BS EN 50465:2015

BSI Standards Publication

European product standard for combined heating power systems using gas fuel

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National foreword

This British Standard is the UK implementation of EN 50465:2015. It supersedes BS EN 50465:2008, which is withdrawn.

The UK committee advises, for the calculation of ηs and ηson of cogeneration space heaters the methodology described in the Commission Communication, reference 2014/C 207/02 should be used. This method is robust, scientific, provides a fair comparison across all technologies and is aligned with established methods for assessing and comparing cogeneration performance.

The UK participation in its preparation was entrusted to Technical Committee GEL/105, Fuel cell technologies.

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

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

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English Version

European product standard for combined heating power systems using gas fuel

Appareils à gaz - Appareils produisant de la chaleur et de l'électricité combinées dont le débit calorifique nominal est inférieur ou égal à 70 kW

Gasgeräte - Geräte zur Kraft-Wärme-Kopplung mit einer Nennwärmebelastung kleiner oder gleich 70 kW

This European Standard was approved by CENELEC on 29 October 2014. CEN and CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN and CENELEC member.

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

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Foreword

This document (EN 50465:2015) has been prepared by CEN/CLC Joint Working Group FCGA, "Fuel cell gas appliances".

The following dates are fixed:

• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2015-10-29
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2017-10-29

This document supersedes EN 50465:2008.

EN 50465:2015 includes the following significant technical changes with respect to EN 50465:2008:

– inclusion of requirements for „Stirling Engine“ and „Internal Combustion Engine“;

– modification of requirements for fuel cell heating appliances to reflect experience since the first edition;

– partly adaptation to EN 15502-1 and EN 15502-2-1, especially to reflect the new requirements for air proving devices;

– introduction of additional types of combustion air and flue duct systems;

– modification of the total efficiency calculation;

– modifications of NO_X weighting and calculation.

Micro-cogeneration is also known as micro combined heat and power [mCHP]. mCHP is an efficient way to deliver heating, cooling and electricity. It is based on the simultaneous production of electrical and thermal energy, both of which are used. The central and most fundamental principle of mCHP is that in order to maximize the many benefits that arise from it, systems should be based according to the heat demand of the application.

A fuel cell, Stirling engine and internal combustion engine are just some of the significant technologies to be the thermal heart of a mCHP appliance.

mCHP appliances that are already established in the market are used to provide central heating and domestic hot water in residential buildings.

Due to the development of new technology other solutions than those described in this European Standard are possible if these solutions provide at least an equivalent level of safety.

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

Due to the change in scope to include technologies in addition to fuel cells, the title of this European Standard has been changed from “fuel cell gas heating appliance” into “combined heat and power appliance”.

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

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

For the relationship with EU Directive(s) see informative Annex ZZ, which is an integral part of this document.The essential requirements of EC Directive 2009/142/EC relating to "rational use of energy" is defined by the maximum quantity of energy recovered (thermal and electrical energy output) from the gas energy input.

_____

1 Scope

This European Standard specifies the requirements and test methods for the construction, safety, fitness for purpose, rational use of energy and the marking of a micro combined heat and power appliance; (hereafter referred to as “mCHP appliance”).

This European Standard applies to mCHP appliances of types B_{22}, B_{23}, B_{32}, B_{33}, B_{52}, B_{53}, C_1, C_3, C_{42}, C_{43} C_{52}, C_{53}, C_{62}, C_{63}, C_{82}, C_{83} and C_9 based on the classifications of CEN/TR 1749:

– that use one or more supplied gases of the three gas families at the pressures stated in EN 437,

– where the temperature of the heat transfer fluid of the heating system (heating water circuit) does not exceed 105 ºC during normal operation,

– where the maximum operating pressure in the

  - heating water circuit does not exceed 6 bar,

  - domestic hot water circuit (if installed) does not exceed 10 bar,

– which are either intended to be installed indoors or outdoors in a partially protected place,

– which are intended to produce hot water either by the instantaneous or storage principle,

– which have a maximum heat input (based on net calorific value) not exceeding 70 kW,

– which are designed for sealed or open water systems.

NOTE 1 For applications where the maximum allowable water temperature exceeds 110 ºC or where volume multiplied by maximum allowable pressure exceeds 50 bar litres, further requirements may be necessary to comply with the essential requirements of Directive 97/23/EC (Pressure Equipment Directive (PED)).

NOTE 2 For mCHP appliances with constructions that might not be fully covered by this European Standard or by another specific standard, the risk associated with the alternative construction will be assessed.

NOTE 3 prEN 13203-4 will specify the assessment of energy consumption for domestic hot water production of gas combined heat and power appliances (mCHP).

This European Standard does not contain the requirements necessary for appliance capable of producing electrical energy without using the thermal energy.

This European Standard does not cover all the requirements for mCHP appliances that are intended to be connected to gas grids where the quality of the distributed gas is likely to vary to a large extent over the lifetime of the appliance (see Annex DD).

2 Normative references

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

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

EN 125, *Flame supervision devices for gas burning appliances – Thermoelectric flame supervision devices*

EN 126, *Multifunctional controls for gas burning appliances*

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

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

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

EN 513, *Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors - Determination of the resistance to artificial weathering*

EN 549, *Rubber materials for seals and diaphragms for gas appliances and gas equipment*

EN 573-1, *Aluminium and aluminium alloys – Chemical composition and form of wrought products – Part 1: Numerical designation system*

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

EN 1092 (all parts), *Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated*

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

EN 1561, *Founding – Grey cast irons*

EN 1856-1:2009, *Chimneys – Requirements for metal chimneys – Part 1: System chimney products*

EN 1856-2:2009, *Chimneys – Requirements for metal chimneys – Part 2: Metal flue liners and connecting flue pipes*

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

EN 10088-1, *Stainless steels – Part 1: List of stainless steels*

EN 10226-1, *Pipe threads where pressure tight joints are made on the threads – Part 1: Taper external threads and parallel internal threads; Dimensions, tolerances and designation*

EN 10226-2, *Pipe threads where pressure tight joints are made on the threads – Part 2: Taper external threads and taper internal threads – Dimensions, tolerances and designation*

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

EN 13203-1, *Gas-fired domestic appliances producing hot water – Appliances not exceeding 70 kW heat input and 300 l water storage capacity – Part 1: Assessment of performance of hot water deliveries*

EN 13216-1:2004, *Chimneys – Test methods for system chimneys – Part 1: General test methods*

EN 13501-1, *Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests*

EN 13611, *Safety and control devices for gas burners and gas burning appliances – General requirements*

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

EN 14471:2013, *Chimneys – System chimneys with plastic flue liners – Requirements and test methods*

EN 50090 (all parts), *Home and Building Electronic Systems (HBES)*

EN 50438, *Requirements for micro-generating plants to be connected in parallel with public low-voltage distribution networks*

CLC/TS 50549-1, *Requirements for the connection of generators above 16 A per phase – Part 1: Connection of the LV distribution system*

EN 55014-1, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission (CISPR 14-1)*

EN 55014-2, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 2: Immunity – Product family standard (CISPR 14-2)*

EN 60335-1, *Household and similar electric appliances – Safety – Part 1: General requirements (IEC 60335-1)*

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

EN 60529:1991, *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)*

EN 61000-3-2, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current up to and including 16 A per phase) (IEC 61000-3-2)*

EN 61000-3-3, *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection (IEC 61000-3-3)*

EN 61000-3-11, *Electromagnetic compatibility (EMC) – Part 3-11: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems – Equipment with rated current ≤ 75 A and subject to conditional connection (IEC 61000-3-11)*

EN 61000-3-12, *Electromagnetic compatibility (EMC) – Part 3-12: Limits – Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase (IEC 61000-3-12)*

EN 61000-6-1, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments (IEC 61000-6-1)*

EN 61000-6-3, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments (IEC 61000-6-3)*

EN 62282-3-100:2012, *Fuel cell technologies – Part 3-100: Stationary fuel cell power systems – Safety (IEC 62282-3-100:2012)*

EN ISO 178, *Plastics – Determination of flexural properties (ISO 178)*

EN ISO 179-1, *Plastics – Determination of Charpy impact properties – Part 1: Non-instrumented impact test (ISO 179-1)*

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)*

EN ISO 527-1, *Plastics – Determination of tensile properties – Part 1: General principles (ISO 527-1)*

EN ISO 527-2, *Plastics – Determination of tensile properties – Part 2: Test conditions for moulding and extrusion plastics (ISO 527-2)*

EN ISO 1183 (all parts), *Plastics – Methods for determining the density of non-cellular plastics (ISO 1183)*

EN ISO 2553, *Welding and allied processes – Symbolic representation on drawings - Welded joints (ISO 2553)*

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

EN ISO 4063, *Welding and allied processes – Nomenclature of processes and reference numbers (ISO 4063)*

EN ISO 8256, *Plastics – Determination of tensile-impact strength (ISO 8256)*

EN ISO 9969, *Thermoplastics pipes – Determination of ring stiffness (ISO 9969)*

EN ISO 16852, *Flame arresters – Performance requirements, test methods and limits for use (ISO 16852)*

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

ISO 37, *Rubber, vulcanized or thermoplastic – Determination of tensile stress-strain properties*

ISO 188, *Rubber, vulcanized or thermoplastic – Accelerated ageing and heat resistance tests*

ISO 262, *ISO general purpose metric screw threads – Selected sizes for screws, bolts and nuts*

ISO 815 (all parts), *Rubber, vulcanized or thermoplastic – Determination of compression set*

ISO 857-1, *Welding and allied processes – Vocabulary – Part 1: Metal welding processes*

ISO 857-2, *Welding and allied processes – Vocabulary – Part 2: Soldering and brazing processes and related terms*

ISO 1817, *Rubber, vulcanized or thermoplastic – Determination of the effect of liquids*

ISO 2781, *Rubber, vulcanized or thermoplastic – Determination of density*

ISO 6914, *Rubber, vulcanized or thermoplastic – Determination of ageing characteristics by measurement of stress relaxation in tension*

ISO 7619 (all parts), *Rubber, vulcanized or thermoplastic – Determination of indentation hardness*

3 Terms and definitions

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

NOTE Table F.1 summarizes the main symbols and abbreviations used in this European Standard.

3.1
reference conditions
these correspond to 15 ºC and 1 013,25 mbar, unless otherwise specified

Note 1 to entry: mbar = 10^2 Pa.

[SOURCE: EN 437: 2003+A1:2009, 3.9]

3.2
combustible gases

3.2.1
test gases
gases intended for the verification of the operational characteristics of gas appliances. They consist of reference gases and limit gases

[SOURCE: EN 437:2003+A1:2009, 3.2]

3.2.2
reference gases
test gases with which appliances operate under nominal conditions when they are supplied at the corresponding normal pressure

[SOURCE: EN 437:2003+A1:2009, 3.3]

3.2.3
limit gases
test gases representative of the extreme variations in the characteristics of the gases for which appliances have been designed

[SOURCE: EN 437:2003+A1:2009, 3.4]

3.2.4
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

A distinction is made between:

– the gross calorific value H_s: the water produced by combustion is assumed to be condensed;

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

Note 1 to entry: The calorific value is expressed:

– either in megajoules per cubic metre (MJ/m³) of dry gas under the reference conditions;

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

[SOURCE: EN 437:2003+A1:2009, 3.11]

3.2.5
relative density
d
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

[SOURCE: EN 437:2003+A1:2009, 3.10]

3.2.6
Wobbe index
gross Wobbe index: W_s**; net Wobbe index:** W_i
ratio of the calorific value of a gas per unit volume to the square root of its relative density under the same reference conditions. The Wobbe index is said to be gross or net according to whether the calorific value used is the gross or net calorific value

Note 1 to entry: The Wobbe indices are expressed:

– either in megajoules per cubic metre (MJ/m³) of dry gas under reference conditions,

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

[SOURCE: EN 437:2003+A1:2009, 3.12]

3.2.7
gas pressure

3.2.7.1
general
all the pressures are static pressures of the moving gas, relative to the atmospheric pressure, measured at right angles to the direction of the flow of the gas

Note 1 to entry: Symbol: p. The gas pressures used are expressed in millibars (mbar) 1 mbar = 10^2 Pa.

3.2.7.2
test pressures
gas pressures used to verify the operational characteristics of gas appliances, consisting of normal and limit pressures

[SOURCE: EN 437:2003+A1:2009, 3.5, modified]

3.2.7.3
normal pressure
p_n
pressure under which the appliances operate in nominal conditions when they are supplied with the corresponding reference gas

[SOURCE: EN 437:2003 + A1:2009, 3.6]

3.2.7.4
limit pressures
maximum pressure: p_{max}**; minimum pressure:** p_{min}
pressures representative of the extreme variations in the appliance supply conditions

[SOURCE: EN 437:2003+A1:2009, 3.7]

3.2.7.5
pressure couple
combination of two distinct gas distribution pressures applied by reason of the significant difference existing between the Wobbe indices within a single gas 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

[SOURCE: EN 437:2003+A1:2009, 3.8]

3.3
Cogeneration
CHP
simultaneous generation of thermal and electrical energy in one process

Note 1 to entry: CHP= combined heat and power

3.3.1
mCHP

condensing or non-condensing CHP appliance with a maximum electrical output power below 50 kW

Note 1 to entry: As defined by Directive 2012/27/EC.

Note 2 to entry: mCHP= microCHP.

3.3.2
mCHP appliance
appliance which is either delivered as a complete package or specified as the complete package to deliver safely and effectively the heating, electrical power and where applicable the domestic hot water service claimed, comprising as relevant:

– primary heat & power generator (PH&PG);

– supplementary heat generator;

– flue ducts;

– thermal store

3.3.3
mCHP appliance technologies and its sub functions

3.3.3.1
fuel cell mCHP appliance
appliance that includes a fuel cell which produces simultaneous thermal energy and electrical energy (electrochemical reaction), consisting typically of distinct parts

Note 1 to entry: See Figure 1.

3.3.3.2
Stirling engine mCHP appliance
appliance that includes a Stirling engine module which thermodynamically converts a proportion of absorbed thermal energy to electrical energy; the remaining energy being transferred to the thermal management system; consisting typically of distinct parts

Note 1 to entry: See Figure 2.

3.3.3.3
internal combustion engine mCHP appliance
appliance that includes an internal combustion engine module which generates mechanical and thermal energy and a generator to convert mechanical energy into electrical energy, the remaining energy being transferred to the thermal management system; consisting typically of distinct parts

Note 1 to entry: See Figure 3.

3.3.3.4
Sub functions
3.3.3.4.1
primary heat & power generator
preferential heat generator producing thermal and electrical energy comprising

- for fuel cell mCHP appliances: fuel processing system, fuel cell module and power conditioning and chp-control system, see Figure 1
- for Stirling Engine mCHP appliances: Engine burner, Stirling Engine module, power conditioning and chp-control system, see Figure 2
- for internal combustion engine mCHP appliances: internal combustion engine, power generator and power conditioning and chp-control system, see Figure 3

3.3.3.4.2
fuel processing system
chemical processing equipment including any associated heat exchangers and controls required to convert input fuel to a composition suitable for the fuel cell stacks

[SOURCE: IEC/TS 62282-1:2010, 2.2, modified]

3.3.3.4.3
fuel cell module
assembly including one or more fuel cell stack(s) other main components intended to be integrated into the fuel cell gas heating appliance

Note 1 to entry A fuel cell module is comprised of the following main components: one or more fuel cell stack(s), piping system for conveying fuels, oxidants and exhausts, electrical connections for the power delivered by the stack(s) and means for monitoring and/or control. Additionally, a fuel cell module may comprise: means for conveying additional fluids (e.g. cooling media, inert gas), means for detecting normal and/or abnormal operating conditions, enclosures or pressure vessels and module ventilation systems.

[SOURCE: IEC/TS 62282-1:2010, 3.48, modified]

3.3.3.4.4
Internal combustion engine
mechanism delivering shaft power by the combustion of fuel in one or more cylinders in which working pistons reciprocate

3.3.3.4.5
power conditioning and chp-control system
equipment used to change electrical voltage level or waveform, or otherwise alter or regulate the electrical output of the primary heat & power generator to make it suitable and safe for export to other components within or outside the appliance including controls used to operate the primary heat & power generator such as gas valves, safety controls and internal cooling pumps

3.3.3.4.6
supplementary heat generator
non-preferential heat source providing peak load

3.3.3.4.7
thermal management
internal system that manages the transfer of the thermal energy of the appliance to a heat transfer fluid circulating in a distribution system to which a heat exchanging system(s) is connected that is equipped to transfer the thermal energy into space heating or space heating and domestic hot water

Note 1 to entry: The source of the thermal energy of the appliance could be e.g. for a fuel cell mCHP appliance the fuel processing system, fuel cell module or supplementary heat generator.

3.3.3.4.8
support controls
internal control system associated with the supplementary heat generator and the thermal management

Note 1 to entry: The controls associated with the primary heat & power generator are not part of the “support controls”.

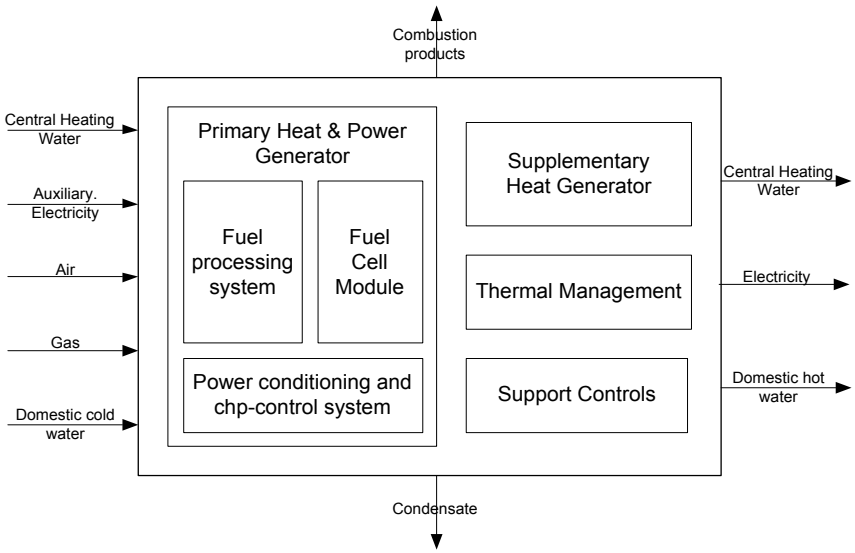


Figure 1 – Typical set-up for a fuel cell mCHP appliance

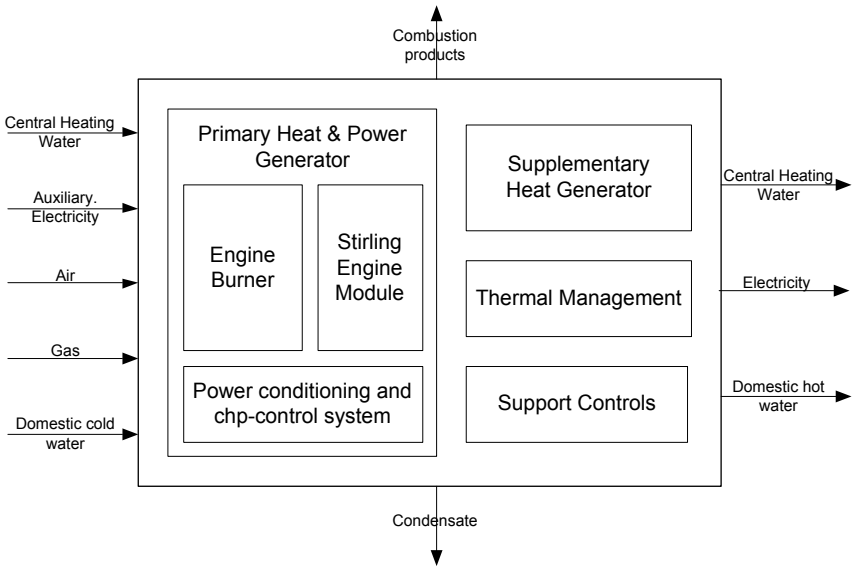


Figure 2 – Typical set-up for a Stirling engine mCHP appliance

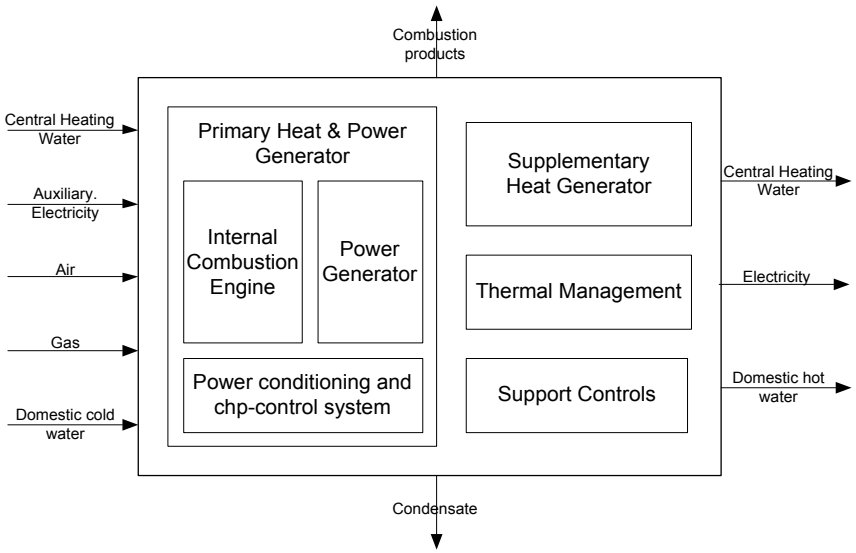


Figure 3 – Typical set-up for an internal combustion engine mCHP appliance

3.3.3.5
condensing mCHP
mCHP appliance in which, under normal operating conditions and at certain operating water temperatures, the water vapour in the combustion products is partially condensed, in order to make use of the latent heat of this water vapour for heating purposes

3.3.3.6
combination mCHP appliance
mCHP appliance designed both for central heating and for the production of domestic hot water

Note 1 to entry: Depending on its type of domestic hot water production, the combination mCHP appliance is classified in accordance with the appliance instruction as instantaneous type or storage type.

3.4
constituent parts of a mCHP appliance

3.4.1
general

3.4.1.1
gas inlet connection
part of the mCHP appliance intended to be connected to the gas supply

3.4.1.2
gas circuit
assembly of parts of the mCHP appliance that carry or contain the supplied gas between the gas inlet connection and the outlet of the safety shut-off valves

3.4.1.3
gas carrying circuit
assembly of parts of the mCHP appliance that carry or contain supplied gas or process gas

Note 1 to entry: This circuit includes the gas circuit.

