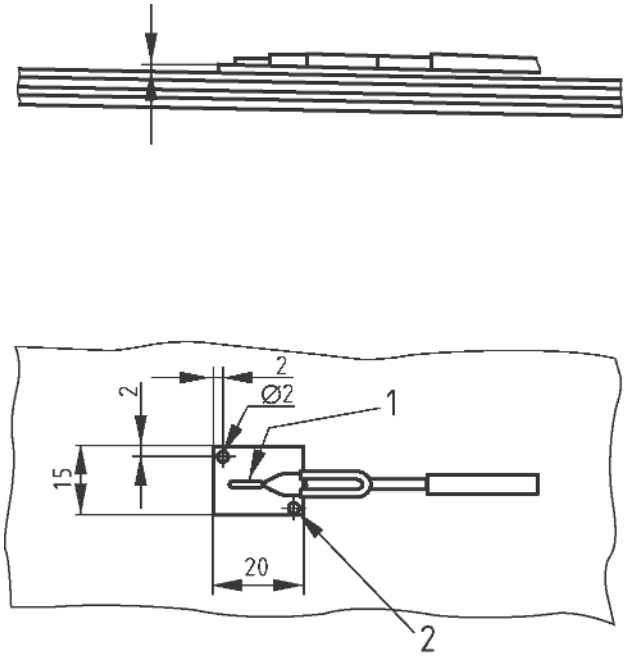


Key

1	air temperature measurement point	5	hollow tube for measurement cable
2	squared-timber frame	6	measurement point
3	Norway spruce with groove and spring	7	test floor for measuring floor temperature
4	glass fibre		

Figure 12 — Test configuration for determining floor temperature

Dimensions in millimetres

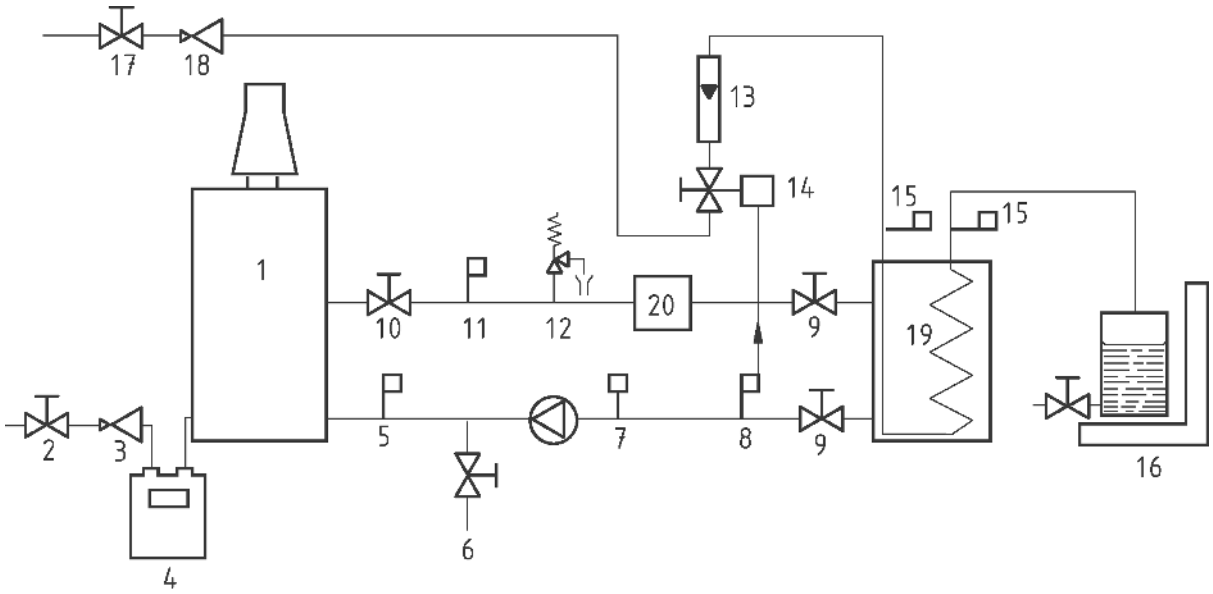


Key

1 thermocouple brazed to copper plate

2 holes for fitting copper plate

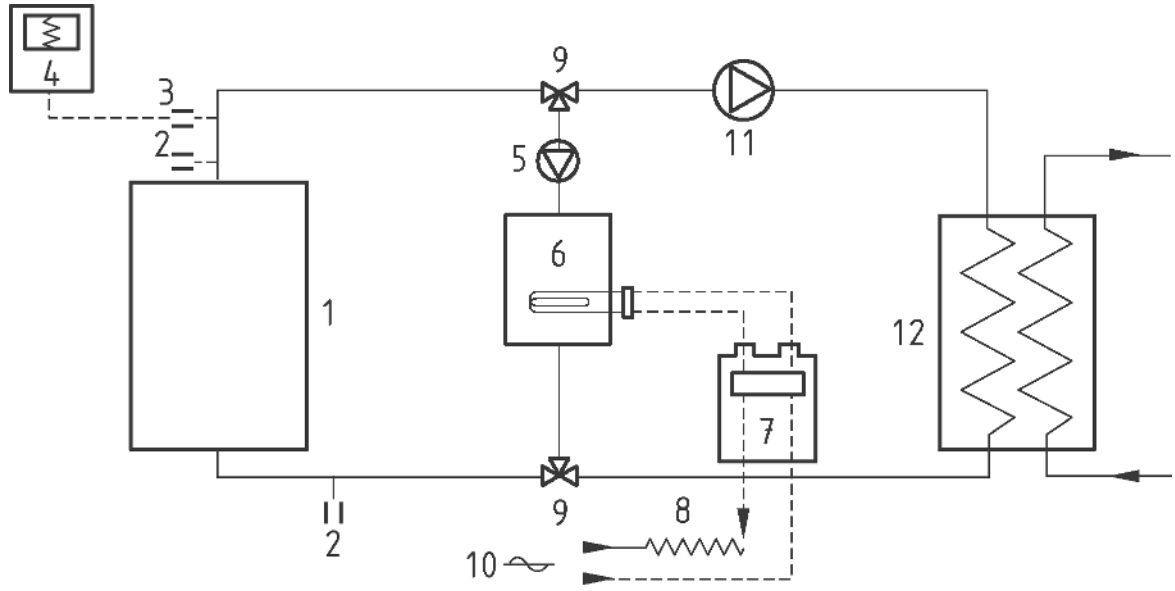
Figure 13 — Thermocouple configuration for measuring surface temperatures on test floor



Key

1	boiler under test	14	control valve
2/17	shut-off valve	9/10	shut-off valve
3/18	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 14 — Test rig for determination of part-load efficiency



Key

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	¼ 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 15 — Test installation to determine the heat emissions of the boiler when the burner is off

Annex A
(informative)

National situations

In each country that this 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, A.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.1 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 and A.2 should be referred to.

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Table A.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
PL			X				X		X		
PT	X				X [a]	X		X	X		X
SE	X						X				
SI	X				X	X	X	X	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 EN 437:2003, B.5.

[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.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	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
PL							X				
PT			X	X							X
SE	X	X									
SI		X	X	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.2 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.3 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.4 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 112/148b
AT		X					X			X			
BE					X	X	X [d]		X		X		
CH	X	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					
PL		X							X				
PT		X				X			X		X		
SE	X	X				X		X					
SI		X				X			X		X		

[a] For certain non-domestic appliances: 17,5 mbar.

[b] Only for certain types of non-domestic appliance.

[c] For certain types of industrial appliances.

[d] 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.5 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 in common use in the various countries

Country code	Category I3						Other categories				
	Threaded connections		Plain connections	Compression joints	Other connections in 5.6.2	Flanges	Threaded connections		Plain connections	Compression joints	Flanges
	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				
BE	Yes			Yes	Yes		Yes				
CH					Yes		Yes				
CZ											
DE					Yes		Yes				
DK					Yes		Yes				
ES		Yes	Yes		Yes			Yes	Yes		
FI	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											
PL	Yes	Yes	Yes				Yes	Yes			
PT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
SE											
SI	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[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 complying with such a standard should not be restricted within the EC except under the safeguard procedure provided for in the relevant Directive.

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

Switzerland
The Swiss law (Luftreinhalte-Verordnung, LRV) of 1985-12-16 (state on 2005-08-23) is applicable instead of the requirements of 6.6 and 6.7 regarding energy efficiency (chimney losses, standby losses) and emissions of *CO* and NO_x.

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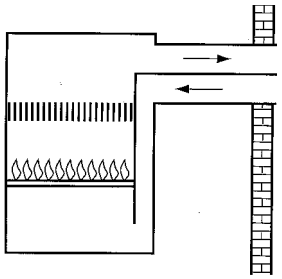
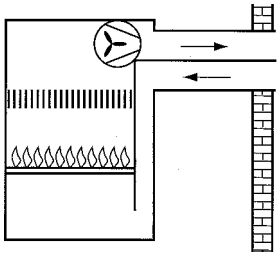
Annex D
(informative)

Classification of type C boilers

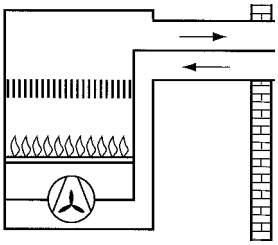
The figures in this annex are purely illustrations; they are intended to be neither technically perfect nor complete in themselves.



a) C11

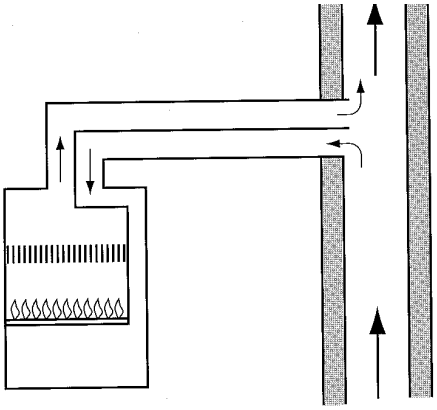


b) C12

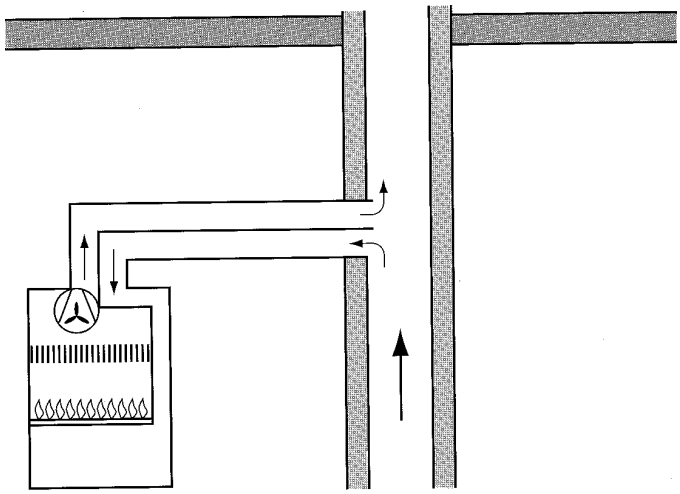


c) C13

Figure D.1 — Type C1



a) C21



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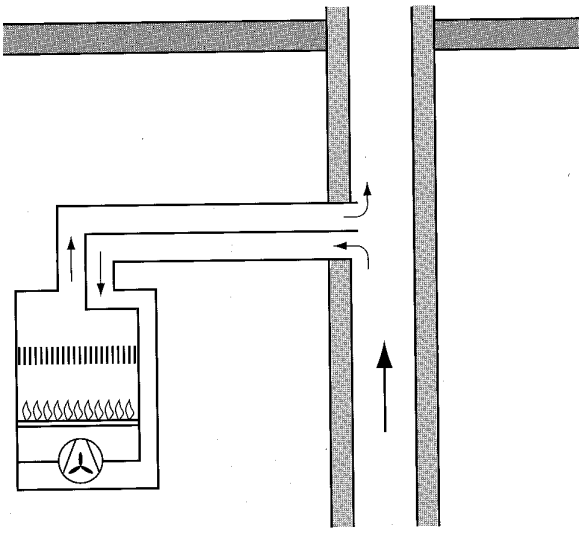

c) C23

Figure D.2 —Type C2

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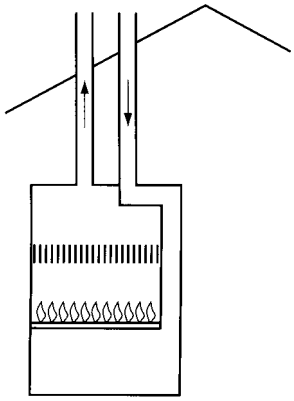
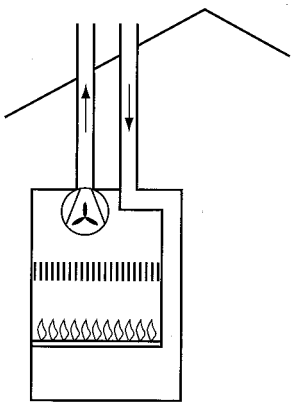
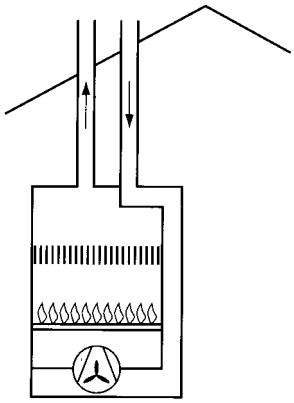


a) C31



b) C32



c) C33

Figure D.3 — Type C3

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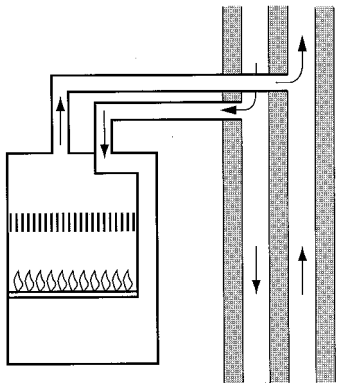
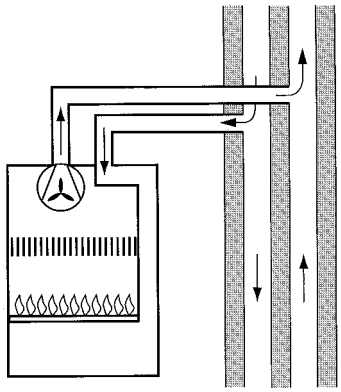
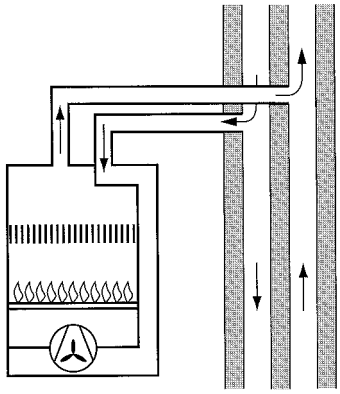


a) C41



b) C42



c) C43

Figure D.4 — Type C4

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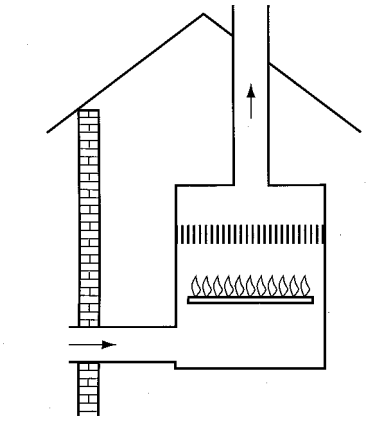
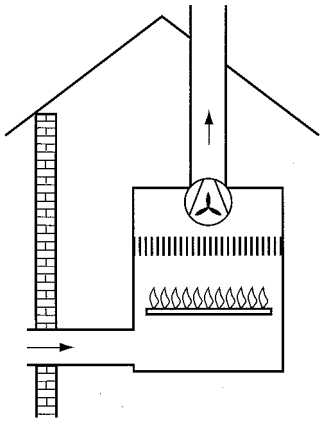
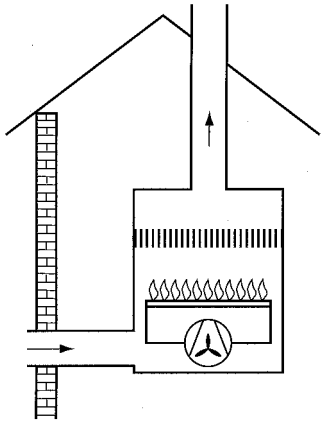