3.4.1.4
restrictor
device which is placed in the gas carrying circuit so as to create a pressure drop and thus bring the gas pressure at a burner or a gas mixture equipment to a predetermined value for a given supply pressure and a given rate

3.4.1.5
injector
component that admits gas into a burner or into an internal combustion engine

3.4.1.6
gas rate adjuster
component allowing the gas rate of a burner or a gas mixture equipment to be brought to a predetermined value according to the supply conditions

Note 1 to entry: The action of operating this device is called “adjustment of the gas rate”.

3.4.1.7
range-rating device
component on the mCHP appliance intended to be used by the installer to adjust the nominal heat input of the mCHP appliance within the range of maximum and minimum heat inputs stated in the technical specifications/instructions, to suit the actual heat requirements of the installation

3.4.1.8
sealing an adjuster or control device
arrangements made to make evident any attempt to change the set adjustment (e.g. breakage of the device or the sealing material)

Note 1 to entry: A sealed adjuster or control device is considered to be non-existent.

3.4.1.9
main burner
any burner that is intended to ensure the thermal function of the mCHP appliance, and is generally called “the burner”

Note 1 to entry: The mCHP appliance may comprise more than one main burner, e.g. serving the primary heat & power generator and the supplementary heat generator.

3.4.1.10
catalytic burner
burner (oxidizer) in which the gas and a quantity of air at least equal to that theoretically necessary for complete combustion are mixed before the reaction zone, with a flameless combustion taking place in the reaction zone which is supported by catalysts

3.4.1.11
ignition device
any means (e.g. flame, electrical, etc.) used to ignite the gas admitted to the burner(s) or to the internal combustion engine

3.4.1.12
ignition burner
burner intended to ignite another burner; recognised ignition burners are:

3.4.1.12.1
permanent ignition burner
ignition burner that operates continuously throughout the whole period that the relevant part of the mCHP appliance is in use

3.4.1.12.2
alternating ignition burner
ignition burner that is extinguished as soon as the ignition of the burner it is intended to ignite is effected and re-ignites from the flame of the burner it has ignited just before the latter is extinguished

3.4.2
constituent parts specific to a fuel cell mCHP appliance

3.4.2.1
process gas
gas, transformed from supplied gas to a gas containing predominantly hydrogen

3.4.2.2
anode
electrode at which fuel oxidation takes place by the removal of electrons from the fuel to the electric load, followed by the release of oxidized fuel products

[SOURCE: IEC/TS 62282-1:2010, 3.2, modified]

3.4.2.3
fuel cell stack
assembly of cells, separators, cooling plates, manifolds and a supporting structure that electrochemically converts, typically, hydrogen rich gas and air reactants to DC power, heat and other reaction products

[SOURCE: IEC/TS 62282-1:2010, 3.50]

3.5
air supply and combustion products evacuation

3.5.1
combustion circuit
circuit including the air supply duct and the combustion products circuit

3.5.2
combustion products circuit
circuit including the combustion chamber, the heat exchanger, the combustion products evacuation duct and either the fitting piece or the connection to the terminal, if any

3.5.3
combustion chamber
enclosure inside which combustion of the air-gas mixture takes place

3.5.4
air supply and combustion products evacuation ducts
means for transporting combustion air to the burner or internal combustion engine and the combustion products to the terminal or fitting piece

Note 1 to entry: 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.

3.5.5
terminal
part of the combustion circuit fitted external to the building which has the function of the air supply inlet and/or combustion products outlet of the appliance

3.5.6
terminal guard
device that protects the terminal from physical damage from outside influences

3.5.7
fitting piece
device which allows the fitting of

– a type C_4 mCHP appliance via its two ducts to a common duct system,
– a type C_6 mCHP appliance to a separately certified and marketed system for the supply of combustion air and the discharge of combustion products,
– a type C_8 mCHP appliance via one of its ducts to a single or common duct system that is part of the building
– the air supply duct to a chimney that is part of the building for type C_9 mCHP appliances

Note 1 to entry: The fitting piece may be part of the mCHP appliance or of the air supply and/or combustion products evacuation system.

3.5.8
backflow valve
valve to prevent flue gas backflow

3.6
adjusters, monitoring and safety devices

3.6.1
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

3.6.2
adjustable pressure regulator
pressure regulator fitted with a means of adjusting the downstream pressure

Note 1 to entry: This means is considered as an “adjusting device”.

3.6.3
water rate monitoring device
device that shuts off the gas supply to the main burner or to the internal combustion engine when the water rate through the mCHP appliance is less than a predetermined value and automatically reopens the gas supply when the water rate reaches at least this value

3.6.4
flame supervision device
device that, in response to a signal from a flame detector, keeps the gas supply open and shuts it off in the absence of the supervised flame

3.6.5
control thermostat
device enabling the water temperature to be kept automatically within a given range at a predetermined value

3.6.6
adjustable control thermostat
control thermostat that permits the user to obtain setting temperatures between a minimum and a maximum value

3.6.7
limit thermostat
device that causes a shut off of the gas supply when a limit value of the temperature is reached, and automatically enables a new start-up sequence when the temperature returns below the fixed limit

3.6.8
safety temperature limiter
device that causes safety shutdown and non-volatile lockout so as to prevent a gas or a water temperature exceeding a pre-set limit

3.6.9
overheat cut-off device
device that causes safety shutdown and non-volatile lockout before the mCHP appliance is damaged and/or before safety is put in question

3.6.10
control knob
component intended to be moved by hand in order to act on a mCHP appliance control (e.g. tap, thermostat, etc.)

3.6.11
flame detector
device which detects and signals the presence of a flame

Note 1 to entry: It may consist of a flame sensor, an amplifier and a relay for signal transmission. 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.

3.6.12
flame signal
signal given by the flame detector, normally when its sensor reacts to a flame

3.6.13
programming unit
device that reacts to impulses from control and safety systems, gives control commands, controls the start-up programme, supervises burner or internal combustion engine operation and causes controlled shutdown, safety shutdown or lockout, if necessary. The programming unit follows a predetermined sequence of actions and operates in conjunction with a flame detector and/or combustion detection device

3.6.14
automatic burner / engine control system
automatic burner control system
automatic engine control system
system that comprises a programming unit and the flame detector and/or combustion detection function

Note 1 to entry All the functions of an automatic control system may be assembled in one or more housings.

3.6.15
start
action which causes the mCHP appliance to leave its start position and the predetermined programme of the programming unit to commence

3.6.16
programme
sequence of control operations determined by the programming unit, involving switching on, supervising and switching off burner / internal combustion engine

3.6.17
automatic shut-off valve
device that automatically opens, closes or varies a rate on a signal from the automatic burner / engine control system

Note 1 to entry Automatic valves are classified in accordance with EN 161 into classes A, B, C, D and J.

3.6.18
multifunctional control
device having two or more controls and/or control function(s) whereby the functional parts cannot operate if separated

3.6.19
closure member
movable part of the valve or the thermoelectric device that opens, varies or shuts off the gas path

3.6.20
breather hole
orifice that allows atmospheric pressure to be maintained in a compartment of variable volume

3.6.21
diaphragm
flexible component that operates a valve by means of a force resulting from a pressure difference

3.6.22
external soundness
soundness, with respect to the atmosphere, of an enclosure containing gas

3.6.23
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

3.6.24
fault tolerating time
time between the occurrence of a fault and the shut-down of the burner / internal combustion engine which is tolerated by the application without creating a hazardous situation

3.6.25
frost protection system
system that actively protects the water in the mCHP appliance against freezing

Note 1 to entry An anti-freeze solution is not considered as an active frost protective system.

3.6.26
maximum allowable working temperature
temperature the material can withstand over a long period of time under working condition

3.6.27
remote control function
function providing automatic and normal operation by means of a control intended to be actuated with or without line of sight of the mCHP appliance, e.g. through

a) communication lines/protocols,

b) additional hardware and/or software,

c) ultra-sonic,

d) infrared (IR)/radio frequency (RF) transmission,

e) all kind of combinations of a) to c) via the internet, e.g. modems, portable telephones

3.6.28
remote control
device that performs the remote control function by wires or wireless connection, with or without line of sight of the mCHP appliance

3.6.29
remote reset
device that performs a specific remote control function, being reset from lock-out to allow a restart attempt

3.6.30
thermal store
heat reservoir sited mainly in heating water, as opposed to the domestic hot water storage in the tank

3.6.31
tank
reservoir of combination mCHP appliances for domestic hot water

3.7
operation of a mCHP appliance

3.7.1
heat input
Q
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

Note 1 to entry: The heat input is expressed in kilowatt (kW).

[SOURCE: EN 437:2003+A1:2009, 3.13, modified]

3.7.2
nominal heat input
Q_n
value of the heat input declared in the technical specifications/instructions

Note 1 to entry: The nominal heat input is expressed in kilowatt (kW).

Note 2 to entry: Range rated mCHP appliances operate at a nominal heat input between the maximum and minimum adjustable heat input. Modulating mCHP appliances operate between the nominal and minimum controlled heat inputs.

[SOURCE: EN 437:2003+A1:2009, 3.14]

3.7.3
ignition rate
Q_{IGN}
average heat input during the ignition safety time

Note 1 to entry: The ignition rate is expressed in kilowatt (kW).

3.7.4
outputs

3.7.4.1
nominal output
useful output in kW stated in the technical specifications/instructions, corresponding to the operation of the mCHP appliance in a nominal (e.g. 80 °C/60 °C) water temperature regime

3.7.4.2
useful heat output
P_{th}
heat transmitted to the heat transfer fluid in kW

3.7.4.3
nominal heat output
P_{th_n}
useful heat output as stated in the technical specifications/instructions in kW

3.7.4.4
maximum and minimum electric power output
net AC electricity transmitted to low voltage grid in kW

Note 1 to entry: The symbol is $P_{el_{max}}$ resp. $P_{el_{min}}$.

3.7.4.5
net AC electric power output
P_{el}
electric power output of the primary heat & power generator

Note 1 to entry: The net AC electric power output is expressed in kilowatt (kW).

3.7.4.6
nominal electric power output
P_{el_n}
net AC electric power output stated in the technical specifications/instructions

3.7.4.7
net AC electric energy
W_{el}
electric energy output of the primary heat & power generator

Note 1 to entry: The net AC electric energy is expressed in kilowatt hours (kWh).

3.7.4.8
electric auxiliary energy
electric energy consumed by the support controls (e.g. pump, fan, valves, control unit)

3.7.5
overall efficiency
ratio of the useful heat output and the net AC electric power output to the heat input, expressed in per cent

3.7.6
combustion

3.7.6.1
complete combustion
combustion with no more than traces of combustible constituents (hydrogen, hydrocarbons, carbon monoxide, carbon etc.) in the combustion products

3.7.6.2
incomplete combustion
combustion at which at least one combustible constituent is present in significant proportions in the combustion products

3.7.7
flame stability
characteristics of flames that remain on the burner ports or in the flame retention zone

3.7.8
flame lift
phenomenon characterized by the total or partial lifting of the base of the flame away from the burner port or the flame retention zone

3.7.9
light-back
phenomenon characterized by the entry of a flame into the body of the burner

3.7.10
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

3.7.11
yellow tipping
phenomenon characterized by the yellowing of the tip of the blue cone of an aerated flame

3.7.12
ignition safety time
T_{SA}
time that elapses between the order to open and the order to close the gas supply to the burner / internal combustion engine in the event of ignition not taking place

3.7.13
maximum ignition safety time
$T_{SA,max}$
ignition safety time measured under the least favourable conditions of ambient temperature and variation in supply voltage

3.7.14
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 / internal combustion engine

3.7.15
ignition restoration
automatic process by which, following flame failure, the ignition device is switched on again without total interruption of the gas supply

3.7.16
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

3.7.17
controlled shutdown
process by which a control device (on the mCHP appliance or external to it) causes the gas supply to the burner / internal combustion engine to be stopped immediately; the mCHP appliance returns to its start position

3.7.18
safety shutdown
process which is effected immediately following the response of a protection device or the detection of a fault and puts the burner(s) / internal combustion engine out of operation such as to maintain a safe condition and avoid damage to the appliance; the resulting state of the system is defined by deactivated terminals for the shut-off valves and the ignition device

3.7.19
locking out
complete interruption of the gas supply with lockout

3.7.20
non-volatile lockout
shutdown condition such that a restart can only be accomplished by a manual reset

3.7.21
volatile lockout
shutdown condition such that a restart can also be accomplished by restoration of the electricity supply after its loss

3.7.22
purge
mechanical introduction of air into the combustion circuit in order to displace any gas/air mixture, which could remain there. A distinction is made between

– pre-purge: the purge that takes place between the start command and the ignition device being energized,
– post-purge: the purge that is carried out after burner shutdown

3.7.23
pre-purge time
period during which pre-purge takes place

Note 1 to entry: Definition shall avoid misunderstandings e.g. to EN 298.

3.7.24
air proving device
device intended to cause safety shutdown in the event of abnormal conditions of air admission or of combustion products evacuation

3.7.25
gas/air ratio control
device that automatically adapts the combustion air rate to the gas rate or vice versa

3.7.26
nominal voltage
voltage or range of voltages stated in the technical specifications/instructions at which the mCHP appliance can operate normally

3.7.27
nominal frequency
frequency stated in the technical specifications/instructions at which the mCHP appliance can operate normally

3.7.28
nominal working combustion products temperature
maximum temperature of the combustion products of normal functioning, at the exit of the mCHP appliance where it is intended to be connected to a duct, flue or chimney

Note 1 to entry: Normal functioning is considered to reflect the situation of running the mCHP appliance at heating water inlet/outlet temperatures of 70 °C/90 °C, or just at the point that the control thermostat is switching when set to the highest possible value.

3.7.29
overheat combustion products temperature
maximum temperature of the combustion products in case of overheat, at the exit of the mCHP appliance where it is intended to be connected to a duct, flue or chimney

3.7.30
condensing operation mode of the flue system
operation mode where, under normal operation conditions, condensate is produced in the combustion products

3.7.31
summer operating mode
operating mode in which the combination mCHP appliance only provides heating of the domestic water

3.7.32
nominal domestic hot water heat input (Q_{nw})
value of the heat input in the domestic hot water mode indicated in the appliance instructions

Symbol: Q_{nw}
Unit: kilowatt (kW)

3.7.33
maximum water service pressure
maximum pressure permitted in the domestic water circuit of combinations mCHP appliance, as stated in the appliance instructions

3.8
country of destination

3.8.1
direct country of destination
country for which the mCHP appliance has been certified, and which is specified in the technical specifications/instructions as the intended country of destination

Note 1 to entry: At the time of putting the mCHP appliance on the market and/or of installation, the mCHP appliance 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 mCHP appliance, in its current state of adjustment, can be used in each of these countries.

3.8.2
indirect country of destination
country for which the mCHP appliance has been certified, but for which, in its present state of adjustment, it is not suitable

Note 1 to entry Subsequent modification or adjustment is essential in order that it can be used safely and correctly in this country.

3.9
internal cooling circuit
loop in which a fluid circulates intended to maintain the various elements of the mCHP appliance at their operating temperature

3.10
domestic hot water
DHW
water delivered by the mCHP appliance, raised to a certain temperature in order to use it for domestic needs, e.g. kitchen, bathroom, etc.

3.11
system for permanent operation
system that is designed to remain in the running condition for longer than 24 h without interruption

3.12
system for non-permanent operation
system that is designed to remain in the running condition for less than 24 h

3.13 Installation

3.13.1
mCHP appliances intended to be installed in a partially protected place
mCHP appliances intended to be installed in the open air, not exposed to the direct action and infiltration of rain, snow or hail

Note 1 to entry: If an appliance is sold with a casing to provide protection, this casing is an integral part of the appliance.

3.13.2
minimum declared installation temperature for mCHP appliances in partially protected places
minimum ambient temperature as stated in the technical specifications/instructions, at which the mCHP appliances is designed to operate and at which all materials and devices shall operate properly and safely

3.13.3
maximum declared installation temperature for mCHP appliances in partially protected places
maximum ambient temperature as stated in the technical specifications/instructions, at which the mCHP appliances is designed to operate and at which all materials and devices shall operate properly and safely

3.14
competent person
person who has gained the ability by appropriate training, knowledge and experience to supervise or carry out the work being undertaken in a safe and proper manner

4 Classification

4.1 Gases/Categories

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

mCHP appliances are classified into categories in accordance with EN 437.

NOTE It could be possible that additional test gases have to be taken into account. Unless there is no decision made, the currently existing limit gases are state of the art.

4.2 Mode of air supply and evacuation of combustion products

4.2.1 General

NOTE 1 The classification used in this European Standard is based on the classification of CEN/TR 1749.

Type B mCHP appliance is an appliance intended to be connected to a flue system evacuating the combustion products to the outside the room containing the appliance, with the combustion air being drawn directly from the room where the appliance is installed.

Type C mCHP appliance is an appliance in which the combustion circuit is sealed with respect to the room in which the appliance is installed.

The air supply and the combustion products evacuation ducts and the terminal or the fitting piece which is used to connect the mCHP appliance to a chimney or duct system are part of the mCHP appliance unless otherwise stated in the technical specifications/instructions. They admit fresh air from inside or outside the inhabitable part of the building to the system and they discharge the products of combustion to the outside.

mCHP appliances 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 the informative Annex B).

The types are defined by two subscripts:

– the first subscript number is based upon the possible installation of the mCHP appliance 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 the positioning of one or more integral fan(s) in the mCHP appliance (see 4.2.3).

NOTE 2 A combination of suitable type B and type C appliances may be permitted if they are separated to the different functions of a fuel cell mCHP appliance as e.g. reformer or stack.

4.2.2 Type of installation of a mCHP appliance (See informative Annex B)

4.2.2.1 Type B_2

This is a type B mCHP appliance without a draught diverter.

4.2.2.2 Type B_3

This is a type B mCHP appliance without a draught diverter. The appliance is connected via its ducts possibly by means of a fitting piece to a duct system or to an individual or common chimney for the discharge of the combustion products. The supply of the combustion air is drawn directly from the room where the appliance is installed. The duct for the combustion products is completely integrated in the combustion air duct.

4.2.2.3 Type B_5

This is a type B mCHP appliance, without a draught diverter, that is designed for connection via its flue ducts to its flue terminal.

4.2.2.4 Type C_1

This is a type C mCHP appliance which is connected via its ducts to a horizontally installed terminal at the wall or on the roof. The orifices of the ducts are either concentric or close enough to come under similar wind conditions.

4.2.2.5 Type C_3

This is a type C mCHP appliance which is connected via its ducts to a vertically installed terminal. The orifices of the ducts are either concentric or close enough to come under similar wind conditions.

4.2.2.6 Type C_4

This is a type C mCHP appliance which is connected via its ducts possibly by means of a fitting piece to a common duct system consisting of a duct for the supply of the combustion air and a duct for the discharge of the combustion products.

The orifices of the ducts are either concentric or close enough to come under similar wind conditions.

4.2.2.7 Type C_5

This is a type C mCHP appliance which is connected via its separate ducts to two terminals that may terminate in zones of different pressure.

4.2.2.8 Type C_6

This is a type C mCHP appliance 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.

4.2.2.9 Type C_8

This is a type C mCHP appliance which is connected via its ducts possibly by means of a fitting piece to an air supply terminal and fitted to an individual or common chimney.

4.2.2.10 Type C_9

This is a type C mCHP appliance similar to a type C_3 appliance in that it is designed for use with 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.

However, the only difference for this appliance type is that the air inlet duct, or part of it, is an existing vertical duct within the building e.g. a converted chimney.

4.2.3 Presence and position of a fan

A type B or type C mCHP appliance that incorporates at least one fan downstream of the combustion chamber/heat exchanger is identified by the second subscript number “2”.

A type B or type C mCHP appliance that incorporates at least one fan upstream of the combustion chamber/heat exchanger or, in the case of an internal combustion engine type mCHP appliance, a comparable suction / pressure function is identified by the second subscript number “3”.

4.3 Maximum water side operating pressure

mCHP appliance classification according to the maximum water side operating pressure (PMS):

- pressure class 1: PMS = 1 bar
- pressure class 2: PMS = 3 bar
- pressure class 3: 3 bar < PMS < 6 bar

NOTE Internal cooling circuits in mCHP appliances are not considered under this classification, e.g. internal cooling circuits for heat exchange in fuel cell mCHP appliances.

4.4 Expansion system

mCHP appliances are classified according to the expansion system used for the central heating circuit:

- open vented system: intended exclusively for a central heating system with an open expansion vessel;
- sealed system: suitable for a central heating system with a sealed expansion vessel.

5 Constructional requirements

5.1 General construction

Except where otherwise stated, the constructional requirements of the mCHP appliance are verified by inspection and the technical documentation. Appropriate materials, components and control devices shall be used.

Component parts of covers, operating controls and safety devices and electrical accessories shall be arranged in such a way that their environmental temperatures at the location of the components in the mCHP appliance under steady state conditions do not exceed those specified for the component' part standard or in the components specifications if these temperatures are exceeding those given in the component part standard.

The use of asbestos-containing materials is forbidden.

Hard solder containing cadmium in its formulation shall not be used in the construction of the appliance.

For mCHP appliances intended to be installed in a partially protected place, all materials employed in the construction, including seals, gaskets and sealing pastes, if any, shall function properly in the environmental conditions under which they are expected to operate.

For mCHP appliances installed in partially protected places it shall be declared in the technical instructions for the installer the minimum and maximum ambient temperatures at which the appliance is designed to operate.

For mCHP appliances with any alternative constructions and/or functions, which might not fully be covered by this European Standard or a specific standard, the risk associated with this alternative construction shall be assessed.

The following components of a fuel cell or internal combustion engine mCHP appliance shall be housed in a unit to prevent unintended discharge of supply gas, process gas, or flue gas in the installation room:

- gas carrying circuit;
- fuel cell stack or internal combustion engine as appropriate for the type of mCHP appliance;
- internal flue system;
- fuel gas processing (if existing);
- internal cooling circuits (if existing).

An alternative of housing the above mentioned components is to comply with EN 62282-3-100:2012, 4.6.1.

The mCHP appliance shall be resistant to deformation and shall be such that

- the materials shall withstand the thermal, mechanical and chemical stresses arising during normal operation,
- the primary heat & power generator cannot become heated to create a hazard,
- in the event of engine malfunction or appliance ageing, there shall be no possible direct leakage path between the chambers containing working fluid and chambers containing the fluid used in the central heating or DHW production circuits,

NOTE Examples of unacceptable paths are those sealed with screw joints, o-ring joints, flange joints.

– for ICE and Stirling Engine pipes and other conduits for gas or gas/air mixtures connecting those parts of the appliance which are to be fixed to those parts of the appliance subject to mechanical vibration shall be demonstrably fit for purpose especially with regard to temperature, pressure, general degradation and level of vibration. Such pipes may be semi-rigid or connect via suitable mechanically flexible connectors. Entirely rigid connections shall not be used.

5.2 Use and servicing

The appliance shall be so designed that the user has access to and can operate all control knobs and buttons necessary for normal use of the mCHP appliance without having to remove any part of the case.

However, part of the case may be removed provided that this part can be handled safely by the user, that this part can be removed without the use of tools and that incorrect replacement is difficult (e.g. by the provision of stops).

All markings intended for the user 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, in accordance with the instructions for maintenance/servicing.

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

If the appliance instructions require parts of the mCHP appliance to be cleaned it shall be possible to do this easily and/or remove them easily for servicing with the use of commercially available tools. This shall not involve disconnection of the mCHP appliance from the gas or water pipes.

For mCHP appliances 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 mCHP appliance 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 appliance instructions, after replacement of the seal(s) following cleaning and servicing operations.

5.3 Connections to the gas and water pipes

5.3.1 General

The mCHP appliance connections shall be easily accessible. They shall be clearly identified in the installation instructions and possibly on the mCHP appliance.

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.

5.3.2 Connection to the gas pipe

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

If the mCHP appliance has a threaded connection, this thread shall comply with EN ISO 228-1 or ISO 7-1. In the first case (EN ISO 228-1), the end of the mCHP appliance 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.

The different national gas connection conditions are given in Table A.1.

5.3.3 Connection to the central heating or domestic water pipes

Threaded connections shall comply with EN ISO 228-1, EN 10226-1 or EN 10226-2.

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

If other than metallic materials are used, the appropriate justification for their suitability of use shall be given in the design documentation.

In accordance with the appliance instructions, the domestic water circuit shall be able to be drained, without the discharge of water compromising electrical safety.

5.4 Soundness

5.4.1 Soundness of the gas carrying circuit

The gas circuit shall consist of metallic parts.

Where the internal pressure for the gas carrying circuit is at or above ambient pressure during conditions when supplied gas or process gas is carried by that circuit, the following apply:

- Holes for screws, studs, etc., intended for the assembly of parts shall not open into gas paths. The wall thickness between drillings and gas paths shall be at least 1 mm. This does not apply to orifices used for measurement purposes.

- The soundness of parts and assemblies making up the gas carrying circuit and likely to be dismantled during a normal routine servicing operation in situ or during gas conversion shall be achieved by means of mechanical joints, for example metal to metal joints, gaskets or toroidal seals. These sealing materials shall remain effective under normal conditions of mCHP appliance use. The use of sealing materials such as tape, paste, glue or liquid is not acceptable, although this type of sealing material may be used for permanent assemblies.

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

If a control function ensures that the gas carrying circuits operates below ambient pressure, and the above requirements have not been taken into account or the tests according to 6.2.1 have not been performed, the

- mechanical/ pneumatic control shall comply with EN 88-1 or the relevant clauses of EN 13611, or

- the control function shall be a class C control function according to EN 13611.

5.4.2 Soundness of the combustion circuit

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

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

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

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

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

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

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

For ICE the internal leakage in the combustion chamber to the crank case shall be re-circulated to the air-inlet of the engine.

For ICE the external leakage of the engine shall

a) be ignited immediately with the mixture designed to be burned in the engine, or

b) be contained by the entire engine being surrounded by combustion air or cooling water, or

c) lead to non-operation of the engine under such leakage conditions, or

d) meet the leakage requirements of 6.2.2.

5.4.3 Soundness of lubricating oil circuit

In the case of leakage from the lubricating-oil system or as a result of a fault or crack in parts of the appliance where lubricating-oil is designed to be present, there shall be no escape of oil into the room where the mCHP appliance is installed.

5.5 Supply of air and evacuation of combustion products

5.5.1 General

All mCHP appliances shall be designed so that there is an adequate supply of air during ignition and over the whole range of possible heat inputs stated in the technical specifications/instructions. A gas/air ratio control is permitted.

All fuel cell mCHP appliances shall be designed so that there is an adequate supply of air during all operation conditions of the fuel cell stack and over the whole range of possible heat inputs stated in the technical specifications/instructions.

Fan assisted mCHP appliances may be fitted with a means of adjustment in the combustion circuit intended to adapt the mCHP appliance 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 for installation.

5.5.2 Air supply and combustion products evacuation ducts

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 appliance.

It shall be possible to connect the mCHP appliance, the air supply and combustion products evacuation ducts and the terminal or fitting piece in accordance with the appliance installations instructions using ordinary tools if necessary.

Terminal guard if it exists and fitting pieces have to be installed in accordance with the instructions for installation.

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

- shall fit inside a square with an edge length of 50 cm for type C_1 and C_3 appliances,
- may terminate in zones of different pressure for type C_5 appliances, but not on opposite walls of the building.

5.5.3 Terminal

Terminals on appliances without a fan should prevent the intrusion of external objects by having no opening in the external surfaces of the terminal which shall permit the entry of a 16 mm diameter ball when applied with a force of 5 N.

Any horizontal terminal for non-condensing mCHP appliances shall be designed in such a way that condensate is discharged away from the wall.

Any horizontal terminal for condensing mCHP appliances shall be designed in such a way that condensate is directed towards the appliance.

5.5.4 Terminal guard

If the installation instructions require a protective guard for the terminal for use when the outlets for evacuation of the combustion products open on to a walkway, the dimensions of the terminal guard 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.

5.5.5 Fitting piece

For appliances of the types C_4 and C_8, the fitting piece shall be designed so that it is possible to obtain the distances specified in the instruction for installation 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.

5.6 Requirements for a fan incorporated in a mCHP appliance

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

5.7 Gas/air ratio controls

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

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

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

Control tubes may be made of metal with suitable mechanical connections or of other materials with at least equivalent properties and in this case are considered immune to breakage, accidental disconnection and leakage after initial soundness checks.

Control tubes for air or combustion products shall have a minimum cross-sectional area of 12 mm² 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.

If the installation instructions state (see 9.2.1.3) that the gas/air ratio control settings are not intended to be adjustable by a gas operative during installation, appliance service or when the gas valve is replaced then the appliance shall incorporate additional provisions to discourage unauthorised interference with the gas/air ratio control settings.

The following examples are considered to be suitable additional provisions:

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

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

c) Addition of a suitably worded warning label affixed to the gas valve and/or in close proximity to the adjuster screws. This label shall be clearly visible to any gas operative whilst gaining access to the adjuster screws and provision shall be made to indicate if the valve setting has been changed.

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

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

If the appliance installation instructions indicate that the valve can be adjusted, by a suitably qualified gas operative using appropriate instruments, a provision shall be made to indicate that the valve setting has been changed.

NOTE 3 An example of a suitable provision is to use a paint spot on the adjusting device.

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

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

5.8 Air proving

mCHP appliance with fans[1)] shall be fitted with a system for air proving.

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

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

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

a) gas/air ratio control[2)];

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

c) start-up supervision of the combustion air rate or combustion products rate provided that:
   - the combustion products circuit is completely surrounded by the air supply circuit, or the leakage rate of the combustion products circuit meets the requirements of 6.2.2.2.2 and
   - there is a shutdown at least every 24 h[3)] and
   - there is an indirect system for air proving (e.g. fan speed supervision) during operation.

1) In an ICE, a *turbo charger is considered to be comparable to a combustion air fan. Adequate measures to ensure at least the same level of safety (according 5.10) shall be used.*

2) The Gas/Air ratio control according to EN 12067-2:2004, 7.1 includes the function that the air flow is ensured (signal directly activated by the flow) and if not a safety reaction is initiated.

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

Only for mCHP appliances 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 6.2.2.2.2, the following two indirect supervision methods are also allowed:

d) 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;

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

5.9 Checking the state of operation

The design of the appliance shall be such that the installer can determine, by visual means, the operational phase of the mCHP appliance including whether it is in its “starting” or “stopping” phase.

NOTE This may be by observing the ignition and operation of the burner(s) and also the length of the flame(s) of the ignition burner, if any OR by an indirect means of indication (e.g. an indicator light). Indirect means are dependent on the specific solution of the manufacturer.

If used, mirrors, sight glasses, etc., shall continue to retain their optical properties.

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 mCHP appliance is operating, either by visual observation of the flame or by some other indirect means.

If the indirect signal of flame presence is only available on a remote control, this remote control shall be supplied and tested with the mCHP appliance.

5.10 Operational safety in the event of failure of the energy supply for the control systems

If the mCHP appliance uses an energy supply for the control systems, its design shall be such that no risk can occur in the event of failure of the auxiliary energy or following its restoration.

5.11 Drainage

If it is not possible to drain the appliance by means of its water connections, it shall carry a device that enables it to be drained and can be operated by means of a tool such as a spanner or screwdriver. Suitable directions for drainage, without the discharge of water compromising electrical safety, shall be included in the instructions.

5.12 Conversion to different gases

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

– electronic adjustment to ensure correct maximum heat input and/or combustion quality;

– adjustment of the gas rate of the main burner(s), internal combustion engine and ignition burner;

– change of restrictor or injector;

– change of ignition burner or its components;

– change of gas rate modulation system;

– adjustment of the ignition point;

– putting out of service and sealing an adjuster or control device (e.g. gas rate adjuster, pressure regulator);

- changes of configuration parameters by data exchange (for requirements see EN 14459);
- by use of combustion control system methods taking the requirements of EN 12067-2 into account.

For each of the operations mentioned above the appliance shall be tested with each of the gases. These operations shall be possible without having to interfere with the connections of the mCHP appliance to its connecting pipe-work, i.e. gas supply, water supply and air inlet and combustion product evacuation ducts.

5.13 Materials and thickness

5.13.1 General

The quality and thickness of the materials used in the construction of the mCHP appliances, their combustion product evacuation ducts, fitting pieces and terminals 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.

All parts of the mCHP appliance shall withstand the mechanical, chemical and thermal conditions to which they may be subjected when the appliance is used normally.

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

The materials of the parts containing domestic water shall not affect the quality of the domestic water in respect of either health or taste.

The whole of the domestic hot water circuit shall be made up of corrosion resistant materials or shall be protected against corrosion.

5.13.2 Materials and thicknesses of walls or tubes under water pressure of pressure class 3

5.13.2.1 General

The characteristics of the materials and the thicknesses of walls under pressure shall comply with the requirements of 5.13.2.2, 5.13.2.3 and 5.13.2.4. If other materials and/or other thicknesses are used, these shall have an equivalent level of fitness for purpose.

5.13.2.2 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 chemical 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.

5.13.2.3 Thickness

The minimum wall thicknesses of parts under water pressure are given in Table 5 and Table 6.

For rolled steel the tolerances are given in EN 10029.

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 appliance sections and of parts subjected to pressure shall be greater than 0,8 times those given in the drawings.

5.13.2.4 Welded seams and welding fillers

Materials shall be suitable for welding. The materials given in Table 1 may be used and do not require additional heat treatment for welding.

Welded seams shall show no cracks or bonding faults and butt welded seams shall be faultlessly welded over the whole cross-section.

Single-sided fillet welds and half Y-welds without full penetration into the base metal shall not be subjected to bending stresses. Flue pipes, set-through stays and similar components need not to be welded from both sides. Double fillet welds are permissible if sufficiently cooled.

Projections into the flue ways in areas of high thermal stresses shall be avoided.

Corner welds, edge welds and similar welds which are subject to considerable bending stresses under unfavourable manufacturing or operating conditions are to be avoided.

For welded-in longitudinal stays, stay tubes or stay bolts, the shearing cross-section of the fillet weld shall be at least 1,25 times the required cross-section of the bolt or stay tube.

Details of the welds mentioned are given in Table 7. Welding fillers shall permit a joint appropriate to the base material to be made.

The terms given in Table 7 are in accordance with EN ISO 2553; the reference numbers of welding processes are respectively in accordance with ISO 857-1, ISO 857-2 and EN ISO 4063.

Table 1 – Mechanical properties and chemical compositions of carbon and stainless steels

Mechanical properties						Chemical composition by mass %									
Materials	**Steel type**	**Tensile strength R_m** N/mm²	**Yield point R_{oH}/R_p 0,2** N/mm²	**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 steel shall be guaranteed.

Table 2 – Minimum requirements for cast iron

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

Table 3 – Parts in aluminium and aluminium alloys

	Tensile strength R_m N/mm²	Temperature range °C
Al 99,5	≥ 75	up to 300
Al Mg2 Mn 0,8	≥ 275	up to 250

Table 4 – Parts in copper or copper alloys

	Tensile strength R_m N/mm²	Temperature range °C
SF – Cu	≥ 200	up to 250
Cu Ni 30 Fe	≥ 310	up to 350

Table 5 – Minimum thicknesses for rolled parts

Carbon steels; aluminium			Protected steels; stainless steels; copper		
a [a] mm	b [b] mm	c [c] mm	a [a] mm	b [b] mm	c [c] mm
4	3	2,9	2	2	1

[a] Column a: for walls of combustion chambers exposed to water and fire, and for horizontal walls of convection heating surfaces.

[b] Column b: for walls exposed only to water and for rigid shapes, for example convection heating surfaces outside the combustion chamber.

[c] Column c: tubes of convection heat exchangers.

Table 6 – Nominal minimum thicknesses of mCHP appliance sections

Nominal heat input Q_n kW	Flake graphite cast iron aluminium mm	Spheroidal graphite annealed ferritic cast iron, copper mm
≤ 35	3,5	3,0
> 35	4,0	3,5

Table 7 – Weld joints and welding processes

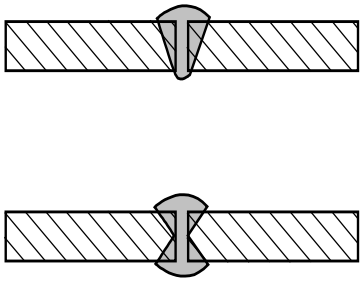
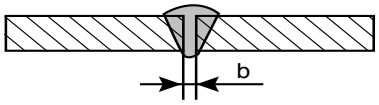
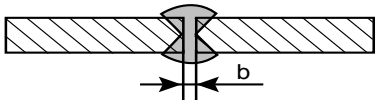
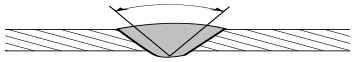
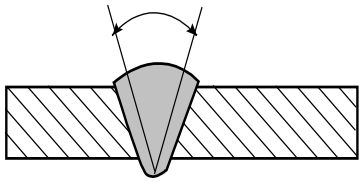
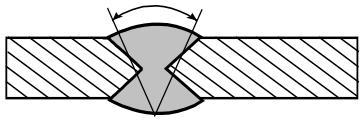
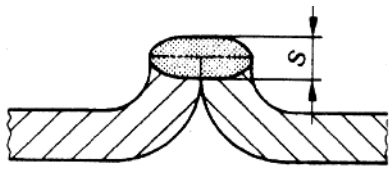
No.	Weld joint type	Material thickness *t* mm	Welding process [a]	Remarks
1.1	Square butt weld 	≤ 6 (8)	135 12 131 (111)	Permissible up to t = 8 mm on use of deep penetration electrodes or welding on both sides
1.2	Square butt weld 	≥ 6 up to 12	12	Root gap b = 2 mm to 4 mm with stiffener, powder holder 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 	up to 12	(111)	Seam preparation V-seam 60°
1.5	Single-V butt weld 	up to 12	135 12	Seam preparation V-seam 30° to 50° depending on thickness of material
1.6	Double-V butt weld 	greater than 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 t

Table 7 – Weld joints and welding processes *(continued)*

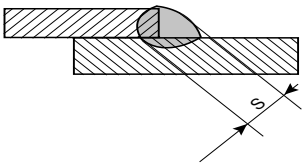
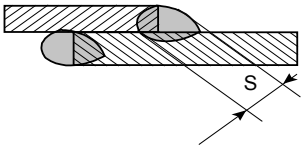
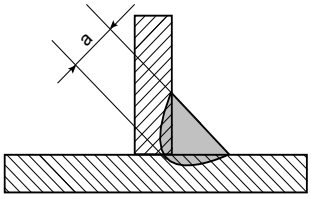
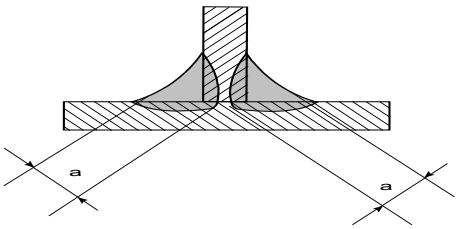
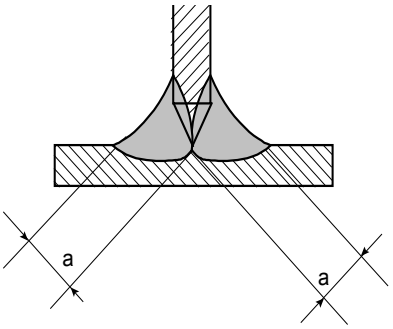
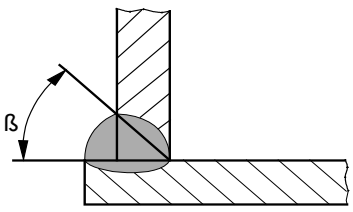
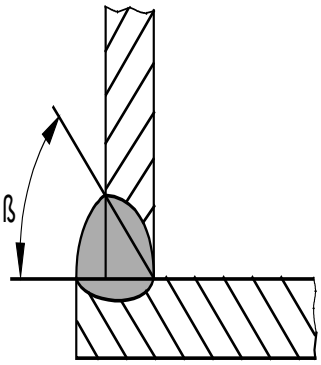
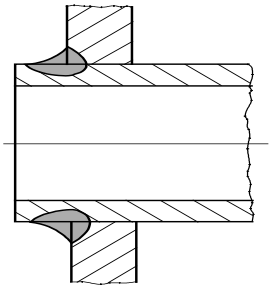
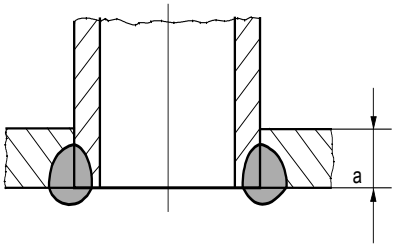
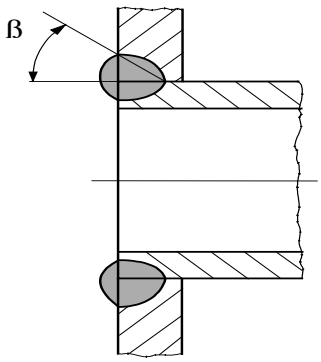
No.	Weld joint type	Material thickness *t* mm	Welding process [a]	Remarks
1.8	Overlap welding 	≥ 6	135 12	Welds of this type are to be kept largely free from bending stresses. Not suitable for directly fired wall parts $s = t$
1.9	Overlap welding *(continued)* 	≤ 6	135 12 (111)	Not suitable for directly fired wall parts $s = t$
2.1	Fillet weld 	≤ 6	135 12 (111)	Welds of this type are to be kept largely free from bending stresses. $a = t$
2.2	Double-fillet weld 	≤ 12 > 12	135 12 (111) 135 12 (111)	$a = t$ $a = 2/3\ t$
2.3	Double-bevel butt weld 	≤ 12 > 12	135 12 (111) 135 12 (111)	$a = t$ $a = 2/3\ t$
2.4	Single-bevel butt weld 	≤ 12	135 12 (111)	for (111) ß = 60°

Table 7 – Weld joints and welding processes *(continued)*

No.	Weld joint type	Material thickness *t* mm	Welding process [a]	Remarks
		> 12	135 12	for 135, 12 ß = 45° to 50°
2.5	Single-bevel butt weld 	≤ 12	135 12 (111)	for (111) ß = 60° for 135, 12 ß = 45° to 50°
2.6		≤ 12	135 (111)	Tube ends shall not project beyond fillet weld if it is subjected to heat radiation.
2.7		≤ 6	135 (111)	Welding in of tube under high thermal stress $a \geq t$
2.8			135 (111)	Welding in of tube under high thermal stress For (111) ß = 60° For 135 ß = 45° to 50°

[a]	Reference numbers of welding processes in accordance with ISO 857-1, ISO 857-2 or EN ISO 4063:	
	Reference number	Process
	12	Submerged arc welding
	111	Metal-arc welding with covered electrode
	131	Metal-arc inert gas welding; MIG welding
	135	Metal-arc-active gas welding; MAG welding
	141	Tungsten inert gas arc welding TIG welding

5.13.2.5 Materials and method of construction of components of the domestic water circuit for combination mCHP appliances

Materials shall be appropriate for their use, under intended application and at the maximum water pressure stated in the installation instruction.

The requirements relating to thermal insulation and its use specified in 5.14 only apply to parts of the domestic water circuit likely to come into contact with flames or sited close to the combustion products outlet.

The materials of the parts containing domestic water shall not affect the quality of the domestic water in respect of either health or taste.

The whole of the domestic hot water circuit shall be made up of corrosion resistant materials or shall be protected against corrosion.

5.14 Thermal insulation

The insulation shall withstand the normally expected thermal and mechanical stresses, without deformation and shall retain its insulating properties under the influences of heat and ageing.

The insulation shall be of fire-retardant material Euro-Class B according to EN 13501-1. However, normal-flammability materials Euro-Class D according to EN 13501-1 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 flames can come into contact with the insulation the insulation shall be non-flammable material Euro-Class A1 or A2 according to EN 13501-1.

5.15 Durability against corrosion of metallic combustion product circuits

The durability against corrosion of the combustion product circuit is demonstrated by fulfilling either:

a) the requirements in Table 8, or

b) a corrosion test method from normative Annex A of EN 1856-1:2009.

Table 8 – Metallic combustion products circuit material specifications

Material	Symbol	Minimum Nominal Thickness non- condensing [b] mm	Minimum nominal Thickness condensing [b] mm
EN 573-1 Aluminium designation			
EN AW – 4047A	EN AW Al Si 12 (A), and CU <0,1%, Zn<0,15% (cast aluminium)	0,5	1,5
EN AW – 1200A	EN AW-AL 99,0 (A)	0,5	1,5
EN AW-6060	EN AW-Al MgSi	0,5	1,5
EN 10088-1 Steel number	**EN 10088-1 Steel name**		
1.4401	X5CrNiMo 17-12-2	0,4	0,4
1.4404[a]	X2CrNiMo 17-12-2	0,4	0,4
1.4432	X2CrNiMo 17-12-3	0,4	0,4
1.4539	X1NiCrMoCu 25-20-5	0,4	0,4
1.4401	X5CrNiMo 17-12-2	0,11[c]	0,11[c]
1.4404[a]	X2CrNiMo 17-12-2	0,11[c]	0,11[c]
1.4432	X2CrNiMo 17-12-3	0,11[c]	0,11[c]
1.4539	X1NiCrMoCu 25-20-5	0,11[c]	0,11[c]

[a] Equivalent for material N° 1.4404 = 1.4571 (symbol X6CrNiMoTi 17-12-2).