a) C51



b) C52



c) C53

Figure D.5 — Type C5

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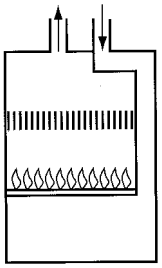
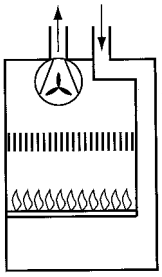
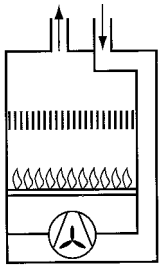


a) C61



b) C62



c) C63

Figure D.6 — Type C6

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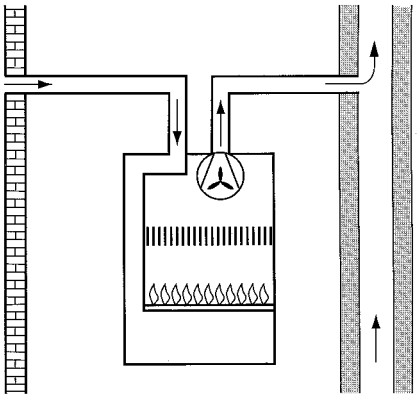
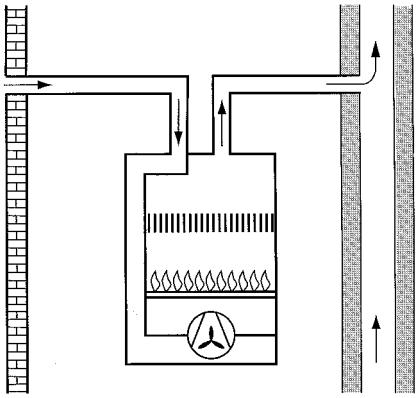
C81

(not covered by this standard)



a) C82



b) C83

Figure D.7 — Type C8

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Annex E
(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 must 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.

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Annex F
(informative)

Main symbols and abbreviations used

Table F.1 — Main 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}
Useful output	P
Nominal output	P_n
Useful efficiency	η_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}

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Annex G
(informative)

Compilation of test conditions

Table G.1 — First family

Test		Test gas	Pressure/heat input [a]
Initial adjustment with reference gas		G 110	Q
Ignition, cross-lighting with reference gas		G 110	0,7 p_n
Light-back with limit gas		G 112	p_{min}
Flame lift with limit gas		G 110 G 110	p_{min} p_{max}
Combustion	Nominal voltage	G 110 G 110 G 110	1,07 Q 1,05 Q 0,95 Q
	Wind conditions	G 110	Q
	0,85 to 1,10 times the nominal voltage	G 110	p_n

[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 G.2 — Second family

Test		Test gas groups			Pressure/heat input [a]	
		E	H	L	Without pressure regulator [b]	With pressure regulator
Initial adjustment with reference gas		G 20	G 20	G 25	Q	Q
Ignition, cross-lighting with reference gas		G 20	G 20	G 25	0,7 p_n	0,7 p_n
Light-back with limit gas		G 222	G 222	G 25	p_{min}	p_{min}
Flame lift with limit gas		G 231	G 23	G 27	p_{min} p_{max}	p_{min} p_{max}
Combustion	Nominal voltage	G 20	G 20	G 25	1,10 Q	1,05 Q
		G 21	G 21	G 26	1,075 Q [c]	1,05 Q
		G 231	G 23	G 27	p_{min} [d]	0,95 Q
	Wind conditions	G 20	G 20	G 25	Q	Q
	0,85 to 1,10 times the nominal voltage	G 20	G 20	G 25	p_n	p_n

[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] 1,05 Q if the boiler is intended to be installed exclusively with a governed meter or Q_{max} for gas/air ratio controls.

[d] 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.

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Table G.3 — Third family

Test		Test gas groups		Pressure/heat input [a]	
		Butane/ Propane	Propane	Without Regulator [b]	With Regulator
Initial adjustment with reference gas		G 30	G 31	Q	Q
Ignition, cross-lighting with reference gas		G 30	G 31	$0{,}7p_n$	$0{,}7p_n$
Light-back with limit gas		G 32	G 32	p_{min}	p_{min}
Flame lift with limit gas		G 31	G 31	p_{min} p_{max}	p_{min} p_{max}
Combustion	Nominal voltage	G 30	G 31	1,10 Q	1,05 Q
		G 30	G 31	1,075 Q [c]	1,05 Q
		G 31	G 31	p_{min} [d]	0,95 Q
	Wind conditions	G 30	G 31	Q	Q
	0,85 to 1,10 times the nominal voltage	G 30	G 31	p_n	p_n

[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] 1,05 Q if the boiler is intended to be installed exclusively with a regulated meter or Q_{max} for gas/air ratio controls.

[d] 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 H
(informative)

Valving

H.1 General

For valve arrangements on appliances with automatic ignition which have ignition burner heat inputs between 250 W and 1 000 W, 6.5.3.3.1, second indent, is applicable.

H.2 Boilers with permanent ignition burner or alternating ignition burner or leakage control device or with pre-purge

H.2.1 Heat inputs up to 150 kW

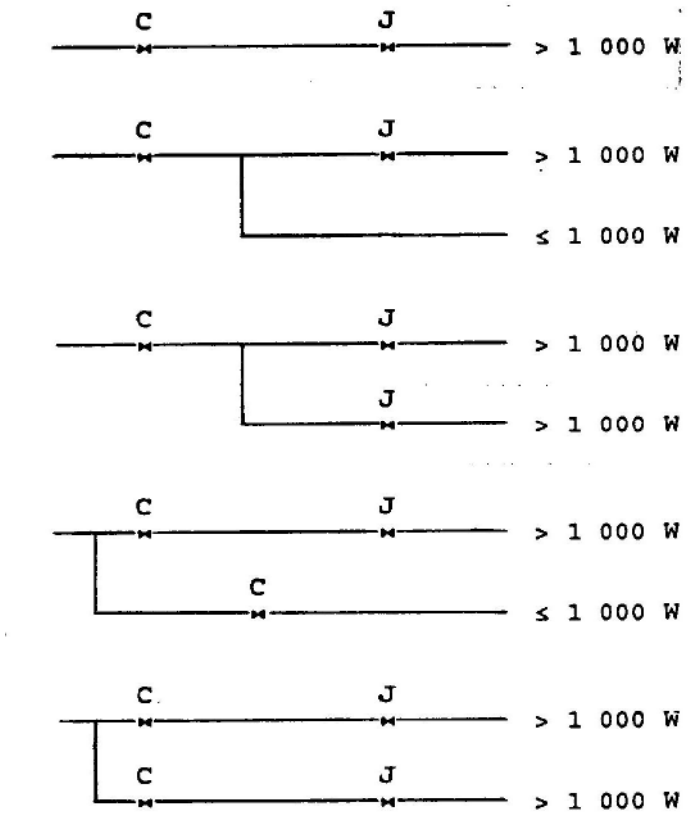


Figure H.1 — Heat inputs up to 150 kW

H.2.2 Heat inputs up to 300 kW

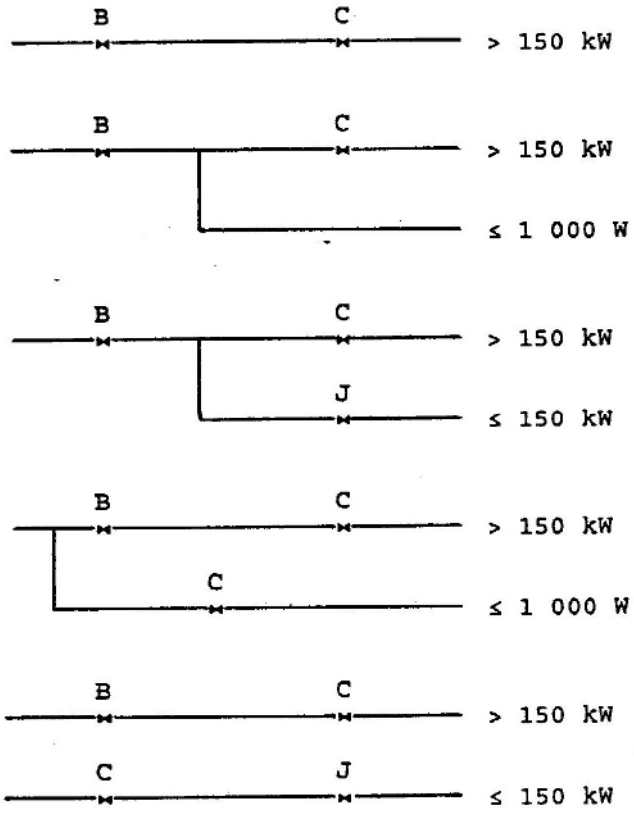


Figure H.2 — Heat inputs up to 300 kW

H.3 Boilers without permanent ignition burner or alternating ignition burner, without leakage control device and without pre-purge