[b] The condensing column shall be used if, under normal operation conditions, condensate is produced in the combustion products circuit (according to 3.7.30)

[c] Flexible liners (when installed in an existing chimney)

The actual minimum thickness of the materials shall always be greater than 90 % of the minimum nominal thicknesses.

5.16 Requirements for valves as parts of the gas circuit

Safety related automatic shut off valves shall meet the requirements of EN 161, other valves shall meet the applicable requirements of EN 13611.

5.17 Combustion products evacuation duct

5.17.1 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/m².

5.17.2 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 mCHP appliance.

5.17.3 Corrosion resistance

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

5.17.4 Resistance to condensate and moisture under normal operating conditions

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

5.18 Design

5.18.1 General

The mCHP appliance shall be designed such that when it is installed and used in accordance with the instructions for installation and use, if it is not self-venting, it shall be possible to vent the air from the mCHP appliance waterways.

If condensation is produced, 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 servicing, in accordance with the instructions for installation, maintenance and use, shall be free from sharp edges and corners that might cause damage or personal injury during use and servicing.

5.18.2 Materials in contact with condensate

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

5.18.3 Discharge of condensate

Condensate produced during operation of the mCHP appliance, including the condensate formed in the flue and its connecting pipes, shall be removed by means of a discharge pipe (or pipes) or other constructions resulting in safe discharge of condensate. Such condensate discharge system shall be of corrosion-resistant material or covered by a durable protection against corrosion.

Where disposal of condensate from the mCHP appliance is by gravity the internal diameter of the condensate discharge outside connection shall be at least 13 mm. If the mCHP appliance incorporates some form of pump assisted condensate disposal the size of the discharge from the mCHP appliance and connection to any point of gravity discharge shall be specified in the instructions for installation.

The disposal system, forming part of the mCHP appliance supplied with the mCHP appliance, shall be such that:

– it can be easily inspected and cleaned in accordance with the appliance instructions,

– it cannot transmit combustion products into the room where the mCHP appliance is installed, this requirement is satisfied if the disposal system incorporates a water trap.

The water trap shall meet 2 requirements:

– a water trap has a seal of at least 25 mm water column,

– The functional operating of the water trap will be tested under the applicable blockage tests b) of 6.5.5.2 or 6.5.5.3.2. In that condition there shall be no leakage of combustion products into the room where the mCHP appliance is installed.

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

5.19 Gas carrying circuit

5.19.1 General

Where the internal pressure for the gas carrying circuit is at or above ambient pressure, the following minimum requirements of the mCHP appliance are detailed below:

Screwed fastenings that have to be removed for servicing of the device shall have a metric thread complying with ISO 262, unless a different thread is essential for the correct functioning and adjustment of the device.

Thread-forming screws that form a thread and do not produce swarf may be used. Metric machine screws shall comply with ISO 262.

Self-tapping screws that cut a thread and produce swarf shall not be used for the assembly of gas-carrying parts or of parts that may be removed for servicing.

Breather holes shall be so designed that, if the diaphragm is perforated, the air leakage rate does not exceed 70 dm³/h at the maximum upstream pressure. This requirement is deemed to be satisfied if, for a maximum gas supply pressure of 30 mbar, the diameter of the breather hole does not exceed 0,7 mm.

The use of bellows as the sole sealing element with respect to atmosphere is permitted only if the air leakage rate in the event of fracture does not exceed 70 dm³/h at the maximum upstream pressure.

Breather holes shall be protected against blockage or shall be located so that they cannot be easily blocked. They shall be so arranged that the diaphragm cannot be damaged by a device inserted for cleaning purposes.

Seals for moving parts which pass through the body to atmosphere and the seals for the closure member shall only be made of solid material (e.g. synthetic materials with proper mechanical support and of proper mechanical stability) of a type which does not deform permanently (e.g. no sealing paste).

Manually adjustable packing glands shall not be used for sealing moving parts. An adjustable gland which is adjusted and protected against further adjustment and which need not be readjusted is not considered adjustable.

There shall be no accessible shafts or operating levers that could be interfered with in such a way as to prevent closure of the valves.

A strainer according to EN 13611 shall be positioned near the gas inlet.

The design shall be such that

- unintended flow back of process gas into the combustion product circuit shall be prevented or controlled,
- no unintended excess pressure can arise in the process gas,
- no unintended air can enter the supplied gas and/or the process gas,
- no unintended outflow of process gas or working fluid can occur within the unit or into the atmosphere.

5.19.2 Control devices

Every mCHP appliance shall be provided with at least one device to enable the user to close the gas supply to the burner, ignition burner or internal combustion engine (or similar oxidation devices), and the process circuit, as relevant to the design of the mCHP appliance.

The shut-off shall be effected without delay.

Any control and setting device shall be clearly marked and give appropriate instruction as to prevent any error in handling. No markings are required if incorrect operation is impossible.

If the mCHP appliance 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 gas shut-off device operates by turning, it shall turn off in a clockwise direction as seen by an observer facing the knob.

5.19.3 Composition of the gas circuit

Safety devices which require non-volatile lockout to occur shall give rise to simultaneous signal to close the two valves.

The two valves shall be at least class C

a) 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.

b) under the condition that a possible pressure generated by the running internal combustion engine at the gas valve output is less than 7 mbar above the minimum gas inlet pressure during start-up or shut-down periods where the valve is closed. If this pressure is > 7 mbar, then the class of the shut-off valve (see EN 161) shall be selected considering 30 % reserve margin compared to the pressure generated by the running internal combustion engine.

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

The composition of the gas circuit shall be according to Table 9.

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

Table 9 – Composition of the gas circuit

Heat input of the individual gas line within the gas circuit	Burner without fan	Burner with fan / internal combustion engine[c]		
		With pre-purge	Without pre-purge but with a valve proving system or permanent or alternating ignition flame	Without pre-purge
Input ≤ 0,250 kW	C [a]			C [a]
Input ≤ 70 kW	C [a,b] + J			C [a,b] + C or B + J

[a] or the valve of the flame supervision device

[b] For ignition burners with a heat input ≤ 1 000 where $T_{SA,max}$ exceeds 10 s and it has been proved that no hazardous situation can occur, see 6.5.3.2.1, only one class C valve is needed.

[c] Other classes of valves are necessary if the pressure generated by the engine exceeds 7 mbar, see 5.19.3 b)

5.19.4 Fuel cell mCHP appliance – composition of the purge circuit (if any)

If the amount of released flammable gas exceeds the limit as specified in 6.4.5, then the purge circuit (e.g. anode outlet gas), which allows the release of flammable gas to the environment (e.g. via the exhaust gas system) by opening valves, shall be fitted with at least two valves of class C.

Alternative valve arrangement is possible, if the valve class is higher (this could be either two valves in parallel to the safety shut off valve(s) or one valve down stream of the safety shut off valve).

5.20 Electrical equipment

The electrical equipment of the mCHP appliance shall comply with EN 60335-2-102, except where reference is made to another electrical standard.

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

– to give the degree of personal protection against contact with dangerous electrical components inside the mCHP appliance case,

– to give the degree of electrical protection, inside the mCHP appliance case, against harmful actions affecting safety due to water penetration.

The technical requirements for connection and operation in parallel with public low voltage distribution networks shall comply with EN 50438 for I ≤ 16 A per phase or CLC/TS 50549-1 for I > 16 A per phase.

For appliances intended to be installed in a partially protected place,

- the enclosure protection degree shall be at least IPX4D;
- the electrical and/or electronic equipment ambient temperature range shall be suitable for the specified temperature range of the appliance.

5.21 Requirements for adjusting, control and safety devices

5.21.1 General

The mCHP appliance shall be equipped with control and safety devices for start, operation and control of the gas supply.

These devices shall ensure the automatic start and the automatic monitoring for the operating functions of the engine and the mCHP appliance as well as the gas supply.

In case of failure of the normal operating functions (malfunctions), the gas supply shall be cut off, if need be, with lock-out in accordance with the operating programme.

The functional safety specification for control and supervision as well as for the automatic restart shall be part of the design documents.

All materials used for the control and supervision device shall be suitable for the minimum and maximum ambient temperatures occurring.

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 not possible to perform two or more actions which are 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 in 5.21 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 can result in confusion.

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

Rubbers used in adjusting, supervision, control and safety devices shall comply with the relevant requirements of EN 549.

Adjusting, supervision, control and safety devices shall comply with the relevant requirements of relevant harmonized European Standards, as appropriate.

NOTE 1 EN 88-1, EN 125, EN 126, EN 161 and EN 298 are presumed to comply with the relevant requirements of this European Standard, as appropriate.

At least the following functions not covered in the above mentioned product standards shall be classified as class A, B or C according to EN 13611 and meet the applicable requirements according to EN 14459 based on a risk analysis of

- reaction monitoring,

NOTE 2 Depending on the type of mCHP appliance, this may be air-gas ratio control / fuel processing system / stack).

- heating water circuit supervision,
- internal cooling circuit supervision,
- safeguard of the gas purge circuit,
- avoidance of reverse power operation,
- speed control for ICE.

5.21.2 Adjusters and range-rating devices

5.21.2.1 General

Any parts of a mCHP appliance which are not intended to be altered by the user or the installer shall be protected in an appropriate manner. Paint may be used for this purpose provided that it withstands the temperature to which it is subjected during normal operation of the mCHP appliance.

The adjusting screws shall be arranged in such a way that they cannot fall into the gas ways.

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

Adjustment of the adjuster and/or of the range-rating device may be continuous (e.g. use of an adjusting screw) or discrete (e.g. change of restrictors).

5.21.2.2 Adjusters

Gas rate adjusters are mandatory for mCHP appliances using several groups of 1st family gas.

The adjuster shall be sealed or be able to be sealed after adjustment during the installation.

For mCHP appliances in a category which include a “+” sign, the adjusters shall be sealed.

5.21.2.3 Range-rating devices

The mCHP appliance may have a range-rating device.

If this device and the gas rate adjuster are one and the same, the instructions for installation shall provide instructions for the use of the adjuster.

5.21.2.4 Gas pressure regulator

mCHP appliances intended to operate with first family gases shall have a gas pressure regulator; for other mCHP appliances a pressure regulator is optional.

A pressure regulator intended for operation with a pressure couple shall be, 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 pressure regulator for the ignition burner is permitted.

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

5.21.3 Ignition devices (if applicable)

5.21.3.1 Ignition of the ignition burner

Ignition and re-ignition shall be smooth and cross-lighting is ensured without interfering with the combustion products circuit.

Ignition devices for the ignition burner shall be designed and fitted in such a way that they are located correctly in relation to the components and the ignition burner.

It shall be possible to fit or remove the ignition device for the ignition burner, or the ignition burner ignition device assembly, using commonly available tools.

5.21.3.2 Ignition device for the main burner

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

Direct ignition shall not cause deterioration of the burner.

5.21.3.3 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 rate of the ignition burner is not governed, a gas rate adjuster is obligatory for mCHP appliances operating on first family gases and optional for second family and third family gases. 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.

Admission of gas to the ignition burner ($Q_{IB} \leq 250$ W) during the pre-purge is permitted, if ignition is effected after the pre-purge period.

5.21.3.4 Direct ignition

Devices for direct ignition 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.

If the type of ignition could simulate a flame signal e.g. as possible by ignition spark and ionisation flame supervision signal, the ignition device shall be de-energized no later than at the end of the ignition safety time

If the ignition device is energized prior to the valve opening or during operation or controlled shut down then the ignition shall not have any influence on the flame monitoring system (e.g. Ionisation) or other safety related control functions.

5.21.4 Flame supervision or reaction monitoring

5.21.4.1 General

The presence of a flame or combustion process shall be detected

- either directly by the flame detector of an automatic burner control system
- or indirectly by monitoring characteristic functions which ensures the availability of a flame or combustion process.

If the main burner is ignited by an ignition burner, the presence of flame or combustion process at the ignition burner flame shall be detected before gas is released to the main burner.

To avoid for ICE reverse power operation of the generator as electric motor in case when the unburnt gas mixture enters into the flue gas circuit the mCHP appliance shall proceed with safety shut-down.

The presence of a flameless oxidation in a catalytic burner shall be detected in a suitable way.

If the temperature of the combustion compartment and the parts of the combustion compartment directly in touch with the gas/air mixture is above the auto ignition temperature, flame supervision may be substituted by the temperature monitoring. If the temperature drops below the auto ignition temperature the safety shut-off valves shall be de-energized. Furthermore the gas flow shall only be released after the self-ignition temperature is ensured. The control function of monitoring the auto ignition temperature shall be a class C control function based on EN 13611.

The control function for detecting the presence of the flame or the combustion process shall be class C according to EN 13611.

NOTE For ICE the following indirect methods could be applied:

– measurement of CO;

– measurement of temperature of combustion products;

– measurement of electrical power;

– measurement of engine speed.

5.21.4.2 Automatic burner / engine control system

Automatic burner / engine control systems shall comply with the appropriate requirements of EN 298. For those aspects that are not covered by EN 298, a risk assessment shall be done according to EN 14459 for class C to identify requirements and tests for that part of the function.

In case of flame failure, the system shall cause at least

– ignition restoration,

– or recycling,

– or volatile lockout.

In the case of ignition 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 case of loss of flameless oxidation monitoring signal, the system shall cause at least

- restoration of the pre-heating device, or
- recycling, or
- volatile lockout.

In the case of restoration of the pre-heating device or recycling, an absence of the flameless oxidation monitoring signal at the end of the ignition safety time (T_{SA}) shall result in, at least, volatile lockout.

If for a system using the “auto ignition temperature” to ignite the mixture, the surface temperature is below the auto ignition temperature then the system shall cause at least safety shut down followed by recycling or volatile lock-out

5.21.5 Thermostats and water temperature limiting devices for the heating water circuit

5.21.5.1 General

mCHP appliances shall be fitted with a fixed setting or adjustable control thermostat complying with 5.21.5.4.

In addition, mCHP appliances shall be fitted with the appropriate temperature limiting devices specified below.

5.21.5.2 mCHP appliances intended exclusively for heating systems with an open expansion vessel

Temperature limiting devices are not required when the mCHP appliance is designed to be installed exclusively with an open expansion vessel and when a failure of the control thermostat does not cause a dangerous situation for the user or damage to the mCHP appliance. Appropriate information shall be given in the technical instructions.

5.21.5.3 mCHP appliances intended for heating systems with an open or sealed expansion vessel

5.21.5.3.1 mCHP appliances of pressure class 1 and 2

A limit thermostat complying with 5.21.5.5 and an overheat cut-off device complying with 5.21.5.6 are required.

Instead of a limit thermostat, other devices (e.g. water rate monitoring device, low water detector safety device) are possible if all the requirements of 6.4 are satisfied.

mCHP appliances fitted with a device complying with the requirements of 5.21.5.3.2 are considered to comply with the requirements of this subclause.

5.21.5.3.2 mCHP appliances of pressure class 3

A safety temperature limiter in accordance with 5.21.5.7 is required.

Instead of a safety temperature limiter, other protections are possible if all applicable requirements of 6.4 are satisfied.

5.21.5.4 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 instructions for installation shall at least state the maximum temperature.

The positions of the temperature selector shall be recognizable 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 shut-down before the water flow temperature exceeds 95 °C.

5.21.5.5 Limit thermostat

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

The limit thermostat shall cause at least safety shut-down before the water flow temperature exceeds 110 °C.

It shall not be possible to alter the maximum set point of this device.

When the water temperature falls below its set point, the gas supply to the burner / internal combustion engine may be restored automatically.

5.21.5.6 Over-heat cut-off device

The overheat cut-off device shall comply with the requirement of EN 60730-2-9 for type 2 devices.

This device shall cause non-volatile lockout before the mCHP appliance is damaged and/or before a dangerous situation for the user occurs.

This device shall not be adjustable and normal operation of the mCHP appliance shall not give rise to a change in its set point temperature.

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

5.21.5.7 Safety temperature limiter

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

In addition to the requirements stated in 5.21.5.6 the safety temperature limiter shall cause non-volatile lockout before the water flow temperature exceeds 110 °C.

5.21.5.8 Sensors

Thermostats, limit thermostats, overheat cut-off devices and safety temperature limiters shall have independent sensors; with an electronic system, thermostats and limit thermostats may have the same

sensor, provided that a failure of the sensor cannot lead to a dangerous situation for the user or damage to the mCHP appliance.

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

5.21.6 Remote control

5.21.6.1 General

mCHP appliances with a remote control device or devices shall be so designed and constructed that failure of this device can not lead to an unsafe situation. The design of the remote control device shall be such as to prevent accidental operation or manipulation.

Appropriate measures shall be taken to prevent unauthorized access to control the operating of the mCHP appliance.

Connection of any remote controls recommended in the appliance instructions shall be possible without disturbing the internal electrical connections except for purpose-designed removable links.

Operation of the controls at the mCHP appliance shall take priority over remote control.

In case of connection to Home and Building Electronic Systems (HBES) the relevant requirements of EN 50090 shall apply.

For more detailed requirements on data exchange, see EN 14459.

5.21.6.2 Remote control reset functions

5.21.6.2.1 General

mCHP appliance that allow remote control reset functions shall be fitted with a switch or other means for switching off the mCHP appliance.

5.21.6.2.2 Functional requirements

A reset action of a mCHP appliances shall be a clear defined manual action.

An automatic reset (e. g. resets generated by automatic devices, like timers etc.) shall not be possible.

Whenever the remote reset function is performed by a mobile device at least 2 manual actions are required to activate a reset.

The remote reset function shall be at least a class B function according to EN 14459 with a fault tolerating time of 24 h.

Any fault of the remote reset shall not cause the mCHP appliances to operate outside the applicable requirements. It shall be detected before the next start-up or shall not prevent the mCHP appliances from going to shut-down or lock-out.

For reset functions where the manual action is initiated without line of sight of the mCHP appliances the following additional requirements apply:

a) the actual status and relevant information of the process under control shall be visible to the user before, during and after the reset action;

b) the maximum number of resets accepted by the control in the mCHP appliances shall be limited to 5 actions within a time span of 15 min. After this period the mCHP appliances shall not reset by remote control.

5.21.6.2.3 Evaluation of the remote reset function on the mCHP appliance

The remote reset function shall be evaluated with the mCHP appliance.

If the reset is activated by manual switching of a thermostat or device with a similar function this shall be stated in the appliance instructions and be approved with the mCHP appliance.

5.21.7 Expansion vessel and pressure gauge

If the mCHP appliance incorporates a sealed system expansion vessel, this shall be located or protected in such a way that heat cannot damage the diaphragm and the mCHP appliance shall be fitted with a pressure gauge stating the maximum water-side operating pressure PMS, see 4.3, this could also be part of the system installation.

5.21.8 Pressure test points

mCHP appliances shall be fitted with a sufficient number of gas pressure test points. At least a pressure test point for the inlet pressure has to be foreseen.

It shall be possible to measure gas pressure without affecting the soundness of the combustion circuit.

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

5.21.9 mCHP appliances intended to be installed in a partially protected place.

For appliances intended to be installed in a partially protected place, the devices shall operate correctly at the temperatures to which they are subjected on the basis of:

a) the “minimum declared installation temperature for mCHP appliances in partially protected places” (see 3.13.2);

b) the “maximum declared installation temperature for mCHP appliances in partially protected places” (see 3.13.3).

5.22 Burners

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

Every removable 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 mCHP appliance. When the injectors and restrictors are removable, their position shall be well defined and their method of fixing shall be such that it is difficult to position them incorrectly.

If the burners or a part of the burners are removable, their position shall be well defined and their method of fixing shall be such that it is difficult to position them incorrectly.

6 Operational requirements

6.1 General requirements

Except where otherwise stated, the operational requirements are verified by test of the mCHP appliance as defined in Clause 7.

Possible operational states of individual components have to be safe. Failures of individual components, the possibility of an uncontrolled formation of inflammable mixtures, the uncontrolled ignition of

inflammable mixtures as well as the uncontrolled leakage of inflammable mixtures or process gases have to be avoided by using sufficient measures.

The odorizer and any sulphur content of the supplied gas according to the specific standards shall not cause any operational troubles.

NOTE Due to the development of new technology other solutions than those described in the following, provided with specific instructions, are possible if these solutions provide at least an equivalent level of safety.

6.2 Soundness

6.2.1 Soundness of the gas carrying circuit

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

The gas carrying circuit shall be sound in operation and stand-by.

Soundness of the gas carrying circuit carrying supplied gas is ensured when, tested under the conditions of 7.2.1, the leak rate of air does not exceed 0,06 dm^3/h for tests 7.2.1 a), 7.2.1 b) and 7.2.1 c) and 0,14 dm^3/h for test 7.2.1 d).

Soundness of the gas carrying circuit carrying process gas is ensured when tested under the conditions of 7.2.1 e), the leak rate of air does not exceed 3 dm^3/h.

If measured with gas different to air (e.g. nitrogen or other inert gas) the leakage rate has to be converted.

6.2.2 Soundness of the combustion circuit

6.2.2.1 General

The combustion circuit of a mCHP appliance shall be sound with respect to the room where the mCHP appliance is installed when tested in accordance with 6.2.2.2 or 6.2.2.3. If for ICE the soundness of the engine is ensured according to 5.4.2, a) to c), then the engine does not need to be part of these tests.

Ducts shall be sound in accordance with 6.2.2.2.3 and 6.2.2.2.4.

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

6.2.2.2 Air supply and combustion product circuit type C mCHP appliance

6.2.2.2.1 General requirements

Soundness with respect to the room where the system is installed is ensured if, under the specified test conditions as given in 7.2.2.2.1 the leak rates do not exceed the values in Table 10.

Table 10 – Maximum admissible leakage rates

Test object	Surrounding of the combustion products circuit by the combustion air circuit	Maximum leak rate ≤ 40 kW m³/h	Maximum leak rate > 40 kW m³/h
mCHP appliance with its air supply and combustion products evacuation ducts and all their joints	completely	5	5 Q_n/40
	not completely	1	Q_n/40
mCHP appliance and the joint to the air supply and combustion products evacuation duct	completely	3	3 Q_n/40
	not completely	0,6	0,6 Q_n/40
Combustion products evacuation ducts, not completely surrounded by combustion air, with all its joints excluding the joint tested above		0,4	0,4 Q_n/40
Air supply duct with all its joints excluding the joint tested above		2	2 Q_n/40

6.2.2.2.2 Combustion products evacuation duct for mCHP appliances with indirect air proving

The soundness of the combustion products evacuation duct for installation both inside and outside the room where the mCHP appliance is installed, permitted for mCHP appliances with indirect air proving, is ensured when tested under the conditions of 7.2.2.2.2, the leak rate per surface area of the duct does not exceed 0,006 dm³/(s × m²).

6.2.2.2.3 Combustion products evacuation ducts (separate ducts) in areas other than the room where the mCHP appliance is installed

The soundness of a separate combustion products evacuation duct with respect to areas other than the room where the mCHP appliance is installed is ensured when tested under the conditions of 7.2.2.2.3, the leak rate per surface area of the duct does not exceed 0,006 dm³/(s × m²).

6.2.2.2.4 Air supply ducts (separate and concentric) in areas other than the room where the mCHP appliance is installed

The soundness of the air supply ducts with respect to all areas other than the room where the mCHP appliance is installed is ensured when tested under the conditions of 7.2.2.2.4 the leak rate per surface area of the duct does not exceed 0,5 dm³/(s × m²).

6.2.2.3 Soundness of the combustion product circuit of type B mCHP appliance

6.2.2.3.1 General requirements

mCHP appliances shall comply with 6.2.2.3.2 or 6.2.2.3.3. Ducts of type B_5 mCHP appliances shall comply with 6.2.2.3.4. Soundness shall be verified before and after all the tests of this European Standard.

6.2.2.3.2 Type B_2 and B_5 mCHP appliance

The combustion products circuit of mCHP appliances incorporating a fan shall be sound with respect to the room where the mCHP appliances is installed. This soundness is ensured if, under the test conditions of 7.2.2.3.2, combustion products only escape from the flue outlet. Additionally the ducts of type B_5 mCHP appliances should also meet the requirements of 6.2.2.3.4.

6.2.2.3.3 Type B_3 mCHP appliance

Soundness is ensured if, under the test conditions of 7.2.2.3.3, the following applicable requirements are met:

a) the leakage rate of the combustion products circuit does not exceed

- 3,0 m³/h for mCHP appliances with a nominal heat input until 40 kW or
- 3 Q_n/40 m³/h for mCHP appliances above 40 kW;

b) the leakage rate of the combustion circuit (with all the duct and joints) does not exceed

- 5,0 m³/h for mCHP appliances with a nominal heat input until 40 kW or
- 5 Q_n/40 m³/h for mCHP appliances above 40 kW.

6.2.2.3.4 Combustion products evacuation ducts of type B_5 mCHP appliances passing through walls

The soundness of a combustion products evacuation duct, not completely surrounded by combustion air, with respect to areas other than where the mCHP appliances is installed, is ensured if under the test conditions of 7.2.2.3.4 the leakage rate per square metre surface of the duct does not exceed 0,006 dm³/s.

6.2.3 Soundness of the heating water circuit

6.2.3.1 General

The mCHP appliance and/or their sections shall withstand a hydraulic test according their classification as stated in 4.3.

6.2.3.2 mCHP appliance for class 1 and 2

Under the test conditions of 7.2.3.2, there shall be neither leakage during the test, nor permanent visible distortion, at the end of the test.

6.2.3.3 mCHP appliance of pressure class 3

6.2.3.3.1 mCHP appliance of sheet steel or non-ferrous metals

Under the test conditions of 7.2.3.3.1 there shall be neither leakage during the test, nor permanent visible distortion, at the end of the test.

6.2.3.3.2 mCHP of cast iron and cast materials

6.2.3.3.2.1 mCHP body

Under the test conditions of 7.2.3.3.2.1 there shall be neither leakage during the test, nor permanent visible distortion at the end of the test.

6.2.3.3.2.2 Resistance to bursting

Under the test conditions of 7.2.3.3.2.2, the sections shall remain sound.

6.2.3.3.2.3 Tie bars

Under the test conditions of 7.2.3.3.2.3 the tie bars shall withstand the pressure.

6.2.4 Soundness of the internal cooling circuit (if applicable)

Under the test conditions of 7.2.4, there shall be neither leakage nor permanent visible distortion.

6.3 Heat input and heat and electrical output

6.3.1 Heat input for nominal appliance outputs (100 % CHP + 100 % Sup) and for 100 % CHP + 0 % Sup

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 mCHP appliances without a range-rating device, or
- the maximum and minimum heat input for mCHP appliances with a range-rating device,
- the nominal heat input for the CHP part.

If these 5 % are less than 500 W, a tolerance of 500 W or 10 %, whichever is lower, is acceptable.

6.3.2 Adjustment of the heat input by the downstream gas pressure (if applicable)

When the appliance 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.

If these 5 % are less than 500 W, a tolerance of 500 W is acceptable.

6.3.3 Ignition rate (if applicable)

For mCHP appliances which may be ignited at a heat input less than the nominal heat input under the test conditions of 7.3.3, it is verified that the ignition rate does not exceed the ignition rate stated in the design documentation.

6.3.4 Nominal output (thermal and electrical output)

It is verified that the product of the overall efficiency determined under the test conditions of 7.3.4 and the nominal heat input is not less than the nominal overall (thermal and net AC electrical) output.

6.3.5 Nominal domestic hot water heat input

Under the test conditions of 7.3.5, the nominal domestic hot water heat input shall be obtained, or may be adjusted, to within ± 5 %.

6.3.6 Water pressure to obtain the nominal heat input for instantaneous combination mCHP appliances

Under the test conditions 7.3.6, the heat input obtained shall be at least 95 % of the heat input obtained in 6.3.5.

6.3.7 Obtaining the domestic hot water temperature for instantaneous combination mCHP appliances

Under the conditions of 7.3.7, it shall be possible to achieve or adjust to, a water rate that corresponds to a temperature of between 50 °C and 80 °C for mCHP appliances with a thermostatic control or a temperature rise at the mCHP appliance outlet of between 45 K and 65 K for mCHP appliances with proportioning control.

6.4 Safety of operation (temperature / limit gas)

6.4.1 Limiting temperatures

6.4.1.1 Limiting temperatures of the adjusting, control and safety devices

Under the test conditions of 7.1, the temperature of the adjusting, control and safety devices shall not exceed the value stated in the design documentation and their 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 mCHP appliance, 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.

NOTE The values above are based on an ambient temperature not normally exceeding 25 °C but occasionally reaching 35 °C. However, the temperature rise values specified are based on 25 °C.

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

6.4.1.2 Limiting temperatures of the side walls, the front and the top

The temperature of the side walls, front and top of the mCHP appliance 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, if any, and within 15 cm of the flue duct are exempt from this requirement.

6.4.1.3 Limiting temperature of the test panels and the floor

The temperature of the floor on which the mCHP appliance is placed, where appropriate, and that of the panels placed at the side of and behind the mCHP appliance 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 appliance instructions shall state for the installer the nature of the protection which has to be applied between the mCHP appliance 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 mCHP appliance 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.

6.4.1.4 External temperature of the ducts

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

If this temperature rise exceeds 60 K the installation instructions shall state the nature of the protection which has to be applied between the ducts and the walls when they are constructed from inflammable materials.

With the protection fitted, the external surface temperature in contact with the wall measured under the test conditions of 7.4.1.5 shall not exceed the ambient temperature by more than 60 K.

6.4.2 Thermostats and temperature limiting devices

6.4.2.1 General

Under the test conditions of 7.4.2.1 the opening and closing temperatures of the thermostats shall not differ from those stated in the design documentation by more than 6 K. For adjustable thermostats, this requirement is checked at the minimum and maximum temperatures of the control range.

6.4.2.2 Water control thermostats

6.4.2.2.1 Accuracy of adjustment

Under the test conditions of 7.4.2.2.1,

- the maximum water temperature of mCHP appliance fitted with a fixed setting thermostat shall be within ± 10 K of the temperature stated in the design documentation,
- for mCHP appliances fitted with an adjustable thermostat, it shall be possible to select, within ± 10 K, the water flow temperatures stated in the appliance instructions,
- the flow temperature shall not exceed 95 °C; however, when the control thermostat is located on the return, this requirement may be satisfied by action of the limit thermostat located on the water flow,
- the limit thermostat (unless the control thermostat is on the return), overheat cut-off device and safety temperature limiter shall not operate.

6.4.2.2.2 Endurance

Thermostats shall withstand an endurance test of 250 000 cycles under the test conditions of 7.4.2.2.2. At the end of the tests, their operation shall comply with the requirements of 6.4.2.2.1.

6.4.2.3 Water temperature limiting devices

6.4.2.3.1 Inadequate water circulation (if applicable)

No deterioration of the mCHP appliance shall occur under the test conditions of 7.4.2.3.1

This requirement does not apply to a mCHP appliance intended exclusively for a central heating system with an open expansion vessel.

6.4.2.3.2 Overheating

6.4.2.3.2.1 mCHP appliances of pressure classes 1 and 2

Under the test conditions of 7.4.2.3.2.1 a) the limit thermostat (or equivalent see 5.21.5.3.1) shall cause safety shutdown before the water flow temperature exceeds 110 °C.

Under the test conditions of 7.4.2.3.2.1 b) the overheat cut-off device (or equivalent see 5.21.5.3.1) shall cause non-volatile lockout of the mCHP appliance before a situation occurs that is dangerous to the user or capable of damaging the mCHP appliance.

6.4.2.3.2.2 mCHP appliances of pressure class 3

Under the test conditions of 7.4.2.3.2.2, the safety temperature limiter (or equivalent see 5.21.5.3.2) shall cause non-volatile lockout of the mCHP appliance before the water flow temperature exceeds 110 °C.

6.4.2.3.3 Endurance

6.4.2.3.3.1 Limit thermostats

Under the test conditions of 7.4.2.2.2 limit thermostats shall withstand an endurance test of 10 000 cycles. At the end of the tests, their operation shall comply with the requirements of 6.4.2.1 applying the test conditions of 7.4.2.3.2.1 a).

6.4.2.3.3.2 Overheat cut-off devices and safety temperature limiters

Under the test conditions of 7.4.2.3.3.2, the devices shall withstand an endurance test of 4 500 thermal cycles without activation and 500 cycles of lockout and resetting.

At the end of the tests, their operation shall comply with the requirements of 6.4.2.1 and 6.4.2.3.2.1 applying the test conditions of 7.4.2.3.2.1 b).

Under the test conditions of 7.4.2.3.3.2, interruption of the link between the detector and the device responding to its signal shall cause at least safety shutdown.

6.4.2.4 Temperature of combustion products

If the mCHP appliance incorporates a device to limit the maximum temperature of the combustion products, under the conditions of 7.4.2.4, the temperature of the combustion products shall not exceed the maximum allowable working temperature of the materials of the combustion circuit and the flue materials specified in the design documentation.

A limiting thermostat needs to be installed only if the flue gas temperatures can possibly exceed the maximum allowable temperature of the materials.

Operation of the device shall cause a non-volatile lock-out of the mCHP appliance.

6.4.2.5 Temperature of internal cooling circuits (if applicable)

The requirements of 6.4.2.2 and 6.4.2.3 also apply for the internal cooling circuits (if applicable).

6.4.3 Ignition – Cross lighting – Flame stability

6.4.3.1 General

The burner and ignition burner, if any shall comply with the following requirements.

6.4.3.2 Limit conditions (if applicable)

Under the test conditions specified in 7.4.3.2 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, if any, shall occur at all gas rates which can be given by the controls and there shall be neither light-back nor prolonged flame lift. 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 mCHP appliance 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 mCHP appliance 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.

In addition, to test flame stability, for mCHP appliances 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 cm^3/m^3.

NOTE 1 cm^3/m^3 = 1 ppm.

The above requirements shall also be fulfilled where spark restoration or recycling is provided.

6.4.3.3 Special conditions (if applicable)

Under the test conditions of 7.4.3.3, 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 operating simultaneously shall be ensured.

Slight flame disturbance is permitted but there shall be no flame extinction.

6.4.3.4 Reduction of the gas rate of the ignition burner (if applicable)

Under the test conditions of 7.4.3.4 and when the gas rate of the ignition burner is reduced to the minimum required to keep open the gas valve of the flame supervision device, ignition of the main burner shall be ensured without damage to the mCHP appliance.

6.4.3.5 Reduction of the gas pressure

Under the test conditions of 7.4.3.5, there shall be no dangerous situation for the user or damage to the mCHP appliance.

6.4.3.6 Defective closure of the gas valve immediately upstream of the main burner (if applicable)

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 7.4.3.6 that no dangerous situation can arise in the event of defective closure of the gas valve immediately upstream of the main burner when the ignition burner is ignited.

6.4.3.7 Defective operation of the valve controlling the supply of ignitable mixture for ICE engine (if applicable)

For mCHP appliances equipped with a valve control for the supply of the ignitable mixture it is checked under the test conditions of 7.4.3.7 that

- no discharge of the exhaust gases may cause backfiring into the mixture intake system or
- if there is backfiring into the mixture the ignition of the mixture does not cause any deterioration to the appliance.

If a flame arrestor, complying with EN ISO 16852, is used, the above requirements are assumed to be complied with.

6.4.3.8 Resistance to draught for type B mCHP appliance

The flames shall be stable under the test conditions of 7.4.3.8.

6.4.4 Pre-purge

6.4.4.1 Pre-purge under normal conditions

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

- the mCHP appliance is fitted with a permanent or alternating ignition burner;
- if the heat input is greater than 0,250 kW and the gas circuit is fitted with two valves which are of at least class C or classes B and J, which close simultaneously;
- the mCHP appliance satisfies 6.4.4.5 (verification of normal ignition in a combustible air/gas mixture for type C mCHP appliance incorporating a fan). This condition is only applicable for type C_{12} and C_{13} mCHP appliance;
- mCHP appliances satisfying 6.4.4.3 (Verification of the protected nature of a combustion chamber).

Under the test conditions of 7.4.4.1, the volume or the pre-purge time shall be at least

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

- for other mCHP appliances: at least three times the volume of the combustion chamber or at least 15 s at the air rate corresponding to nominal heat input .

6.4.4.2 Pre-purge after safety shut-down or reset from lock-out

Pre-purge as given in 6.4.4.1 is always necessary after a safety shutdown or a lock out situation unless, when tested in accordance with the test conditions of 7.4.4.2 no hazard or damage occurs.

6.4.4.3 Verification of the protected nature of a combustion chamber

If the protected nature of a combustion chamber is claimed, then under the test conditions of 7.4.4.3 it is checked that an ignition within the combustion chamber does not ignite a combustible mixture of air and gas outside the combustion chamber.

6.4.4.4 Functioning of a permanent ignition burner when the fan stops during the standby time (if applicable)

Under the test conditions of 7.4.4.3, the flame stability of the ignition burner shall be correct.

6.4.4.5 Verification of normal ignition in a combustible air/gas mixture for type C mCHP appliance incorporating a fan

Under the test conditions of 7.4.4.5, it is checked that ignition occurs correctly without deterioration to the mCHP appliance when the combustion chamber is first filled with a combustible air/gas mixture.

6.4.5 Process gas purge (if applicable)

The amount of purge gas released shall not exceed the volume of the purge circuit of the appliance. The maximum number of purge cycles shall be limited to 5/h.

Under the test conditions of 7.4.5 it is checked that that there are not more than 5 cycles per hour possible.

6.5 Start / Release and adjusting, control and safety devices (if applicable)

6.5.1 General

The supplied gas shall only be released if all functional and safety prerequisites are fulfilled.

The start-up program shall be defined. A change in the switching time may only arise within the admissible tolerances due to influences of temperature, voltage as well as electromagnetic or magnetic disturbances.

The devices shall operate correctly under extreme conditions, namely, at the maximum temperature to which they are subjected in the mCHP appliance 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 ensure safety or cause safety shutdown.

6.5.2 Combination mCHP appliances

If the nominal heat input in domestic hot water mode exceeds the nominal heat input in the central heating mode, the following safety requirements of this standard are checked at the nominal heat input in the domestic hot water mode and at the maximum water temperature:

a) soundness of the combustion circuit;

b) limiting temperatures;

c) ignition - Cross lighting - Flame stability;

d) flame supervision or reaction monitoring;

e) carbon monoxide.

6.5.2.1 Safety of the domestic hot water circuit

6.5.2.1.1 Instantaneous and storage types

6.5.2.1.1.1 Soundness of parts containing domestic water

Under the test conditions of 7.5.2.1.1.1, the parts containing domestic water shall withstand the test pressure without permanent distortion or soundness defects, with respect to the outside or the heating circuit.

6.5.2.1.1.2 Overheating of the domestic hot water by the heating circuit

Under the test conditions of 7.5.2.1.1.2, the domestic hot water temperature shall not exceed 95 °C.

6.5.2.1.1.3 Failure of the domestic hot water temperature control device

For mCHP appliances in which the domestic hot water circuit is not in contact with the combustion products, with normal control out of operation and according to the option chosen, at least the requirement relating to the limit thermostat (see 6.4.2.3.2.1 test 1 or the safety temperature limiter see 6.4.2.3.2.2) shall under the test conditions of 7.5.2.1.1.3 be met.

For mCHP appliances in which the domestic hot water circuit does come into total or partial contact with the combustion products, the limit thermostat shall at least cause safety shutdown before the tap water reaches a temperature of 100 °C.

6.5.2.1.2 Instantaneous type

6.5.2.1.2.1 Maximum temperature of the domestic hot water

Under the test conditions of 7.5.2.1.2.1 the domestic hot water temperature shall not exceed 95 °C.

6.5.2.1.2.2 Overheating of the domestic hot water

Under the test conditions of 7.5.2.1.2.2, the domestic hot water temperature shall not exceed 95 °C.

6.5.2.1.3 Storage type

6.5.2.1.3.1 Maximum temperature of the domestic hot water

Under the test conditions of 7.5.2.1.3.1, the domestic hot water temperature shall not exceed 95 °C.

6.5.2.1.3.2 Overheating of the domestic hot water

Under the test conditions of 7.5.2.1.3.2 for mCHP appliances in which part of the tank is in contact with products of combustion, the domestic hot water temperature shall not exceed 95 °C.

6.5.2.1.3.3 Temperature of the domestic hot water

Under the test conditions of 7.5.2.1.3.3, it shall be possible to adjust to or obtain a domestic hot water temperature of at least 60 °C in the tank.

6.5.3 Control devices

6.5.3.1 Ignition burner

Under the test conditions of 7.5.3.1, the heat input of any ignition burner that remains alight when the main burner is extinguished shall not exceed 0,250 kW.

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

6.5.3.2 Automatic burner / engine control system

6.5.3.2.1 Ignition safety time (T_{SA})

The $T_{SA,max}$ is stated in the design documentation.

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

For combustion circuits incorporating a fan a delayed ignition test is not necessary if the $T_{SA,max}$ determined under the test conditions of 7.5.3.2.1, complies with the following requirement:

$$T_{SA,max} \leq 5 \times \frac{Q_n}{Q_{IGN}} .$$

If $T_{SA,max}$ exceeds 10 s, it shall be proved that no hazardous situation can occur.

Where several automatic ignition attempts are made without being followed by a purge corresponding to 7.4.4.1, the sum of the duration of the ignition attempts shall comply with the above requirement for T_{SA}.

For ICE mCHP appliance performing several trials for ignition with natural ventilation in between, the delayed ignition test according to 7.5.7 shall be performed from 1 s until the end of last ignition trial.

6.5.3.2.2 Extinction safety time (T_{SE})

Under the test conditions of 7.5.3.2.2, unless spark restoration occurs, the extinction safety time of the ignition burner and main burner shall not exceed 5 s.

6.5.3.2.3 Spark restoration

If spark restoration takes place, under the test conditions of 7.5.3.2.2, the ignition device shall be re-energized within a maximum time of 1 s (or the time stated in the design documentation) after the disappearance of the flame signal.

In this case, the T_{SA} is the same as is used for ignition and it starts when the ignition or pre-heating device is energized.

6.5.3.2.4 Recycling

If recycling takes place, under the test conditions of 7.5.3.2.4, this shall be preceded by an interruption of the gas supply; the ignition sequence shall restart from the beginning.

In this case, the T_{SA} is the same as is used for ignition and starts when the ignition device is energized.

A maximum of 5 recycling attempts are permitted.

For ICE, recycling can be performed without interrupting the igniter.

6.5.4 Gas pressure regulator

Under the test conditions of 7.5.4 the gas rate of a mCHP appliance fitted with a pressure 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 a mCHP appliance using gases of the second and third family without a pressure couple, does not meet the requirements between p_n and p_{min}, these mCHP appliances shall meet the requirements given in this European Standard (e.g. 7.8.1.3.1) for a mCHP appliance without a gas pressure regulator, for this pressure range.

6.5.5 Air proving device

6.5.5.1 General

Depending on the principle of air proving, the applicable requirements as described in 6.5.5.2 or 6.5.5.3 shall be satisfied, under the appropriate test conditions of 7.5.5.1.

6.5.5.2 Supervision of the combustion air or combustion products rate

At a reduced flow rate, the CO concentration shall not exceed the specific value given below.

The following methods of flow reduction shall be examined:

a) progressive blockage of the air inlet;

b) progressive blockage of the combustion products evacuation ducts;

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

For air proving the following two supervision strategies are possible; a start-up supervision or a continuous supervision. The mCHP appliance shall under the test conditions of 7.5.5.2 at a reduced flow rate meet one of the following two requirements:

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

e) start-up supervision: no start if the CO concentration exceeds 0,1 %.

The method of e) is only applicable if a heat generator is not designed for permanent operation.

6.5.5.3 Gas/air ratio controls

6.5.5.3.1 Leakage of non-metallic control tubes

Under the test conditions of 7.5.5.3.1, 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 mCHP appliance.

6.5.5.3.2 Safety of operation

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

a) progressive blockage of the air inlet;

b) progressive blockage of the combustion products evacuation ducts;

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

For air proving the following two supervision strategies are possible; a start-up supervision or a continuous supervision. The mCHP appliance shall at a reduced flow rate meet under the test conditions of 7.5.5.3.2 one of the following two requirements:

d) continuous supervision: shutdown before the CO concentration exceeds:

   1) 0,2 % over the range of modulation as stated in the appliance instructions, or

   2) CO % = Q / Q_{KB} × CO_{mes} ≤ 0,20 % below the minimum rate of the modulation range, where

      Q is the instantaneous heat input, in kW;

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

      CO_{mes} is the measured CO concentration.

e) Start-up supervision: no start if the CO concentration exceeds 0,1 %.

The method of e) is only applicable if a heat generator is not designed for permanent operation.

6.5.5.3.3 Adjustment of the air/gas or gas/air ratio

The installation instructions shall state (see 9.2.1.3) minimum and maximum CO_2 and /or O_2 levels between which no action is required.

If the gas/air ratio is adjustable for CO_2 and / or O_2 the test of 6.5.5.3.2 shall be repeated at the test conditions given in 7.5.5.3.3.

6.5.6 Functioning of the fan of a type C_4 mCHP appliance

For type C_{42} and C_{43}, mCHP appliance, when controlled shutdown or safety shutdown occurs, the fan shall stop after any post-purge.

If the mCHP appliance is fitted with a permanent or alternating ignition burner, it is permissible for the fan to function at the lowest speed corresponding to the flow which is necessary for the ignition burner.

Under the test conditions of 7.5.6, it is checked that the above requirements are meet.