H.3.1 Heat inputs up to 150 kW

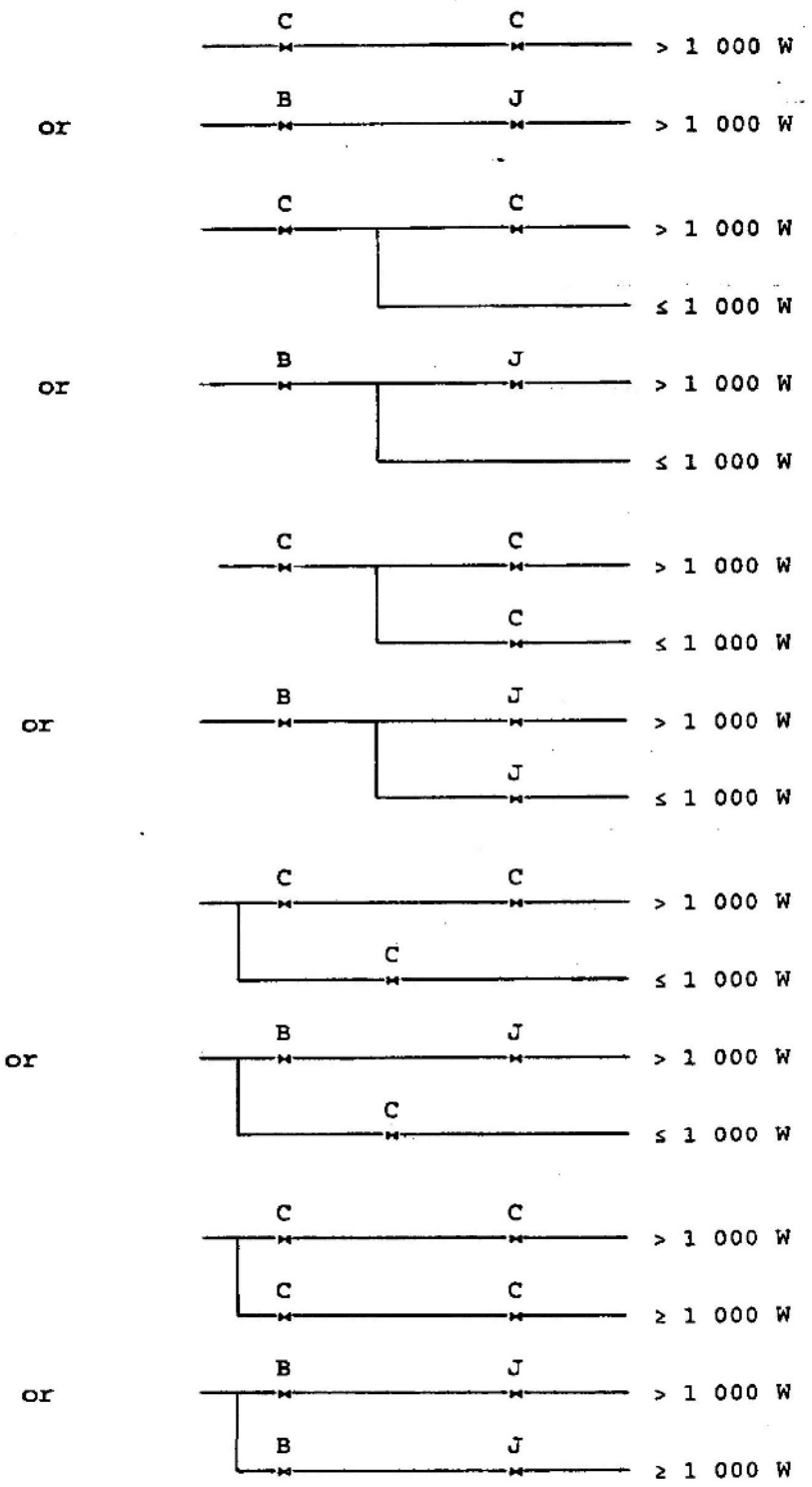


Figure H.3 — Heat inputs up to 150 kW

H.3.2 Heat inputs up to 300 kW

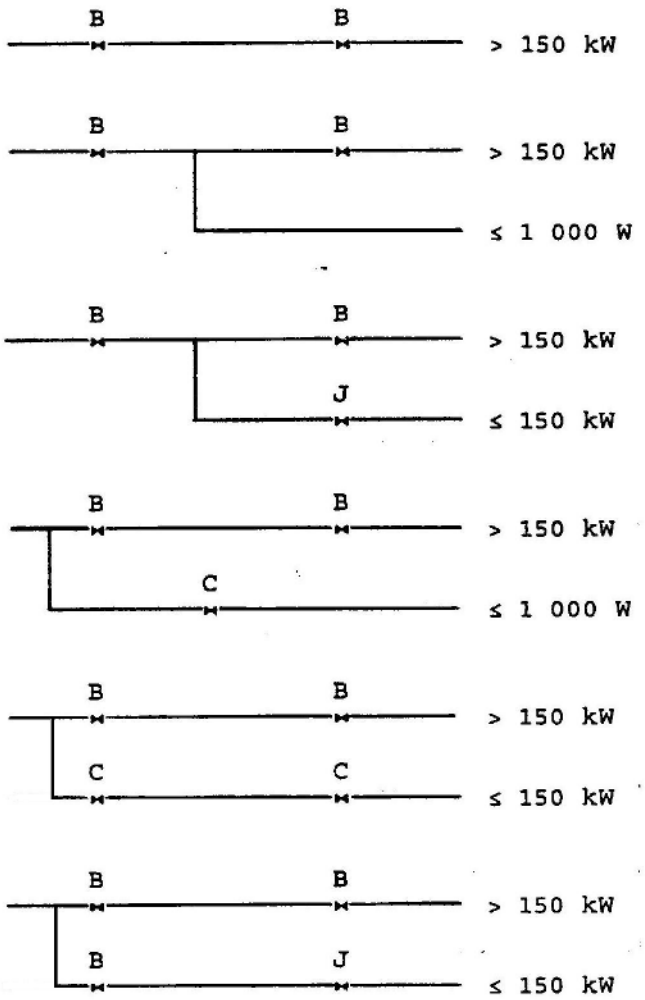
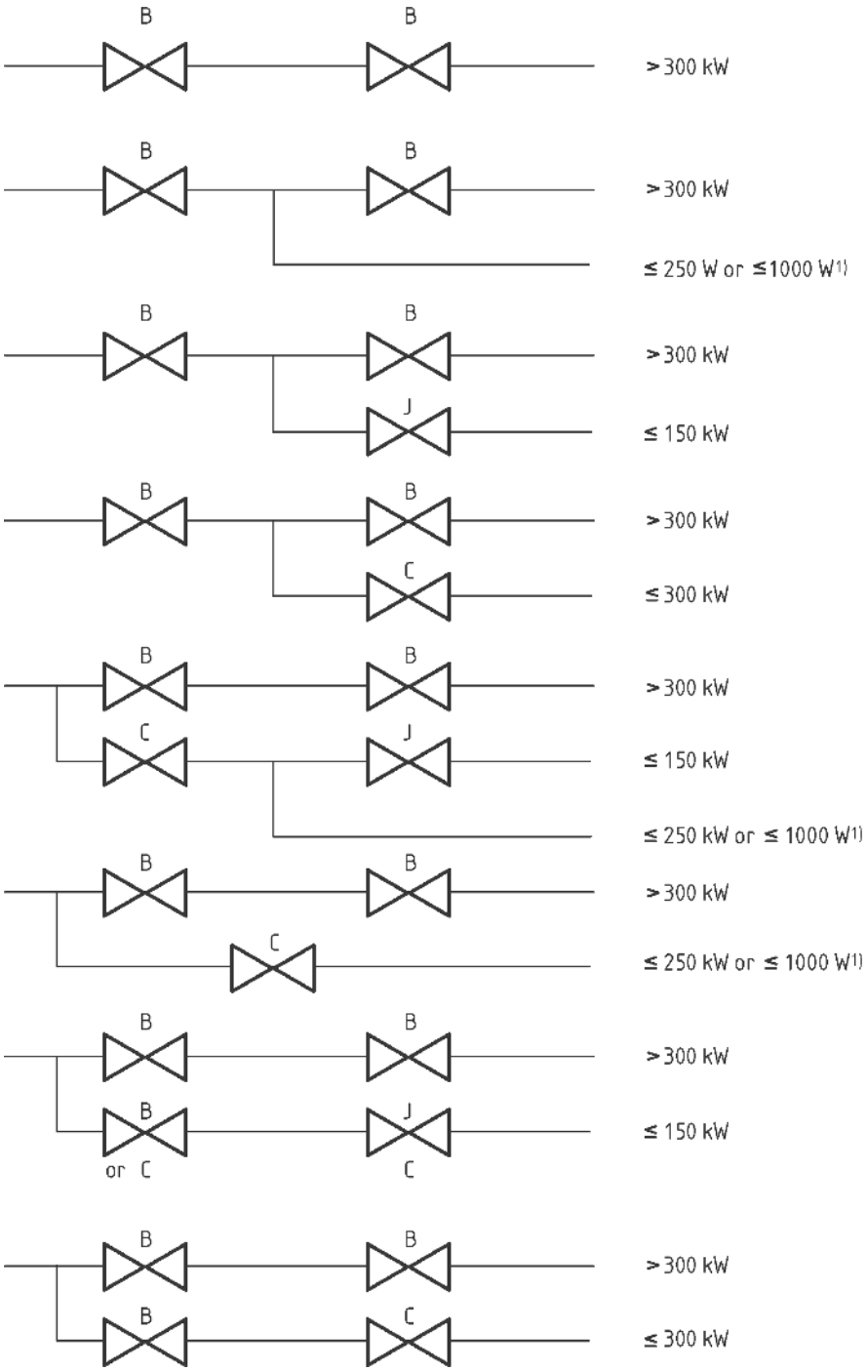


Figure H.4 — Heat inputs up to 300 kW

H.4 Heat Inputs exceeding 300 kW but not exceeding 1 000 kW

H.4.1 Boilers with permanent ignition burner or alternating ignition burner or leakage control device or with pre-purge

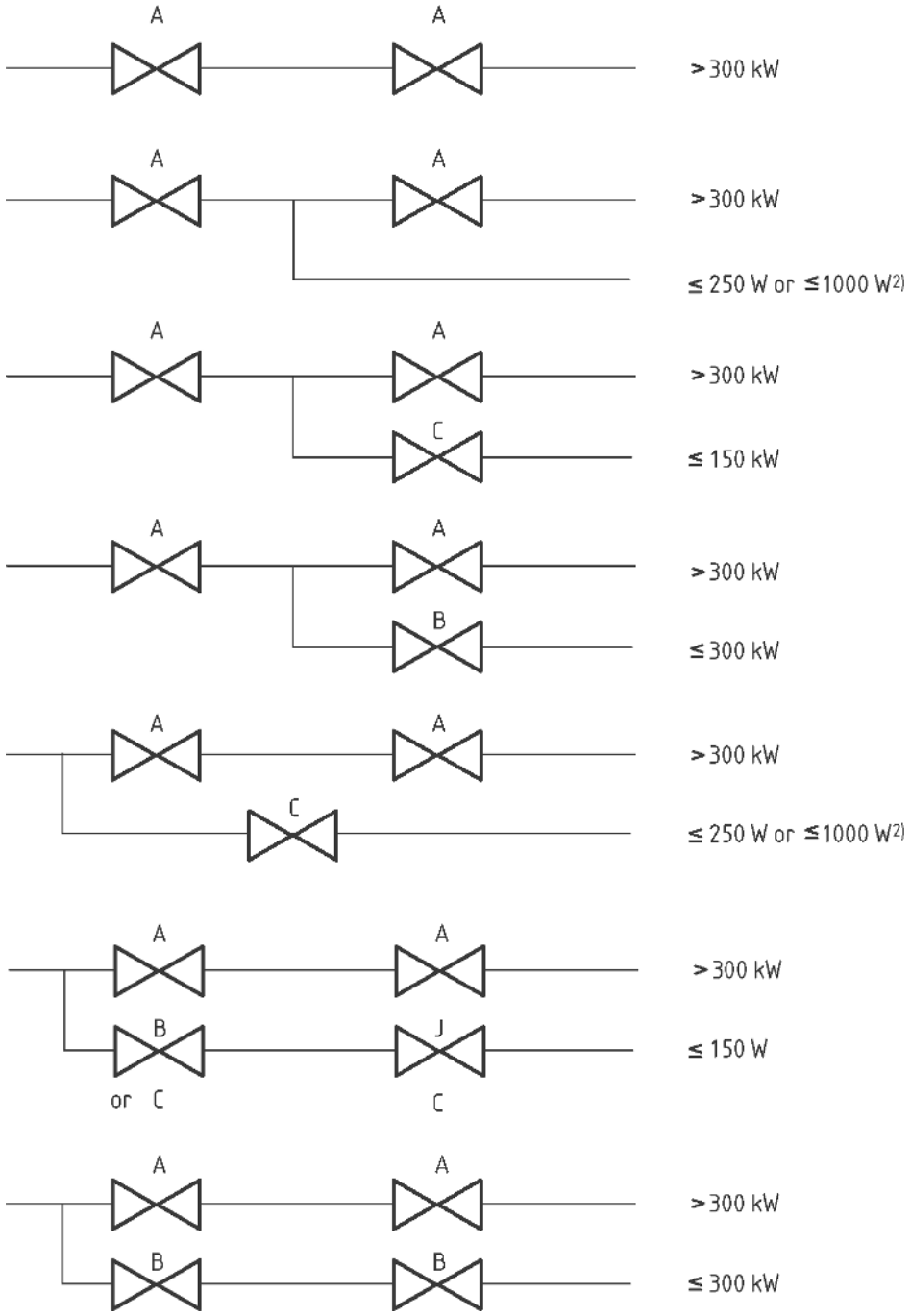


Key

1) See special conditions in 6.5.3.3.1, second indent, if the ≤ 1 000 W value is to apply.

Figure H.5 — Boilers with permanent ignition burner or alternating ignition burner or leakage control device or with pre-purge

H.4.2 Boilers without permanent ignition burner or alternating ignition burner, without a leakage control device and without pre-purge



Key

2) See special conditions in 6.5.3.3.1, second indent, if the ≤ 1 000 W value is to apply.

Figure H.6 — Boilers without permanent ignition burner or alternating ignition burner, without a leakage control device and without pre-purge

Annex I
(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 15 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 - TA) 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).

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Annex J
(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 p1 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:

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

where

Q_{nom} 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_{nom} is the pressure corresponding to the full rate, in mbar;

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

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Annex K
(informative)

Example of the calculation of the NO_x weighting factors for a boiler with several rates

Example of the calculation of the weighting factors for a boiler with several rates

Rates of the boiler: 100 %, 50 % and 30 %

Table K.1

Q_{pi}	70	60	40	20
F_{pi}	0,15	0,25	0,3	0,3

K.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

K.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:

$$F_{pi}(50\%) = F_{pi}(40\%) \times \frac{Q(40\%) - Q(30\%)}{Q(50\%) - Q(30\%)} \times \frac{Q(50\%)}{Q(40\%)}$$

$$F_{pi}(50\%) = 0,3 \times \frac{40 - 30}{50 - 30} \times \frac{50}{40} = 0,1875$$

— Low rate:

F_{pi}(30 %) = F_{pi}(40 %) - F_{pi}(50 %) = 0,3 - 0,187 5 = 0,112 5

K.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:

$$F_{pi}(100\%) = F_{pi}(60\%) \times \frac{Q(60\,\%) - Q(50\,\%)}{Q(100\,\%) - Q(50\,\%)} \times \frac{Q(100\,\%)}{Q(60\,\%)}$$

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$$F_{pi}(100\ \%) = 0,25 \times \frac{60 - 50}{100 - 50} \times \frac{100}{60} = 0,0833$$

— Low rate:

$F_{pi}(50\ \%) = F_{pi}(60\ \%) - F_{pi}(100\ \%) = 0,25 - 0,083\ 3 = 0,166\ 7$

K.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:

$$F_{pi}(100\%) = F_{pi}(70\ \%) \times \frac{Q(70\ \%) - Q(50\ \%)}{Q(100\ \%) - Q(50\ \%)} \times \frac{Q(100\ \%)}{Q(70\ \%)}$$

$$F_{pi}(100\ \%) = 0,15 \times \frac{70 - 50}{100 - 50} \times \frac{100}{70} = 0,0857$$

— Low rate:

$F_{pi}(50\ \%) = F_{pi}(70\ \%) - F_{pi}(100\ \%) = 0,15 - 0,085\ 7 = 0,064\ 3$

K.5 Total apportioning

Table K.2

Rate:	20 %	40 %	60 %	70 %	Total
30 %:	0,30 +	0,112 5			= 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 equation is:

$$NO_{x,pond} = 0,412\ 5 \times NO_{x,mes(30\%)} + 0,418\ 5 \times NO_{x,mes(50\%)} + 0,169 \times NO_{x,mes(100\%)}.$$

Annex L
(informative)

Calculation of conversions of NO_x

Table L.1 — Conversion of the emission value of NO_x for first family gases

1 ppm = 2,054 mg/m^3 (1 ppm = 1 cm^3/m^3)		G 110	
		mg/kWh	mg/MJ
O_2 = 0 %	1 ppm =	1,714	0,476
	1 mg/m^3 =	0,834	0,232
O_2 = 3 %	1 ppm =	2,000	0,556
	1 mg/m^3 =	0,974	0,270

Table L.2 — Conversion of the emission value of NO_x for second family gases

1 ppm = 2,054 mg/m^3 (1 ppm = 1 cm^3/m^3)		G 20		G 25	
		mg/kWh	mg/MJ	mg/kWh	mg/MJ
O_2 = 0 %	1 ppm =	1,764	0,490	1,797	0,499
	1 mg/m^3 =	0,859	0,239	0,875	0,243
O_2 = 3 %	1 ppm =	2,059	0,572	2,098	0,583
	1 mg/m^3 =	1,002	0,278	1,021	0,284

Table L.3 — Conversion of the emission value of NO_x for third family gases

1 ppm = 2,054 mg/m^3 (1 ppm = 1 cm^3/m^3)		G 30		G 31	
		mg/kWh	mg/MJ	mg/kWh	mg/MJ
O_2 = 0 %	1 ppm =	1,792	0,498	1,778	0,494
	1 mg/m^3 =	0,872	0,242	0,866	0,240
O_2 = 3 %	1 ppm =	2,091	0,581	2,075	0,576
	1 mg/m^3 =	1,018	0,283	1,010	0,281

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Annex M
(normative)

Test apparatus for type C2 boilers (see 7.4.2.3.3)

A suitable test rig is shown diagrammatically in Figure 9. It consists of a completely enclosed loop of 1 250 x Q mm^2 ducting through which air is circulated by a bifurcated axial-flow fan. Velocity and pressure conditions are controlled by a series of single leaf dampers.

An auxiliary instantaneous water heater is supplied to provide an additional source of vitiation, its inlet being open to air and fitted with a damper F.

The appliance tested is mounted on the longest side of the duct. It is positioned at least 2 m above the lower horizontal base limb of the rig, with at least 1 m of vertical duct above it.

Access panels are provided on the back of the mounting panels of facilitate the fitting of the sampling probes and thermocouples. The flow in the duct may be measured by an anemometer placed 1 m above the lower horizontal base limb. A calibration factor is used to convert the anemometer reading to the mean flow. To cover the range of rate 0,3 m/s to 5 m/s, two interchangeable anemometers may be used.

The test rig is designed to be used either open or closed circuit, or in any intermediate condition between these extremes. In practice, either the open circuit or an intermediate condition is required for the specified tests.

The conditions required for the tests of 7.4.2.3.3 are obtained as follows:

— With dampers E and F closed, the fan is started. The degree of vitiation and the speed in the duct are controlled by means of dampers A, B, C and D. If the degree of vitiation has to be supplemented, damper F is opened and the auxiliary water heater is lit.

— The proportion of fresh air to re-circulated air is controlled by combinations of adjustments to dampers A, B and C.

— Damper D provides an overriding control of the flow rate.

— When necessary, water may be passed through the finned heat exchanger X in order to reduce the temperature of the circulated combustion products, measured at Y, to within the limits specified in 7.4.2.3.3. In practice, if the duct is made of metal, it is probable that this heat exchange will not be required.

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Annex N
(informative)

Requirements and test methods for separate air supply and combustion products evacuation ducts of type C6 boilers[14)]

N.1 Requirements

N.1.1 Pressure losses

The pressure loss in the combustion products evacuation duct of a combined air supply and combustion products evacuation system corresponding to an air speed of 2 m/s shall be less than 0,2 mbar.

N.1.2 Pressure loss under the influence of wind

Under the test conditions corresponding to a wind speed of 2 m/s in the combustion products evacuation duct, the pressure loss of a combined air supply and combustion products evacuation system shall be less than 0,4 mbar.

N.1.3 Suction under the influence of wind

Under the wind test conditions corresponding to a wind speed of 2 m/s in the combustion products evacuation duct, the pressure difference between the inlet of the air supply duct and the outlet of the combustion products evacuation system shall be less than 0,5 mbar.

N.1.4 Recirculation of the combustion products

Under the wind test conditions corresponding to a wind speed of 2 m/s in the combustion products evacuation duct, the recirculation of the combustion products between the outlet and the inlet shall be less than the value given in Figure N.1.

14) This annex should be revised after the finalizing of the relevant product standard by CEN/TC 166.