6.5.7 Delayed ignition

The following apply if according to 6.5.3.2.1 the delayed ignition test is required.

Under the test conditions of 7.5.7, there shall be no deterioration of the mCHP appliance or hazard to the user.

6.5.8 Common flue evacuation duct

In case of a mCHP appliance with at least two heat sources connected to a common flue gas evacuation duct, the mCHP appliance shall meet the following requirements:

– when tested in accordance with 7.5.8, the CO concentration of combustion shall not exceed 0,10 % measured at the common outlet of the CHP appliance;

– if only one heat source is operating combustion products shall not flow back through the non-operating heat source in a rate > 200 l/h;

NOTE This can be achieved by e.g. under pressure in the non-operating combustion outlet or with a back-flow valve.

- the simultaneous operation shall not impair the combustion of the others concerning, e.g. flame pulsation, flame lift, noise;
- if back-flow valves are used they shall be a part of the appliance and shall be tested as such.

6.5.9 Leak tightness of the back-flow valve

Under the test conditions of 7.5.9, the leak tightness of the applied back-flow valve should be < 200 l/h from 0 Pa to the maximum pressure difference at start, with a minimum pressure difference of 100 Pa.

This leak tightness prevents unacceptable recirculation of flue gas to other appliances and prevents moisture caused by reverse flow of flue gas in the gas appliance.

6.5.10 Functional durability of the back-flow valve

The durability of the applied backflow valve shall be proven according to 7.5.10.

6.6 Efficiency

6.6.1 Efficiency (H_i)

The overall efficiency is the ratio of the useful heat output and the net AC electric power output to the heat input referring to net calorific value (H_i) and expressed in percent.

The following minimum value shall be reached under the test conditions of 7.6.1:

- overall efficiency: ≥ 80 % at nominal heat input.

6.6.2 Seasonal space heating energy efficiency (ErP)

The efficiency values shall be converted according to 7.6.2 for the use as seasonal space heating energy efficiency as used in the ErP directive

6.6.3 Electric auxiliary energy consumption for ErP

The electric auxiliary energy consumption shall be measured according to 7.6.3 for the use as electric auxiliary energy consumption as used in the ErP directive.

6.6.4 Stand-by heat loss P_{stby}

The stand-by heat losses shall be measured according to 7.6.4 for the use as stand-by heat losses as used in the ErP directive.

6.6.5 Permanent ignition burner heat input $_{pilot}$

The permanent ignition burner heat input shall be measured according to 7.6.5 for the use **as ignition burner power consumption** as used in the ErP directive.

6.6.6 Minimum sustained controlled heat output

The minimum sustained controlled heat output shall be measured according to 7.6.6.

6.7 Operation

It shall be possible to switch on and off the mCHP appliance as well as to set the heating water flow temperature and, if applicable, the domestic hot water (DHW) temperature.

6.8 Combustion

6.8.1 Carbon monoxide

6.8.1.1 General

The CO concentration in the dry, air-free products of combustion shall not exceed the values stated in 6.8.1.2 and 6.8.1.3.

6.8.1.2 Limit conditions

Under the test conditions of 7.8.1.2, the CO concentration shall not exceed 0,10 %.

6.8.1.3 Special conditions

Under the test conditions of 7.8.1.3, the CO concentration shall not exceed 0,20 %.

6.8.1.4 Sooting

Under the test conditions of 7.8.1.4, no soot deposition shall be observed although yellow tipping is acceptable.

6.8.2 NO_X (Other pollutants)

The appliance instructions shall state the NOx class of the mCHP appliance, according to Table 11. Under the test and calculation conditions of 7.8.2, the permissible NO_x concentration assigned to this class in the dry, air free products of combustion shall not be exceeded by the overall NO_X emissions NO_{X_mCHP}.

Table 11 – NO_x classes

NO_x-classes	**Limit NO_x concentration** mg/kWh
0	500
1	260
2	200
3	150
4	100
5	70

6.8.3 Supplementary test for condensing mCHP appliance

Under the test conditions according to 7.8.3 the formation of condensate shall not impair the correct operation of the mCHP appliance.

If the mCHP appliance is equipped with a condensate discharge, the mCHP appliance shall meet one of the following requirements:

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

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

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

6.9 Resistance of materials to pressure

6.9.1 General

The mCHP appliance and/or their sections shall withstand a hydraulic test.

The tests are carried out as stated in 7.9 in so far as these tests have not already been carried out under 7.2.3.

6.9.2 mCHP appliances of pressure class 1

Under the test conditions of 7.9.2, there shall be no leakage during the test or permanent visible distortion at the end of the test.

6.9.3 mCHP appliances of pressure class 2

Under the test conditions of 7.9.3, there shall be no leakage during the test or permanent visible distortion at the end of the test.

6.9.4 mCHP appliances of pressure class 3

6.9.4.1 mCHP appliances of sheet steel or non-ferrous metals

Under the test conditions of 7.9.4.1, there shall be no leakage during the test or permanent visible distortion at the end of the test.

6.9.4.2 mCHP appliances of cast iron and cast materials

6.9.4.2.1 mCHP unit body

Under the test conditions of 7.9.4.2.1, there shall be no leakage during the test or permanent visible distortion at the end of the test.

6.9.4.2.2 Resistance to bursting

Under the test conditions of 7.9.4.2.2, the sections shall remain sound.

6.9.4.2.3 Tie bars (if applicable)

The tie bars shall withstand the conditions of 7.9.4.2.3.

6.10 Hydraulic resistance

Under the test conditions of 7.10, the values of the hydraulic resistance or the curve of available pressures, stated in the instructions for installation, are checked.

6.11 Formation of condensate

Under the conditions specified in 7.11, the condensate shall only form at the points intended for this purpose and shall be readily drained.

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

6.12 Designation and measurement of reference temperatures of flue systems

6.12.1 Nominal working combustion products temperature

Where the nominal working combustion product temperature is required in 9.2.1.5 the specified value should be higher or equal to the temperatures recorded in the test according 7.12.1

6.12.2 Overheat combustion products temperature

Where the overheat combustion product temperature is required in 9.2.1.5 the specified value should be higher or equal to the temperatures recorded in the test in 7.12.2.

6.13 Mechanical resistance and stability of ducts, terminal and fitting pieces

6.13.1 General

Where the air supply and combustion product evacuation circuit is an integral part of the mCHP appliance - that is the circuit is supplied with the appliance or specified in the installation instruction - the ducts, terminal and fitting pieces shall meet requirements for mechanical resistance and stability.

6.13.2 Compressive strength

6.13.2.1 Duct sections and fittings

Where compressive stresses occur in the air supply or combustion products evacuation ducts, due to the weight of the duct components, the ducts shall show no permanent deformation, when tested according 7.13.2.1.

6.13.2.2 Ducts support

When tested according to 7.13.2.2 the maximum displacement of the ducts at the support shall not be greater than 5 mm in the direction of the load.

6.13.2.3 Vertical terminals

When tested according to 7.13.2.3 the terminal shall show no permanent deformation.

6.13.3 Lateral strength

6.13.3.1 Flexural tensile strength

When the installation instructions state that the air supply and combustion product evacuation ducts to be suitable for non-vertical installation, these ducts are tested in accordance with 7.13.3.1. The deflection of any part after mounting shall not be more than 2 mm per meter in distance between supports.

6.13.3.2 Components subject to wind load

When the installation instructions specify a certain length of the air supply and combustion product evacuation ducts to be suitable for external installation, the ducts shall show no permanent deformation when tested in accordance with the test conditions of 7.13.3.2

6.13.4 Flexible metallic liners

Flexible metallic liners have to meet the requirements of EN 1856-2:2009, 6.1.2.6.

6.14 Requirements for plastic in the combustion product evacuation ducts, terminals and fitting pieces for mCHP appliances

6.14.1 Thermal resistance

If the thermal resistance is not declared to be zero, the thermal resistance value declared in the installation instructions shall be verified according to 7.14.1.

6.14.2 Materials

6.14.2.1 Characterization

The material shall be identified by the thermal, mechanical and physicochemical behaviour according to 7.14.2.1.

The characterization shall include the density and at least 5 more properties. At least one property has to be taken from each of the three groups of methods in Annex A of EN 14471:2013.

The characterization methods shall be chosen in such a way that the characterization includes the relevant properties of the material. Examples are given in Annex B of EN 14471:2013.

6.14.2.2 Long-term resistance to thermal load

The material shall be capable of withstanding exposure to the nominal working combustion products temperature as described in 7.14.2.2.

The tensile modulus and the yield stress shall be measured in all cases.

In case of thermosetting plastics the flexural modulus and flexural strength shall also be determined.

In case of flexible tubes the ring stiffness shall also be determined.

Other relevant properties like the density or the impact strength shall be measured additional before and after the period of exposure, if they are relevant to evaluate the deterioration of the material.

The properties shall be determined in accordance with the methods of Annex CC.

Alterations to the properties shall not exceed those set out in Table 12.

If these values are not met, it is allowed to do the test again using the same material after 24 h exposure in air at nominal working temperature (conditioning) to release processing pressures/effects.

The requirements for mechanical stability after exposure are covered by 6.13.

Table 12 – Criteria for testing long-term resistance to thermal load

Property	Maximum permitted variation
Impact strength	≤ 50 %
Tensile modulus	≤ 50 %
Yield stress	≤ 50 %
Density	≤ 2 %
Flexural modulus	≤ 50 %
Flexural strength	≤ 50 %
Ring stiffness	≤ 50 %

6.14.2.3 Long-term resistance to condensate exposure

The combustion products evacuation duct with the terminal and fitting pieces shall be so designed that no condensate is retained within them. The material shall be capable of withstanding exposure to condensate as described under test conditions of 7.14.2.3.

The tensile modulus and the yield stress shall be measured in all cases.

In case of thermosetting plastics the flexural modulus and flexural strength shall also be determined.

In case of flexible tubes the ring stiffness shall also be determined.

Other properties like the density or the impact strength shall be measured before and after the period of exposure if they are relevant, by evaluation of the deterioration of the material.

The properties shall be determined in accordance with the methods of Annex CC.

Alterations to the properties shall not exceed those set out in Table 13.

Table 13 – Criteria for testing long-term resistance to condensate exposure

Property	Maximum permitted variation
Impact strength	≤ 50 %
Tensile modulus	≤ 50 %
Yield stress	≤ 50 %
Density	≤ 2 %
Flexural modulus	≤ 50 %
Flexural strength	≤ 50 %
Ring stiffness	≤ 50 %
NOTE If these values are not met, it is allowed to take new reference values obtained after 24 h exposure in air at nominal working temperature (conditioning) to release processing pressures/effects.	

If the air supply and combustion products evacuation duct has been tested before on an appliance with a higher temperature specified in 7.14.2.3 this system will be deemed to meet these requirements.

6.14.2.4 Resistance to condensing/non-condensing cycling

Following application of the test conditions given in 7.14.2.4, the soundness with respect to the room where the mCHP appliance is installed shall comply with 6.2.2.2

Following the soundness test:

- the flue duct is disassembled and visually examined.
- It shall not show damages like cracks and pinholes.
- The dimensions of the sections and fittings shall not change more than 2 %.
- The tensile modulus and the yield stress shall be measured in all cases.
- In case of thermosetting plastics the flexural modulus and flexural strength shall also be determined.
- In case of flexible tubes the ring stiffness shall also be determined.
- Other properties like the density or the impact strength shall also be measured before and after the period of exposure, if they are relevant to the evaluation of the deterioration of the material.

The properties shall be determined in accordance with the methods as given in Annex CC.

Alterations to the properties shall not exceed those set out in Table 14.

If the values are not met, it is allowed to take new reference values obtained after 24 h exposure in air at nominal working temperature (conditioning) to release processing pressures/effects.

Table 14 – Criteria for testing resistance to condensing/non-condensing cycling

Property	Maximum permitted variation
Impact strength	≤ 30 %
Tensile modulus	≤ 30 %
Yield stress	≤ 30 %
Density	≤ 2 %
Flexural modulus	≤ 30 %
Flexural strength	≤ 30 %
Ring stiffness	≤ 30 %

6.14.2.5 Resistance to ultraviolet radiation (UV)

Those parts of the air supply and combustion products evacuation ducts that are exposed to UV shall be tested in accordance with 7.14.2.5.

Testing is not necessary in cases where the free end of the plastic flue duct (terminal) is not more than twice the diameter of the duct, and a maximum 0,4 m in length exposed to UV of the sun.

After the exposure test the following requirements shall be met:

a) the impact strength, as given in Annex CC, shall not change more than 50 %;

b) in the case of thermosetting plastics the flexural modulus and flexural strength, as given in Annex CC, shall not change more than 50 %.

6.14.2.6 Geometrical stability

After exposure in accordance with the test conditions of 7.14.2.6 the change in internal diameter/length of the pipe shall not exceed 2 %.

For each size group of diameters one size shall be tested according to Table 15.

Table 15 – Group sizes of internal flue diameters

Size group	*Declared internal diameter mm*
1	$d \leq 100$
2	$100 < d \leq 160$
3	$160 < d \leq 400$
4	$d > 400$

6.14.2.7 Reaction to fire

The material shall meet the requirements of the classes given in EN 13501-1 except class “F” when tested according to 7.14.2.7.

The reaction to fire shall be declared in the installation instructions.

6.15 Requirements for elastomeric seals and elastomeric sealants in the combustion product evacuation ducts, terminals and fitting pieces

6.15.1 Characterization

The following characterization shall be tested according 7.15.1

a) hardness;

b) density;

c) compression set;

d) tensile strength;

e) stress at 100 % of elongation.

6.15.2 Long-term resistance to thermal load

Under the test conditions of 7.15.2, the material shall be capable of withstanding exposure to the nominal working combustion products temperature.

After exposure the following requirements shall be met:

After 56 days of exposure, the properties given in Table 16 should not deviate from the original value by more than the values as listed in Table 16 in column A.

If the change of a property is greater, then the deviation from the original value shall not be greater than the values as listed in Table 16 in column B. Furthermore the change in properties between 28 and 56 days of exposure shall be less than the change between the original value and 28 days of exposure (stabilization of the material).

Table 16 – Criteria for testing long-term resistance to thermal load

Property	A	B
Hardness (shore A)	7 units	10 units
Tensile strength	30 %	50 %
Stress at 100 % of elongation	35 %	45 %

6.15.3 Long-term resistance to condensate exposure

The material shall be capable of withstanding exposure to test condensate as described in 7.15.3.

The test condensate and its test temperature are depending on the construction class as mentioned below:

a) Construction class K1, “no direct exposure” to the flue gas and/or condensate;

b) Construction class K2, “direct exposure” to the flue gas and/or condensate.

After exposure the following requirements shall be met:

After 56 days of exposure, the properties given in Table 17 should not deviate from the original value by more than the values as listed in Table 17, column A. If the change of a property is higher, then the deviation from the original value shall not be more than the values as listed in Table 17, column B. Furthermore the change in properties between 28 and 56 days of exposure shall be less than the change between the original value and 28 days of exposure (stabilization of the material).

Table 17 – Criteria for testing-long term resistance to condensate exposure

Property	A	B
Hardness (shore A)	≤ 7 units	≤ 10 units
Tensile strength	≤ 30 %	≤ 50 %
Volume	-5 / +25 %	-5 / +25 %
Stress at 100 % of elongation	35 %	45 %

6.15.4 Cyclic condensate resistance test

After exposure in accordance with the test conditions of 7.15.4, the test pieces or seals are inspected. The pieces or seals shall not show damage e.g. cracks.

The inspection shall be performed visually at approximately 100 % elongation.

If the performance of the visual inspection is not applicable (depending on the properties of the test pieces e.g. diameter, hardness) or in case of any suspected change of the material, alternatively it shall be checked that the tensile strength and the stress at 100 % of elongation will not have changed by more than 30 % when tested in accordance with ISO 37 on a minimum of 6 test pieces.

6.15.5 Relaxation behaviour

When tested in accordance with the test conditions in 7.15.5 the stress relaxation shall be lower than 50 %.

6.15.6 Compression set

When tested in accordance with the test conditions in 7.15.6 the compression set shall not exceed 25 %.

6.15.7 Low temperature resistance

When tested in accordance with the test conditions in 7.15.7 the compression set shall not exceed 50 %.

6.15.8 Joints in elastomeric seals

6.15.8.1 Durability

If an elastomeric seal has a joint, the requirements specified in 6.15.2 and 6.15.3 “shall also be met for test pieces that include the joint.

6.15.8.2 Strength

If an elastomeric seal has a joint, during test in accordance with 7.15.8.2 visual inspection of the test pieces that are still being elongated shall not reveal any cracks or fractures.

A joint in an elastomeric seal is always a risk, so seals should not have more than one joint.

6.16 Special provisions for mCHP appliances intended to be installed in a partially protected place

6.16.1 Frost protection system for mCHP appliances intended to be installed in a partially protected place

Under the test conditions as given in 7.16.1 the frost protection system, if any, shall act. A mCHP appliance with a "minimum declared installation temperature for mCHP appliances in partially protected places" (see definition) greater than 0 °C do not need a frost protection system. The temperature of the water shall remain above 0,5 °C at any point in the mCHP appliance during the test. For combination mCHP appliance, the domestic hot water production circuit is also to be protected from damage caused by frost.

6.16.2 Protection against the ingress of rain

The mCHP appliance, including its protective casing, if any, shall meet the requirements for the enclosure protection designated as IPX4D in accordance with EN 60529.

Immediately after the test for the protection against water in 14.2.4 of EN 60529:1991, which is part of the test programme for the enclosure protection IPX4D, the mCHP appliance shall start.

7 Test methods

7.1 General test conditions

7.1.1 General

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

7.1.2 Characteristics of the reference and limit gases

7.1.2.1 General

mCHP appliances are intended to use gases of various qualities.

One of the aims of these specifications is to check that the operation of the mCHP appliance 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.

7.1.2.2 Requirements of the preparation of test gases

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

7.1.2.3 Characteristics and choice of test gases

The characteristics of the test gases are given in EN 437.

The choice of the reference gases and limit gases is given in EN 437, according to the mCHP appliance category.

When tests have to be carried out with only one of the reference gases, the priority according to the mCHP appliance category shall be G_{20}, G_{25}, G_{30} or G_{31}.

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

7.1.2.4 Test pressures

The test pressures, i.e. the pressure required at the gas inlet connection of the mCHP appliance, are given in EN 437.

7.1.3 Installation of the mCHP appliance

The mCHP appliance 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 20 °C ± 5 K, measured at a height of 1,50 m above the floor and at a minimum distance of 3 m from the mCHP appliance, with a temperature sensor protected against radiation from the test installation.

The mCHP appliance is protected from direct solar radiation.

Wall-mounted mCHP appliances 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 appliance 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 mCHP appliance (see 7.4.1.4).

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

Type C_1, C_3, and C_5 mCHP appliances are tested with their terminals fitted. Type C_1 mCHP appliances are tested with a duct suitable for a wall with a thickness of 300 mm.

Type C_4 and C_8 mCHP appliances are tested with their fitting pieces fitted but not connected to a test duct.

Type C_6 mCHP appliances are fitted with restrictors enabling the minimum and maximum duct pressure losses specified in the appliance instructions to be simulated.

Type C_9 mCHP appliances are tested with the minimum diameter / cross section area of the vertical duct supplying the combustion air as specified by the installation instructions.

Type B_2 and B_3 mCHP appliances are tested with terminals according to the installation manual.

Type B_5 mCHP appliances are fitted with their ducts and terminals. The terminal guard is not fitted. Except where otherwise stated type B_5 mCHP appliances are connected to the shortest ducts with the smallest pressure loss stated in the technical instructions. If necessary, an external telescopic duct may be sealed in accordance with the appliance instructions.

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 Figure 4 and Figure 5):

– for circular ducts: $L = D_i$;

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

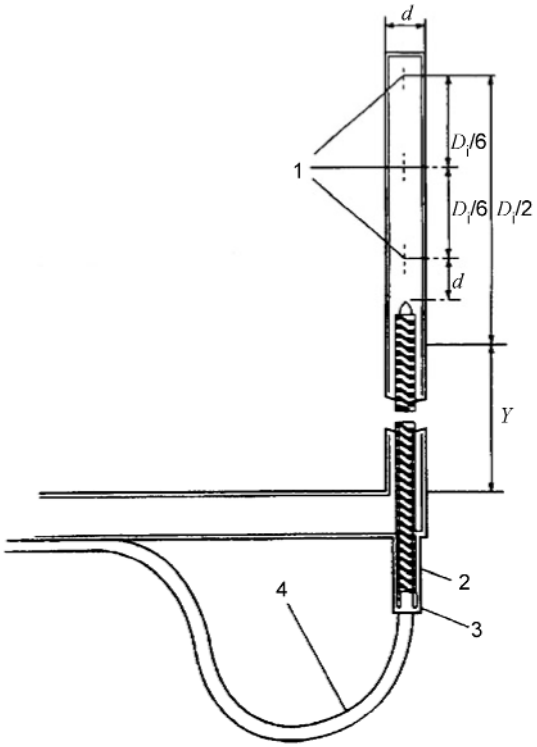
where

C is the circumference of this duct, in mm;

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

S is the cross-sectional area of this duct, in mm².

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



Key

1 sampling holes
2 ceramic pipe with internal double thread
3 concrete insulation
4 chromel/alumel thermoelement wires
D_i is the internal diameter of the combustion products evacuation duct, in mm;
d external diameter of the probe

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

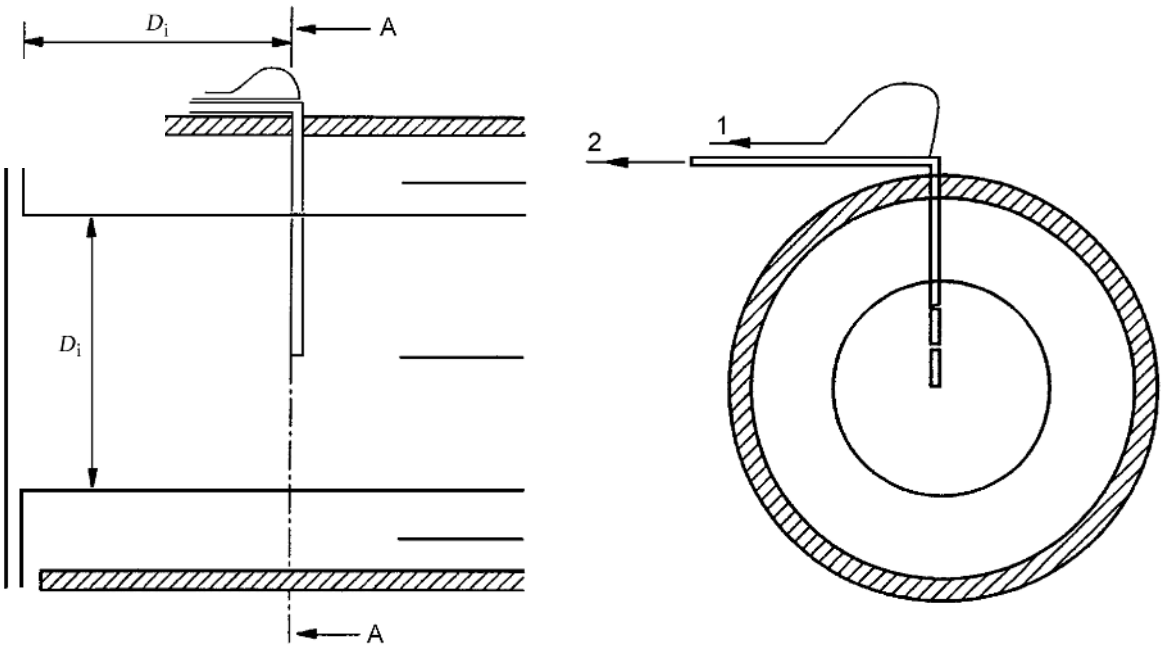
- external diameter of the probe (d): 6 mm
- wall thickness: 0,6 mm
- diameter of the three sampling holes (x): 1,0 mm
- two channel ceramic tube: 3 mm diameter with channels of 0,5 mm diameter
- thermocouple wire: 0,2 mm diameter
- the dimension (d) and (x) of a probe suitable for a flue of diameter less than 75 mm shall be such that:

a) the cross-section of the probe shall be less than 5 % of the cross-section area of the flue

b) the total surface area of the three sampling holes is less than three quarter of the cross-section of the probe.