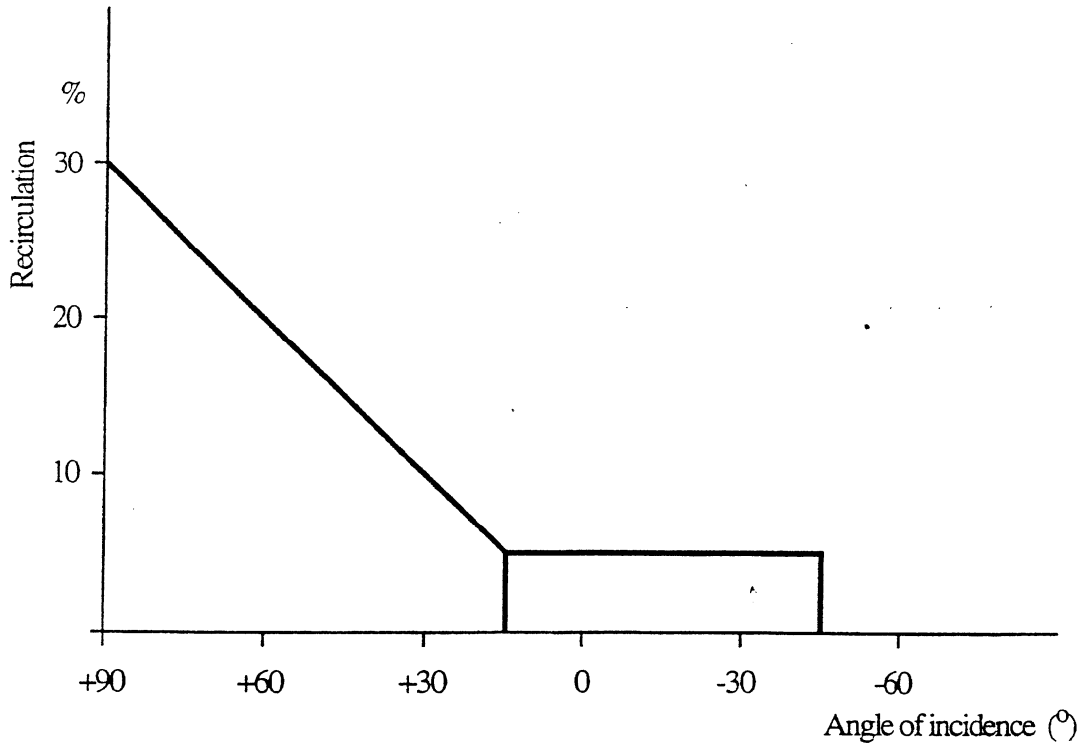


Figure N.1 — Maximum permitted recirculation of the combustion products

N.2 Test methods

N.2.1 Pressure loss in still air

The combined air supply and combustion products evacuation system is connected to the recycling device as shown in Figure N.2.

The air speed is maintained at a constant value of 2 m/s in the combustion products evacuation duct. It is checked that the pressure loss between the inlet and the outlet of the system is less than 0,2 mbar.

N.2.2 Pressure loss under the influence of wind

With the combined system installed and adjusted as stated in N.2.1, it is subjected to a wind speed as stated in N.2.5.

It is checked that, under all test conditions, the pressure loss between the inlet and the outlet of the combined system is less than 0,4 mbar.

N.2.3 Suction under the influence of wind

Under the test conditions of N.2.2, it is checked that the suction between the inlet and the outlet of the combined system is less than 0,5 mbar.

N.2.4 Recirculation of the combustion products

With the combined system installed and adjusted as stated in N.2.1, it is subjected to a wind speed as stated in N.2.5.

The recirculation of air from the evacuation duct to the air supply duct is determined by means of a gas tracer (e.g. CO_2).

It is checked that, at the various wind angles, the recirculation of the combustion products is less than the value of the value derived from Figure N.1.

N.2.5 Wind test conditions

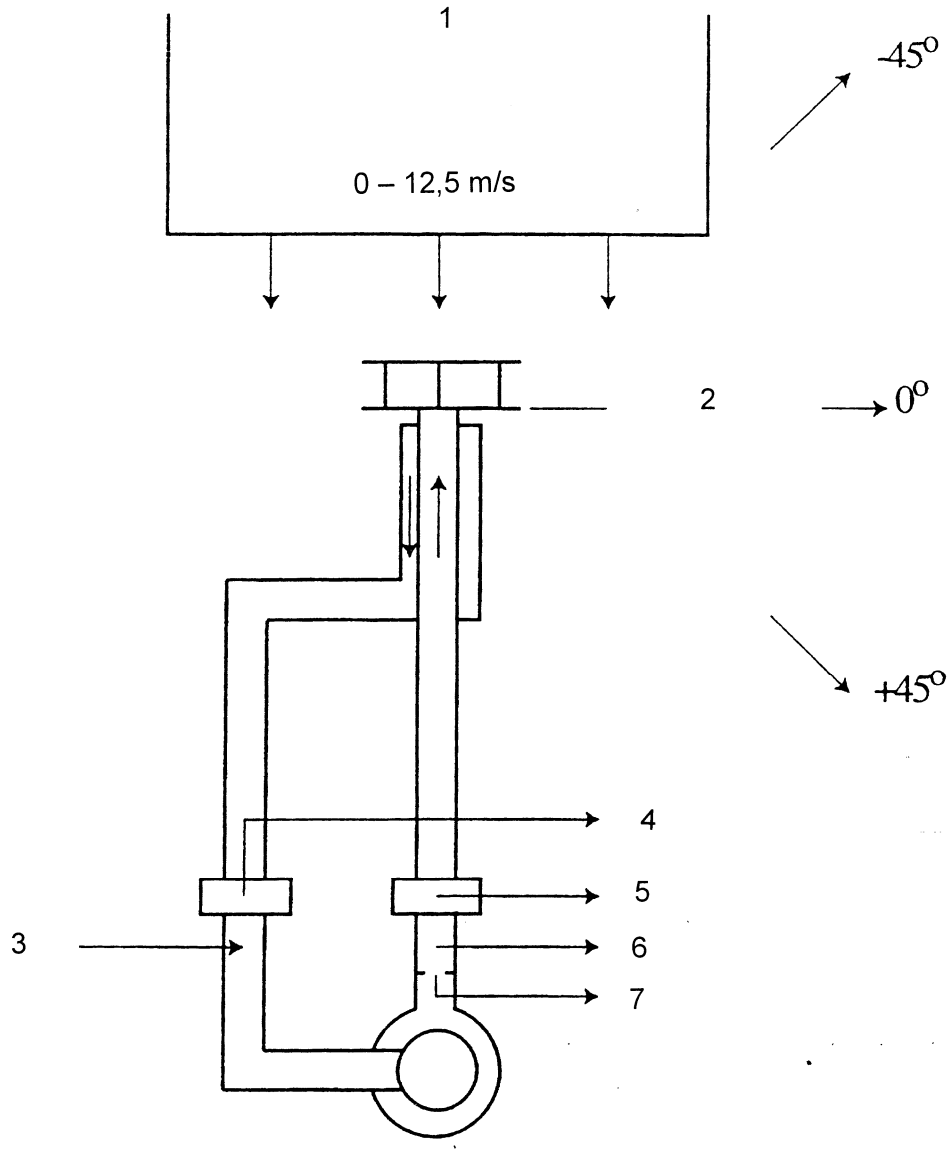
— Angles of incidence:

The boiler terminal is subjected to various wind speeds at angles of incidence varying in 15° steps from – 45° to 90° in relation to a horizontal plane (see Figure N.3).

— Wind speeds:

The tests described in N.2.2 and N.2.3 concerning the pressure loss and suction under the influence of wind, are carried out at a wind speed of 12 m/s.

During the recirculation tests of N.2.4, the wind speed is maintained constant at 2,5 m/s.



Key

1 air tunnel (wind speed = 0 to 12,5 m/s)
2 rotation point
3 CO_2 injection
4 air pressure measurement
5 air pressure measurement
6 CO_2 measurement
7 orifice plate for wind speed from 2 m/s

$$\%\,\text{recirculation} = \frac{\text{difference (\% measured - \% source rec.)}}{\%\,\text{measured}} \times 100$$

Figure N.2 — Test arrangement for measuring aero dynamical properties of the terminal

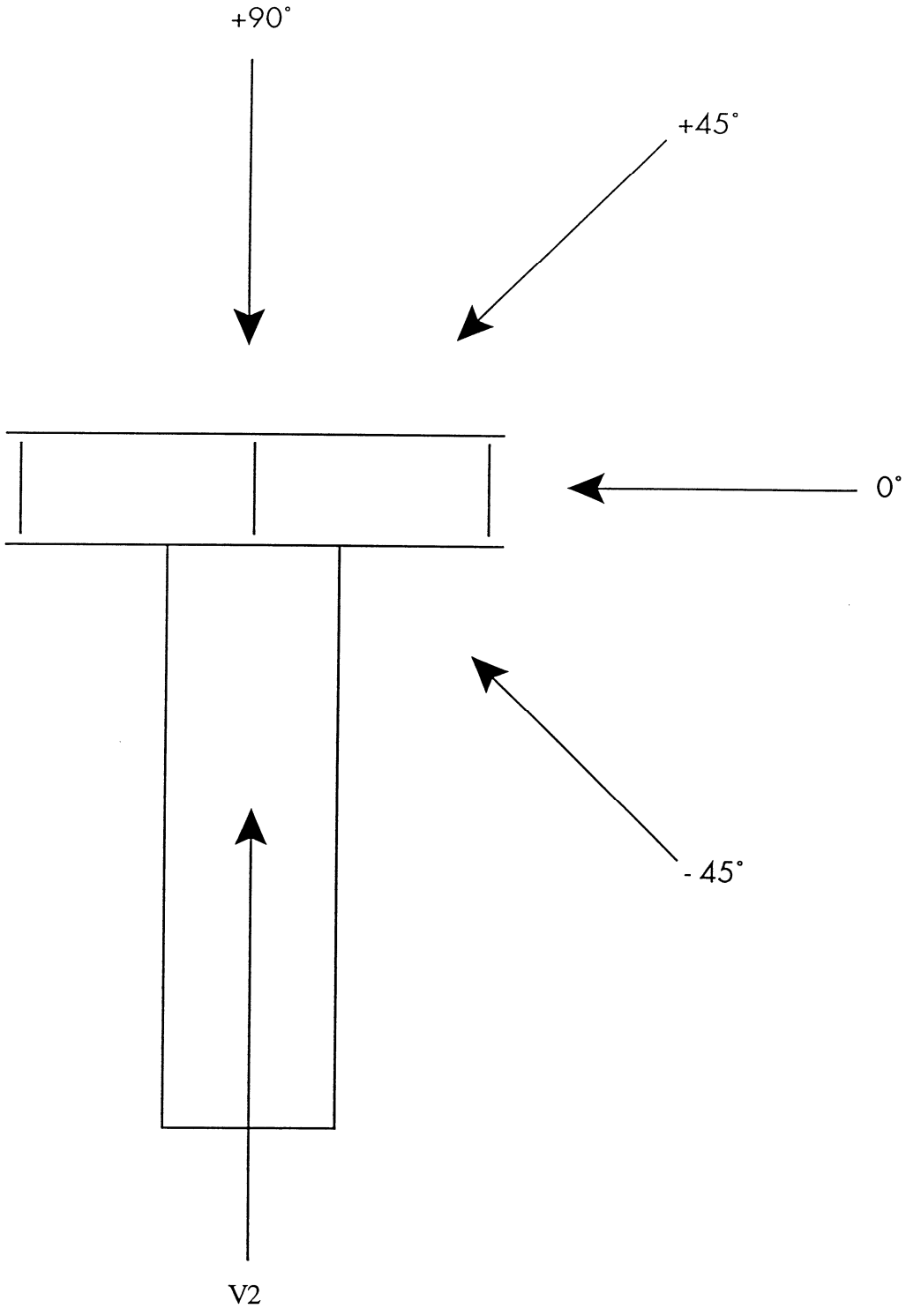


Figure N.3 — Scheme of angles of incidence

Annex O
(informative)

Use of test gases

O.1 Boilers within a range

For boilers within the scope of this standard with inputs greater than 300 kW 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 or equal to 300 kW may 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.

O.2 Guidance on the use of test gases

Tests using only the reference or distributed gas may 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 there is no light back at the burner injector(s).

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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 Directives 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 15420 with the essential requirements of the EU Directive 90/396/EEC on the approximation of the laws of Member States concerning gas appliances

GAD Annex I clause no.	Essential requirement (Annex I of the Gas Appliance Directive)	Relevant clauses in the standard
1	General conditions	
1.1	design and construction	5
1.2	Installation instructions	8.2.1
	User's instructions	8.2.2
	Warning notices on the appliance	8.1.5
	Warning notices on the packaging	8.1.4, 8.1.5
	Official language	8.2.5
1.2.1	Installation instructions contain:	
	Type of gas	8.2.1
	Gas supply pressure	8.2.1
	Flow of fresh air	
	— for combustion air supply	8.2.1
	— danger of unburned gas (3.2.3)	not applicable
	Dispersal of combustion products	8.2.1
	Forced draught burners	not applicable
1.2.2	User's instructions contain:	
	All instructions for safe use	8.2.2
	Restrictions on use	8.2.2

(continued)

Table ZA.1 *(continued)*

GAD Annex I clause no.	Essential requirement (Annex I of the Gas Appliance Directive)	Relevant clauses in the standard
1.2.3	Warning notices state:	
	type of gas	}
	gas supply pressure	} 8.1.4
	restrictions on use	} 8.1.5
1.3	Fittings	not applicable
2	Materials	
2.1	Fitness for purpose	5.3
2.2	Properties of the materials	not applicable
3	Design and construction	
3.1	General	
3.1.1	Safety of construction	5.3, 5.4
3.1.2	Condensation	5.4.1
3.1.3	Risk of explosion in the event of external fire	5.7
3.1.4	Water/air penetration into gas circuit	5.7.1
3.1.5	Normal fluctuation of auxiliary energy	6.5.1, 7.5.7.1, 7.6.1.3.8
3.1.6	Abnormal fluctuation or failure of auxiliary energy	5.12, 6.5.1, 7.5.5.2
3.1.7	Hazards of electrical origin	5.11
3.1.8	Pressurized parts	6.9
3.1.9	Failure of control and safety devices	5.13.1
	Gas circuit	6.5.1
	Automatic shut-off valves	5.13.3.2, 5.13.3.3
	Flame supervision device	5.13.6, 6.5.3
	Combustion products discharge safety device	not applicable
	Air proving device	5.7.8, 6.5.5, 7.5.5
	Automatic burner control system	5.13.6.3
	Thermostat/overheat protection	5.13.7
	Regulator	5.13.4
	Multifunctional control	5.13.1
3.1.10	Overruling of safety devices	5.13.1
3.1.11	Adjustment protection	5.13.2.1
3.1.12	Clear marking of devices	5.13.3.2
3.2	Unburnt gas release	
3.2.1	Risk of gas leak	5.7.1, 6.2.1
3.2.2	Risk of gas accumulation	
	— during ignition	5.13.5, 6.5.2
	— during re-ignition	5.13.6.3, 6.5.3.4.1
	— after extinction	6.5.3
3.2.3	Safety device fitted	5.13.6
	Rooms with sufficient ventilation	not applicable

(continued)

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Table ZA.1 *(continued)*

GAD Annex I clause no.	Essential requirement (Annex I of the Gas Appliance Directive)	Relevant clauses in the standard
3.3	Ignition Ignition Re-ignition Cross-lighting	 5.13.5, 6.5.2, 6.5.4.1, 6.5.3.2.1 6.4.2, 5.13.6.3, 6.5.3.4.1 6.4.2, 6.5.3.4.1
3.4	Combustion	
3.4.1	Fame stability Unacceptable concentrations harmful to health	6.4.2 6.5.5, 6.6.1
3.4.2	No accidental release of combustion products	5.7.2, 6.2.2
3.4.3	No release in dangerous quantity	not applicable
3.4.4	*CO* concentration	not applicable
3.5	Rational use of energy	6.7
3.6 3.6.1	Temperature FLoor and adjacent walls	 6.4.1.3,6.4.1.4
3.6.2	Knobs and levers	6.4.1.2
3.6.3	External parts	6.4.1.5
3.7	Foodstuffs and water used for sanitary purposes	
	Sanitary water	not applicable

Table ZA.2 —Identification form on the compliance of EN 15420 with the essential requirements of the EU Directive 92/42/EEC on the efficiency requirements for new hot-water boilers fired with liquid or gaseous fuels

BED clause no.	Relevant requirement (of the Boiler Efficiency Directive)	Relevant clauses in the Standard
1	Field of application	Foreword, 1
2	Definitions	3
5.1	Efficiency requirements	6.7
5.2	Verification methods	7.7

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[4] EN 61558-2-6, *Safety of transformers, reactors, power supply units and similar products for voltages up to 1100 V — Part 2-6: Particular requirements and tests for safety isolating transformers and power supply units incorporating safety isolating transformers (IEC 61558-2-6:2009)*

[5] CR 1749, *European scheme for the classification of gas appliances according to the method of evacuation of the products of combustion (Types)*

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