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

Figure 4 – Example of a sampling probe for the measurement of the products of combustion



Key

D_i internal diameter of evacuation duct

1 to temperature gauge

2 to withdrawal pump

Figure 5 – Example of the location of the probe for a C type appliance

7.1.4 Gas carrying circuit

The tests are carried out with reference gases and limit gases with the mCHP appliance fitted with the appropriate parts (ignition burners, gas mixing valve, pressure regulator, adjusters, injectors, etc.) for the gas range, gas group or gas family in accordance with the information given in the appliance instructions.

7.1.5 Conduct of the test to obtain a 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 rating mCHP appliances.

The tests are carried out under the following conditions.

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

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

or

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

where

H_i is the net calorific value of the dry reference gas at 15 °C, 1 013,25 mbar, in MJ/kg or MJ/m³;

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

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

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

p_s is the saturated vapour pressure of water at t_g, in mbar;

Q_i is the appropriate heat input, in kW:

- the nominal heat input;
- the maximum heat input; or
- the minimum heat input;

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

V is the measured volumetric rate, in m³/h.

Depending on the supply conditions, the temperature of the test room, the atmospheric pressure and the measuring conditions (dry meter or wet meter), conditions shall be so arranged that the nominal heat input can be obtained within $\pm$ 2 %.

When the gas rate cannot be obtained, a correction to the mCHP appliance 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 mCHP appliance pressure regulator for adjustable mCHP appliances; or
- by changing the supply pressure for mCHP appliances without an adjuster. Any non-adjustable pressure regulator shall be put out of action. For tests at limit pressure, the pressure given in EN 437 shall be corrected to values *p*' such that:

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

7.1.6 Water circuit

The mCHP appliance is connected to the insulated test rig shown schematically in Figure 8 or Figure 9, or to other equipment giving comparable results and equivalent measurement uncertainties; it is purged of air in accordance with the information stated in the technical instructions.

If the mCHP appliance is fitted with a thermostat / electronic temperature control system which is adjustable up to 95 °C or higher, or with a non-adjustable thermostat / electronic temperature control system which has a set point in the range 70 °C to 105 °C, the tests are carried out with a flow temperature of (80 $\pm$ 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 in the appliance instructions.

Valve 2 of Figure 8 or Figure 9 are used to obtain a temperature difference between the flow and return of (20 $\pm$ 1) K at full load, or the value stated in the appliance instructions if the design of the mCHP appliance control system does not allow correct operation at a 20 K temperature difference.

7.1.7 Thermal equilibrium

Except where otherwise stated, the tests are carried out with the mCHP appliance at thermal equilibrium, i.e. when the water flow and return temperatures of the mCHP appliance have stabilized to within ± 2 K

7.1.8 General test conditions for combination mCHP appliances

Unless otherwise specified, the general test conditions for the hot water provision of combination mCHP appliances are:

- cold inlet water temperature: (10 ± 2) °C;
- delivered hot water temperature: 50 °C or as near as possible;
- The domestic water pressure shall be adjusted to ± 4 % of the required value.

For the tests:

- the domestic water pressure is the difference between the static inlet and outlet pressures of the mCHP appliance measured as close as possible to the mCHP appliance;
- the inlet and outlet temperatures of the domestic water are measured in the centre of the flow and as close as possible to the mCHP appliance.

In certain tests, a "low inertia thermometer" is used.

"Low inertia thermometer" means a measuring instrument with a response time such that 90 % of the final temperature rise, in the range 15 °C to 100 °C, is obtained within 5 s when the sensor is plunged into still water.

Except where otherwise specified, the tests are carried out with the mCHP appliance operating in the summer operating mode.

7.1.9 Electrical supply

7.1.9.1 General

The mCHP appliance is supplied at the nominal voltage or one of the nominal voltages, except where otherwise stated in the particular clauses.

7.1.9.2 Power consumption

If there is a connection to the electrical grid only for power consumption reasons, the power consumption shall be measured according to EN 60335-2-102.

7.1.9.3 Electrical output power

The electrical output power of the mCHP appliance shall be measured according to EN 60335-2-102.

7.1.10 Adjustment of ICE mCHP appliance to convert the measured emissions into standard conditions

NOTE 1 The output and the emissions of ICE mCHP appliance depend on the general atmospheric conditions.

NOTE 2 ISO 3046 series defines the standard conditions for the indication of internal combustion engine outputs.

The electrical output of the ICE mCHP appliance shall be set by adjusting the electrical output to the calculated value P_x obtained on the basis of the following formula:

$$P_x = \alpha \times P_r$$

$$\alpha = k - 0{,}7\,(1-k)\left(\frac{1}{\eta_m} - 1\right)$$

$$k = \left(\frac{p_x - a \bullet \Phi_{x,psx}}{p_r - a \bullet \Phi_{r,psr}}\right)^m \left(\frac{T_r}{T_x}\right)^n$$

where

P_r electrical output under standard reference conditions, expressed in kW;

p_r pressure under standard reference conditions (1 000 hPa);

P_x electrical output under considered conditions, expressed in kW;

p_x air pressure under considered conditions, expressed in hPa;

$\Phi_{r,psr}$ partial pressure of water vapour under standard reference conditions (10 hPa, equals 30 % rel. air humidity);

$\Phi_{x,psx}$ partial pressure of water vapour under considered conditions, expressed in hPa;

T_r temperature under standard reference conditions (298 K);

T_x temperature under considered conditions (absolute temperature), expressed in K;

α power correction factor;

η_m mechanical efficiency: 80 %.

For gas-fired engines non-turbocharged, the following applies: a = 1; m = 0,86; n = 0,55.

NOTE 3 The formula references and exponents have been derived by CIMAC (International Council on Combustion Engines), see ISO 3046-1

NOTE 4 The factors and exponents have been established by tests on a number of engines to be representative of the types of engines specified. They may be considered as a guideline. Alternative values appropriate to individual engine design may be considered.

The formula for "k" is limited to the required factors.

7.1.11 Uncertainty of measurements

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

– atmospheric pressure: ± 5 mbar;

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

– gas pressure: ± 2 % full scale;

– water-side pressure loss: ± 5 %;

– water rate: ± 1 %;

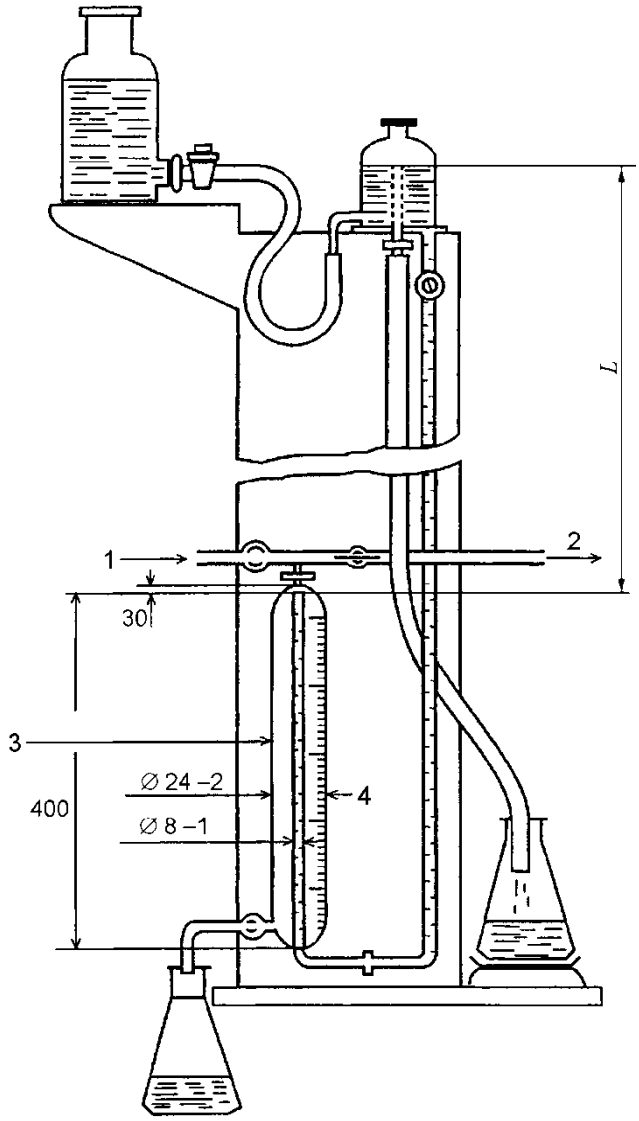
- gas rate: ± 1 %;
- air rate: ± 2 %;
- time: up to 1 h: ± 0,2 s
  beyond 1 h: ± 0,1 %;
- auxiliary electrical energy: ± 2 %;
- temperatures: ambient ± 1 K;
  water ± 2 K;
  combustion products ± 5 K;
  gas ± 0,5 K;
  surface ± 5 K;
- CO, CO_2 and O_2 for the calculation of flue losses: ± 6 % full scale;
- CO_2 in extracted air: ± 0,01 %;
- gas calorific value: ± 1 %;
- gas density: ± 0,5 %;
- mass: ± 0,05 %;
- torque: ± 10 %;
- force: ± 10 %;
- current: ± 1 %;
- voltage: ± 1 %;
- electrical power: ± 2 %.

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

For the determination of the leakage rate during the soundness tests, a method is used which gives such accuracy that the error in its determination does not exceed 0,01 dm^3/h. The apparatus shown schematically in Figure 6 or Figure 7 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), the lower uncertainties associated with individual measurements may be necessary to limit the total uncertainty.

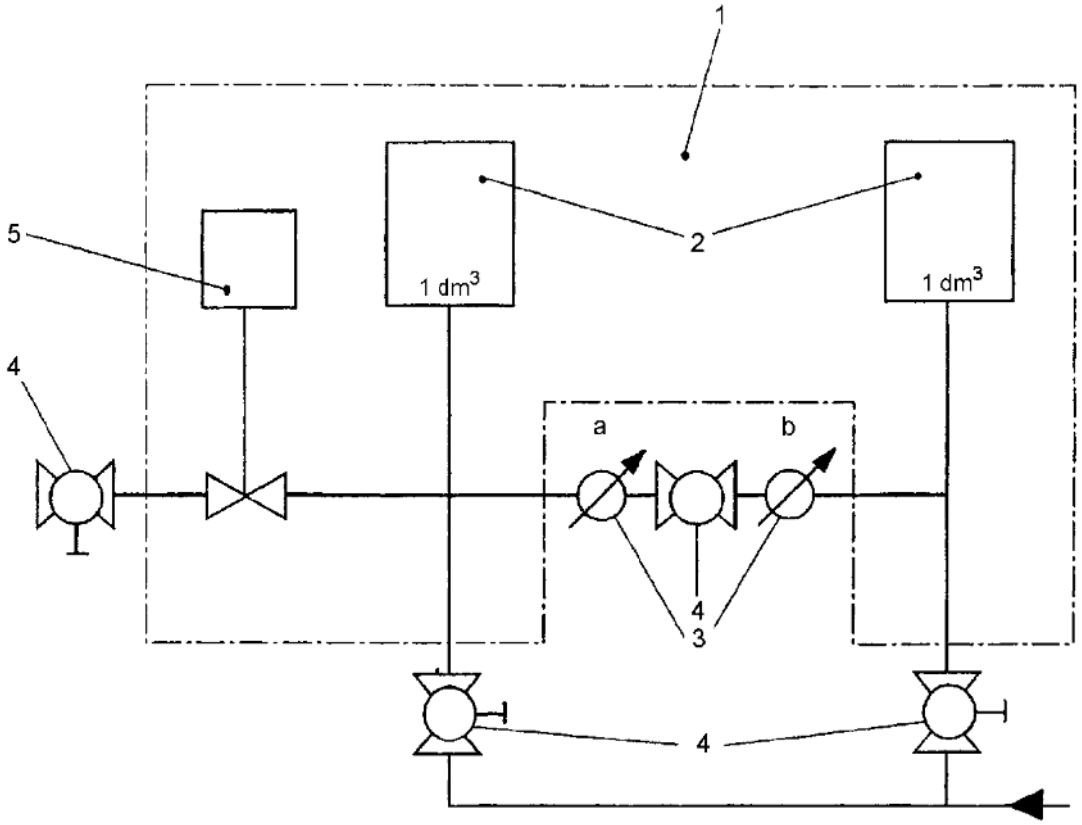
All dimensions in millimetres (mm)



Key

1 compressed air
2 appliance under test
3 measuring vessel
4 graduated scale

Figure 6 – Test rig for the soundness of the gas carrying circuit



Key

1 room with constant temperature
2 air vessel
3 pressure gauge
4 valves
5 test issue

Figure 7 – Test rig for the soundness of components (pressure drop method)

7.2 Soundness

7.2.1 Soundness of the gas carrying circuit

The tests are carried out at ambient temperature using air, nitrogen or other inert gas.

The five following tests are carried out on the mCHP appliance in its delivery state and before any other test, and again on completion of all the tests in the standard, after removing and replacing the assemblies 5 times in the gas carrying circuit that have gas-tight joints whose removal is provided for in the appliance instructions regarding routine servicing.

a) Test no. 1:

If the controls do not comply with EN 88-1, EN 126 or EN 161, the soundness of the first closure member is checked, all the downstream closure members being open. The pressure upstream of the mCHP appliance is 150 mbar.

It is checked that the requirement of 6.2.1 is satisfied.

b) Test no. 2:

If the controls do not comply with EN 88-1, EN 126 or EN 161, the mCHP appliance is put back in its original state of delivery.

The test is carried out in the direction of gas flow with the second closing device closed and the first closing device open. The ignition burner gas carrying circuit is blocked off.

The pressure upstream of the mCHP appliance is 50 mbar for mCHP appliances which do not use third family gases and 150 mbar for mCHP appliances which use third family gases.

Any closing devices in the ignition burner gas carrying circuit are subjected to the same test.

It is checked that the requirement of 6.2.1 is satisfied.

c) Test no. 3:

If the controls do not comply with EN 88-1, EN 126 or EN 161, the mCHP appliance is put back in its original state of delivery.

Test no. 2 is carried out at a test pressure of 6 mbar.

It is checked that the requirement of 6.2.1 is satisfied.

d) Test no. 4:

The leakage rate is checked with all the valves of one gas circuit (in case there are more parallel gas circuits available) open, as if the mCHP appliance was in operation, and this specific gas carrying circuit is blocked off by the use of suitable parts in place of the injectors.

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

It is checked that the requirement of 6.2.1 is satisfied.

e) Test no. 5:

The leakage rate is checked with all the valves of one gas carrying circuit (in case there are more parallel gas carrying circuits available) open, as if the mCHP appliance was in operation, and this specific gas carrying circuit is blocked off by the use of suitable parts, in place of the burner where the final conversion into thermal energy is performed.

The test pressure is 1,5 times of the individual operating pressure.

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 shall check all the joints , between

- the mCHP appliance 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 type C mCHP appliance

7.2.2.2.1 General requirements

The test can be carried out either separately on the mCHP unit and on the ducts or on the mCHP unit assembled with its ducts.

The combustion circuit of the test object in accordance with Table 10 shall be connected to a pressure source on one side and blocked on the other side.

The test pressure difference shall be 0,5 mbar unless otherwise stated.

For mCHP appliances with a fan of which the combustion product circuit is not completely surrounded by the combustion air circuit, the test pressure is increased by the highest pressure between the combustion circuit, in the envelope of the mCHP unit or the ducts, and the atmosphere, measured with the mCHP appliance in thermal equilibrium at nominal heat input and fitted with the longest ducts specified in the appliance instructions.

It is checked that the requirements of 6.2.2.2.1 are met.

7.2.2.2.2 Combustion products evacuation duct for mCHP appliances with indirect air proving

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

The test pressure shall be 2,0 mbar.

It is checked that the requirements of 6.2.2.2.2 are met.

7.2.2.2.3 Combustion products evacuation ducts (separate ducts) in areas other than the room where the mCHP appliance is installed

When tested in accordance with 7.2.2.2.1 but with a test pressure of 2,0 mbar, the requirements of 6.2.2.2.3 shall be met.

7.2.2.2.4 Air supply ducts (separate and concentric) in areas other than the room where the mCHP appliance is installed

When tested in accordance with 7.2.2.2.1 the requirements of 6.2.2.2.4 shall be met.

7.2.2.3 Soundness of the combustion product circuit of type B mCHP appliance

7.2.2.3.1 General requirements

The relevant tests according to 6.2.2.3.1 shall be performed.

7.2.2.3.2 Type B_2 and B_5 mCHP appliance

The mCHP unit is tested alone without its flue duct.

The maximum pressure at which the mCHP appliance can operate is determined by progressively blocking the combustion products evacuation duct or air inlet, until the air proving device acts.

The air proving device is then put out of operation, to allow the operation of the burner at the maximum cut-off pressure of the air proving device.

The mCHP unit is connected to a short length of flue duct incorporating a restriction to reach the maximum operating pressure determined above.

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

In doubtful cases, leaks are looked for with a sampling probe connected to a rapid-response CO_2-analyser enabling concentrations of the order of 0,20 % to be detected. Precautions shall be taken to ensure that sampling does not interfere with the normal evacuation of the combustion products.

It is checked that the requirement of 6.2.2.3.2 is satisfied.

7.2.2.3.3 Type B_3 mCHP appliance

The flue outlet shall be connected to a pressure source. The orifices in the surface of the concentric duct through which air is supplied, shall be blocked.

The test pressure shall be at least 0,5 mbar.

The requirements of 6.2.2.3.3 shall be met.

7.2.2.3.4 Combustion products evacuation ducts of type B_5 mCHP appliances passing through walls

The test checks all the joints , between

a) the mCHP appliances and its ducts,

b) interconnecting ducts,

c) the ducts and any bends and

d) the ducts and any fitting piece or terminal.

To guard against the possibility of leakage along the length of the ducts, the tests are also carried out with the maximum length of duct as specified in the appliance instructions. 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.

The flue duct and its joint to the mCHP appliance shall be connected to a pressure source on one side and blocked on the other side with a pressure corresponding to the maximum pressure measured in 6.2.2.3.2.

It is checked that the above requirement given in 6.2.2.3.4 is met.

7.2.3 Soundness of the heating water circuit

7.2.3.1 General

The tests are carried out with the water at ambient temperature and at the test pressures stated in 7.2.3.2 and 7.2.3.3. The test pressure is maintained for at least 10 min.

7.2.3.2 mCHP appliance for class 1 and 2

At a test pressure of 1,5 * PMS, it is checked that the requirements of 6.2.3.2 are met.

7.2.3.3 mCHP appliance of pressure class 3

7.2.3.3.1 mCHP appliance of sheet steel or non-ferrous metals

At a test pressure of 2 × PMS bar it is checked that the requirements of 6.2.3.3.1 are met.

7.2.3.3.2 mCHP of cast iron and cast materials

7.2.3.3.2.1 mCHP body

At a test pressure of 2 × PMS, with a minimum of 8 bar, it is checked that the requirements of 6.2.3.3.2.1 are met.

7.2.3.3.2.2 Resistance to bursting

Three samples of each type of section are subjected to the test pressure of 4 × PMS + 2 bar. It is checked that the requirements of 6.2.3.3.2.2 are met.

7.2.3.3.2.3 Tie bars

It is checked by either calculation or testing by applying the test pressure of 4 × PMS that the requirements of 6.2.3.3.2.3 are met.

7.2.4 Soundness of the internal cooling circuits

The different cooling circuits of the mCHP appliance are subjected for 10 min to a pressure of 1,5 times the maximum operating pressure specified in the design documentation. It is checked that the requirement of 6.2.4 is fulfilled.

If the test is not feasible due to potential damage, the specific test procedure has to be determined in accordance with the available construction and operation concept.

7.3 Heat input and heat and electrical output

7.3.1 Heat input for nominal appliance outputs (100 % CHP + 100 % Suppl.) and 100 % CHP +0 % Sup

The mCHP appliance is supplied with each of the reference gases for the mCHP appliance category at the normal pressure for these tests.

For mCHP appliances with a fixed output, the adjustment shall not be changed for this test.

The heat input shall be derived from the tests (as far as applicable) to reach the following output conditions, considering the flow and return water temperature according to 7.6:

a) heat input $\boldsymbol{Q}_{CHP\_100+Sup\_100}$ shall be measured at the operating conditions: 100 % CHP + 100 % Sup and

b) heat input $\boldsymbol{Q}_{CHP\_100+Sup\_0}$ shall be measured at the operating conditions: 100 % CHP + 0 % Sup

The heat input $\boldsymbol{Q}_{CHP\_100+Sup\_100}$ and $\boldsymbol{Q}_{CHP\_100+Sup\_0}$ expressed in the volumetric gas rate V or the mass gas rate M obtained under these conditions (p_a, p_g, t_g) shall be 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 the following formula.

If the volumetric gas rate V is measured in m³/h:

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

If the mass gas rate M is measured in kg/h no correction is necessary. The heat input is calculated as follows

$$Q_c = H_i \times \frac{1}{3{,}6} \times M$$

where

H_i is, as appropriate, the net calorific value of dry reference gas at 15 °C, 1 013,25 mbar, in MJ/m³, or in MJ/kg;

M is the measured mass gas rate (measured at $\dot{Q}_{CHP\_100+Sup\_100}$ or $\dot{Q}_{CHP\_100+Sup\_0}$ as applicable), in kilograms per hour (kg/h);

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

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

Q_c is the heat input, if measured as volumetric gas rate then corrected to 1 013,25 mbar, 15 °C, dry gas, with respect to the net calorific value in kilowatt (kW);

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

V is the measured volumetric gas rate (measured at $\dot{Q}_{CHP\_100+Sup\_100}$ or $\dot{Q}_{CHP\_100+Sup\_0}$ as applicable) expressed under the humidity, temperature and pressure conditions at the meter, in cubic metres per hour (m³/h).

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 mCHP appliance is supplied with each of the reference gases for the mCHP appliance category at the normal pressure.

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

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(s) (if applicable)

The ignition rate(s) is determined in accordance with 7.3.1. It is checked that the requirement of 6.3.3 is met.

7.3.4 Nominal output (thermal and electrical output)

The overall efficiency is determined under the test conditions of 7.6. It is checked that the requirement of 6.3.4. is met.

7.3.5 Nominal domestic hot water heat input

The test is carried out with each of the reference gases at a water pressure of 2 bar. The gas rate may be adjusted in accordance with the appliance instructions. A water draw off is carried out to check that the requirement of 6.3.5 is met.

7.3.6 Water pressure to obtain the nominal heat input for instantaneous combination mCHP appliances

The test is carried out by lowering the water pressure to the minimum value stated in the appliance instructions and it is checked that the requirements of 6.3.6 are met.

7.3.7 Obtaining the domestic hot water temperature for instantaneous combination mCHP appliances

The mCHP appliance is adjusted as stated in 7.1.8 and 7.3.6 with one of the reference gases. Then draw offs are carried out at water pressures of 2 bar, 3 bar, 4 bar and 6 bar or at the water pressures stated in the appliance instructions if they are less than these values.

The domestic hot water rate is adjusted at the specific rate in accordance with EN 13203-1.

In the steady state condition, it is checked that the requirement of 6.3.7 is met for the maximum and minimum positions of the central heating thermostat if it is adjustable.

7.4 Safety of operation

7.4.1 Limiting temperatures

7.4.1.1 General

The mCHP appliance is installed as stated in 7.3.1, 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 the adjusting, control and safety devices

The temperatures are measured using temperature sensors.

It is checked that the requirements of 6.4.1.1 are satisfied.

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

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

It is checked that the requirements of 6.4.1.2 are met.

7.4.1.4 Limiting temperature of the test panels and floor

According to its design, the mCHP appliance is installed on a horizontal or vertical test panel of wood.

For mCHP appliances which according to the appliance instructions may be installed near a wall or walls, the distances between the side and back walls of the mCHP appliance and the wooden test panels are those stated in the appliance instructions or, in the case of mCHP appliances designed to be mounted on the wall, those provided by the method of fixing; however in no case shall this distance exceed 200 mm.

This distance is measured from the closest part of the mCHP appliance.

The side panel is placed on the side of the mCHP appliance exhibiting the highest temperatures.

For mCHP appliances which according to the appliance instructions may be installed under a shelf or in a similar installation position, an appropriate panel is placed above the mCHP appliance at the minimum distance appearing in the installation instructions.

When the appliance instructions give no specifications for the distances of the mCHP towards a wall or walls, or under a shelf, the test is carried out with appropriate panels placed in contact with the mCHP appliance.

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 mCHP appliance.

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 mCHP appliance.

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

When the appliance instructions 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 mCHP appliance, with a temperature sensor protected against radiation from the test installation.

It is checked that the requirements of 6.4.1.3 are met.

7.4.1.5 External temperature of the ducts

With the protection, if any, fitted in accordance with the appliance instructions, the temperature is measured after the mCHP appliance has been put into operation and when thermal equilibrium at the measuring point is reached.

The conditions of 6.4.1.4 shall be met.

7.4.2 Thermostats and temperature limiting devices

7.4.2.1 General

If the tests are carried out away from the mCHP appliance, the sensor and body of the thermostats are each placed in a thermostatically controlled enclosure.

The temperature of the body is that stated in 7.5.1, whereas the sensor is subjected to the temperature stated in 7.4.2.2.2.

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 6.4.2.1 are observed.

7.4.2.2 Water control thermostat

7.4.2.2.1 Accuracy of adjustment

The mCHP appliance is installed as stated in 7.1.3 and adjusted to the nominal heat input with one of the reference gases for the mCHP appliance category or an actually distributed gas.

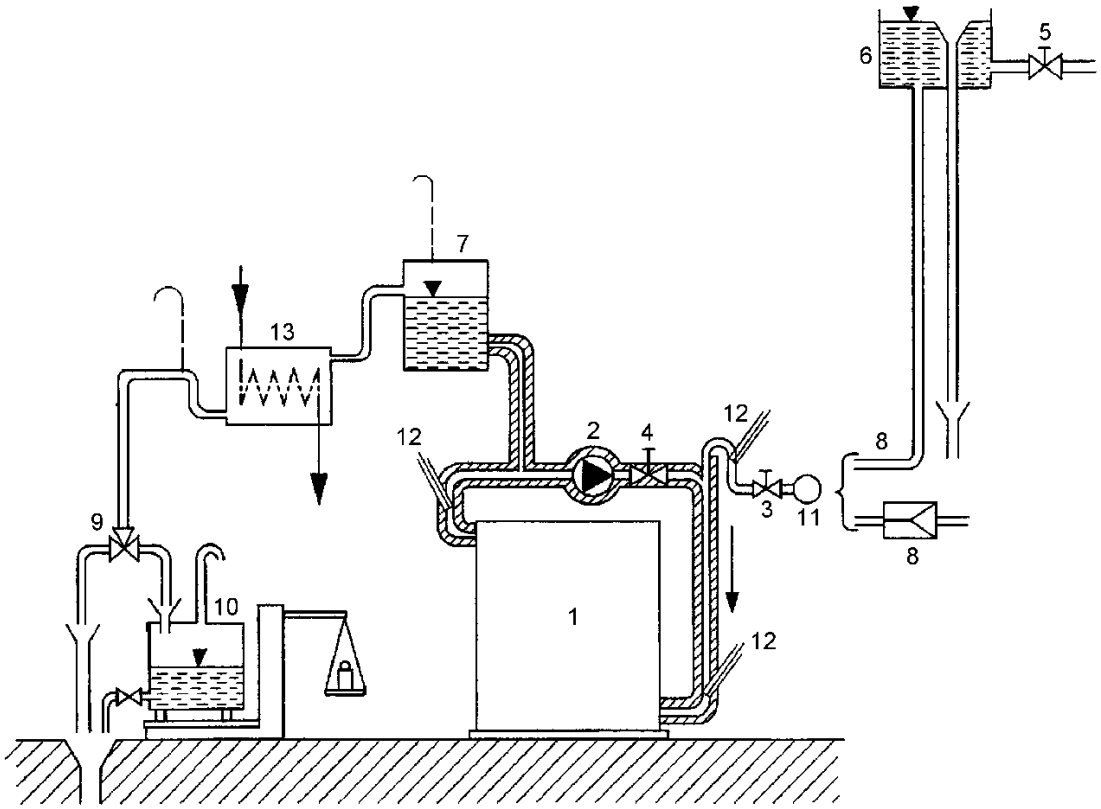
Using control valve 1 in Figure 8 or Figure 9, the cold water rate is adjusted to give a rate of increase of the flow temperature of about 2 K/min.

When 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 mCHP appliance is started at ambient temperature and the controls left to operate.

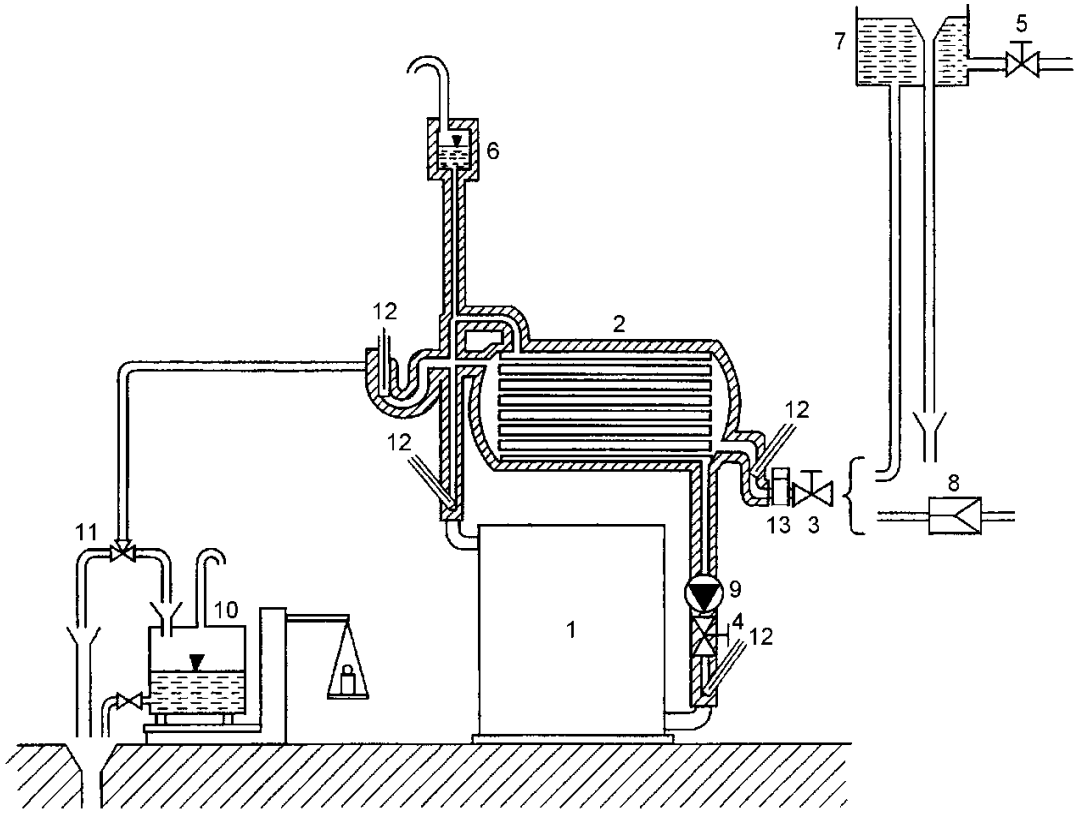
It is checked that the requirements of 6.4.2.2.1 are satisfied.



Key

1 appliance under test
2 recirculation pump
3 control valve 1
4 control valve 2
5 control valve 3
6 top vessel with constant water level
7 compensation vessel
8 connection to distribution grid with constant pressure
9 three-directional valve
10 weighting vessel
11 water volume flow measurement
12 temperature measurement point
13 cooler

Figure 8 – Test rig for thermostats: short cut circulation



Key

1 appliance
2 heat exchanger
3 control valve 1
4 control valve 2
5 control valve 3
6 expansion vessel (not connected to circulation)
7 top vessel with constant water level
8 connection to distribution grid with constant pressure
9 recirculation pump
10 weighting vessel
11 three-directional valve
12 temperature measurement points
13 water volume flow measurement

Figure 9 – Test rig for thermostats with heat exchanger

7.4.2.2.2 Endurance

Bulb thermostats are placed in an enclosure, the temperature of which varies at a maximum rate of 2 K/min between the opening and closing temperatures of the device.

Adjustable thermostats are set to 0,7 times the maximum setting temperature. Non-adjustable thermostats are tested at their maximum temperature.

Contact thermostats are tested under the same conditions, except that they are subjected to a contact temperature instead of an ambient temperature.

After the endurance tests, it is checked that the requirements of 6.4.2.2.2 are satisfied.

7.4.2.3 Water temperature limiting device

7.4.2.3.1 Inadequate water circulation

The mCHP appliance is installed and adjusted as stated in 7.4.2.2.1.

Using control valve 2 in Figure 8 or Figure 9, the water rate through the mCHP appliance is reduced progressively to obtain a temperature increase of about 2 K/min, and it is checked that the requirements of 6.4.2.3.1 are satisfied.

7.4.2.3.2 Overheating

7.4.2.3.2.1 mCHP appliances of pressure class 1 and 2

The mCHP appliance is installed and adjusted as stated in 7.4.2.2.1. The mCHP appliance is at thermal equilibrium.

a) Test no. 1:

- After the control thermostat has been put out of service, the mCHP appliance cold water rate is progressively reduced by operating control valve 1 of Figure 8 or Figure 9, to obtain a temperature increase of about 2 K/min, until the burner (or any other oxidation device) is extinguished.
- It is checked that the requirements of 6.4.2.3.2.1 are satisfied.

b) Test no. 2:

- The control thermostat and the limit thermostat are put out of service.
- The mCHP appliance cold water rate is progressively reduced by operating control valve 1 of Figure 8 or Figure 9, to obtain a temperature increase of about 2 K/min, until the burner is extinguished.
- It is checked that the requirements of 6.4.2.3.2.1 are satisfied.

7.4.2.3.2.2 mCHP appliances of pressure class 3

The mCHP appliance is installed and adjusted as stated in 7.4.2.2.1.

With the mCHP appliance at thermal equilibrium, and after the control thermostat has been put out of action, the mCHP appliance cold water rate is progressively reduced by operating control valve 1 of Figure 8 or Figure 9 such that a water temperature rise of about 2 K/min is obtained, until the burner is extinguished.

It is checked that the requirements of 6.4.2.3.2.2 are satisfied.

7.4.2.3.3 Endurance

7.4.2.3.3.1 Limit thermostats

These devices are subjected to the same test conditions as non-adjustable thermostats (see 7.4.2.2.2).

After the endurance tests, it is checked that the requirements of 6.4.2.3.3.1 are satisfied.

7.4.2.3.3.2 Overheat cut-off devices and safety temperature limiters

These devices are, during the first test series, subjected to the same test conditions as non-adjustable thermostats (see 7.4.2.2.2) except that the enclosure temperature or surface temperature varies between 0,70 and 0,95 times the maximum cut-off temperature.

The second test series is carried out alternately at the temperature causing shut-off and that which permits resetting.

After the endurance tests, it is checked that the requirements of 6.4.2.3.3.2 are fulfilled.

Finally, with the mCHP appliance at thermal equilibrium, the link between the sensor and the device responding to its signal is interrupted. It is checked that the requirements of 6.4.2.3.3.2 are fulfilled.

NOTE If this test causes destruction of the safety device, an appropriate test can be carried out on a separate device.

7.4.2.4 Temperature of combustion products

The mCHP appliance is installed as specified in the general test conditions as applicable (see 7.1 and 7.1.8), and supplied with one of the corresponding reference gases for the mCHP appliance category at the nominal heat input. The use of an actually distributed gas, appropriate to the mCHP appliance category, is permitted.

Type B mCHP appliances are connected to a 1 m test flue and type C, B_3, B_5 mCHP appliances are fitted with the shortest ducts specified in the appliance instructions.

The mCHP appliance thermostat or control temperature set point in electronic temperature control system is put out of operation.

Where fitted, the control to limit the temperature of the combustion products remains in operation.

The temperature of the combustion products is progressively raised, either by increasing the gas rate or by another means which increases the temperature (e.g. removal of baffles) as specified in the design documentation. The temperature rise shall be within the range 1,0 K/min and 3,0 K/min.

It is verified that the requirement of 6.4.2.4 is fulfilled.

7.4.3 Ignition – Cross lighting – Flame stability

7.4.3.1 General

These tests are carried out twice, with the mCHP appliance at ambient temperature and at thermal equilibrium.

7.4.3.2 Limit conditions

The burner / internal combustion engine and ignition burner, if any, fitted with the appropriate injectors, are supplied successively with each reference gas for the mCHP appliance category.

The following tests are then carried out:

a) Test no. 1:

   The test is carried out without altering the adjustment of the burner / internal combustion engine and ignition burner.

   The pressure at the mCHP appliance 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 7.1.5).

   Under these supply conditions, it is checked that the requirements of 6.4.3.2 are satisfied.

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

b) Test no. 2:

Without altering the initial adjustment of the burner / internal combustion engine and ignition burner, the reference gases are replaced by the corresponding light-back limit gas and the pressure at the mCHP appliance inlet is reduced to the minimum pressure.

It is then checked that ignition of the burner / internal combustion engine, by the ignition burner or ignition device, takes place correctly and that the requirements of 6.4.3.2 are satisfied.

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

c) Test no. 3:

Without altering the initial adjustment of the burner / internal combustion engine and ignition burner, the reference gases are replaced by the corresponding flame lift limit gas and the pressure at the mCHP appliance inlet is reduced to the minimum pressure.

It is then checked that ignition of the burner / internal combustion engine, 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 6.4.3.2 are satisfied.

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

d) Test no. 4:

Without altering the initial adjustment of the burner / internal combustion engine and ignition burner, the mCHP appliance 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 6.4.3.2 are satisfied.

e) Test no. 5:

For mCHP appliances incorporating an indirect means of indicating the presence of flame, without altering the initial adjustment of the burner / internal combustion engine and ignition burner, the mCHP appliance is supplied with the flame lift limit gas at the normal pressure and it is checked that the requirements of 6.4.3.2 are met.

7.4.3.3 Special conditions

7.4.3.3.1 General

The mCHP appliance is supplied with one of the reference gases for its category at the nominal heat input and the minimum heat input given by the controls. All settings, including the controls, should be according to the installation instructions.

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.

7.4.3.3.2 Type C_1, C_3 and C_9 mCHP appliances

The mCHP appliance is installed, including the accessories in accordance with the information in the technical instructions, on the applicable test apparatus of Figure 10 or Figure 11 for type C_1 and Figure 12 or Figure 13 for type C_3 and C_9.

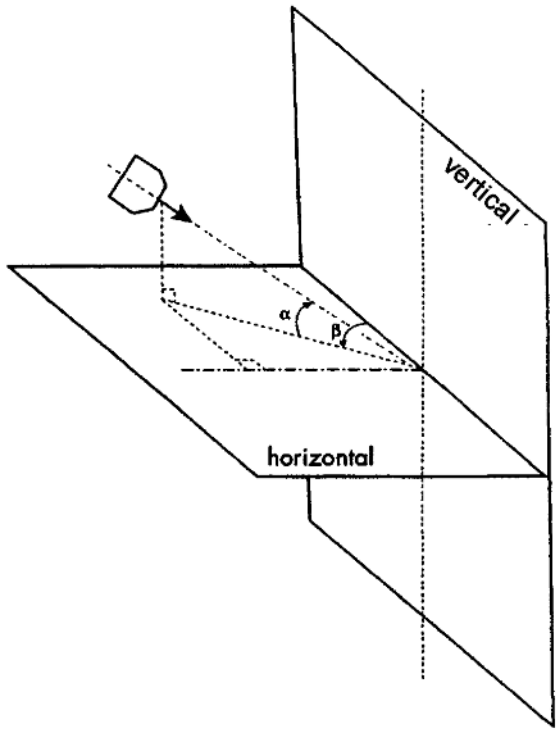


Figure 10 – Test rig for type C_1 appliances, equipped with horizontal wind protection device at a vertical wall

Dimensions in millimetres (mm)

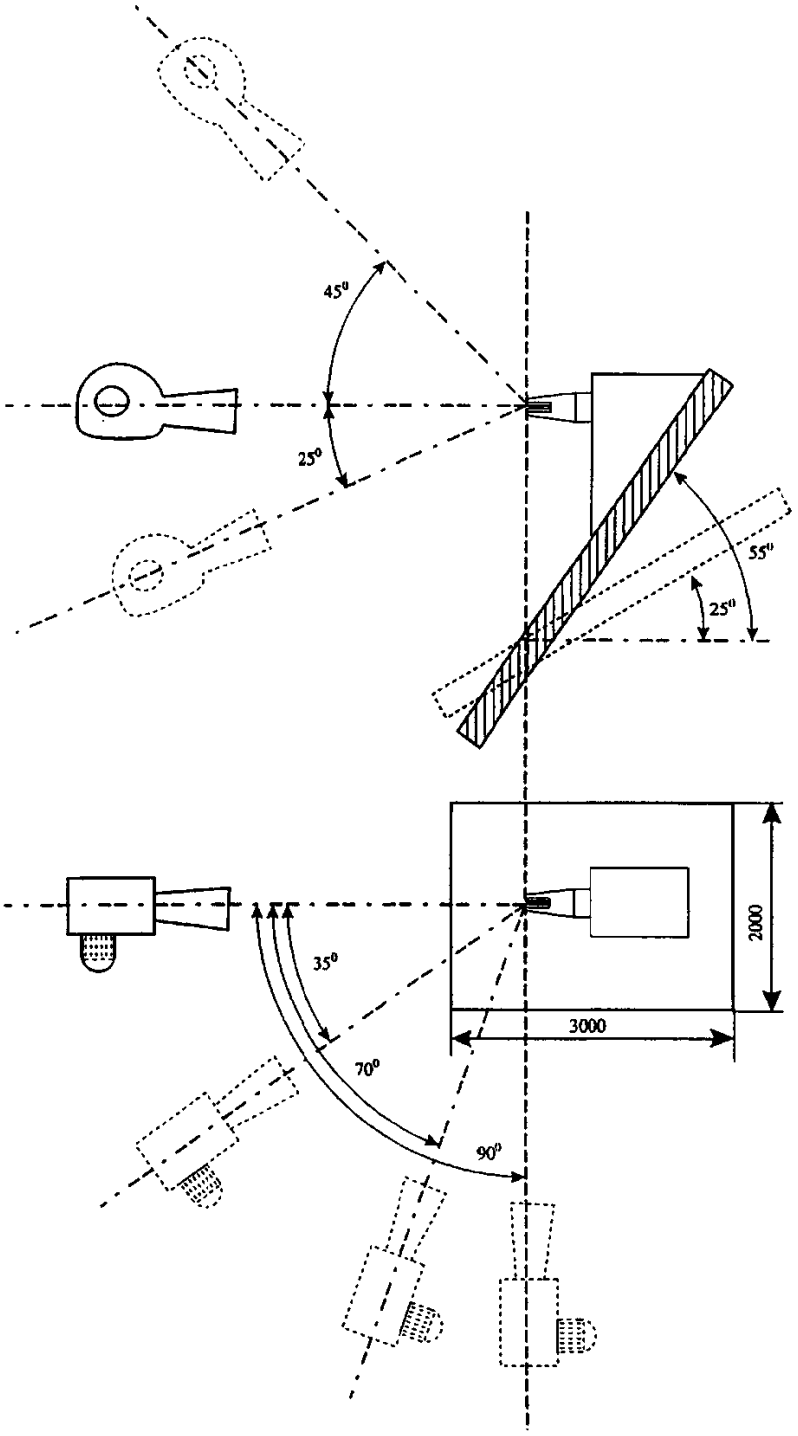


Figure 11 – Test rig for type C_1 appliances for installation in buildings with tilted roof

Dimensions in millimetres (mm)

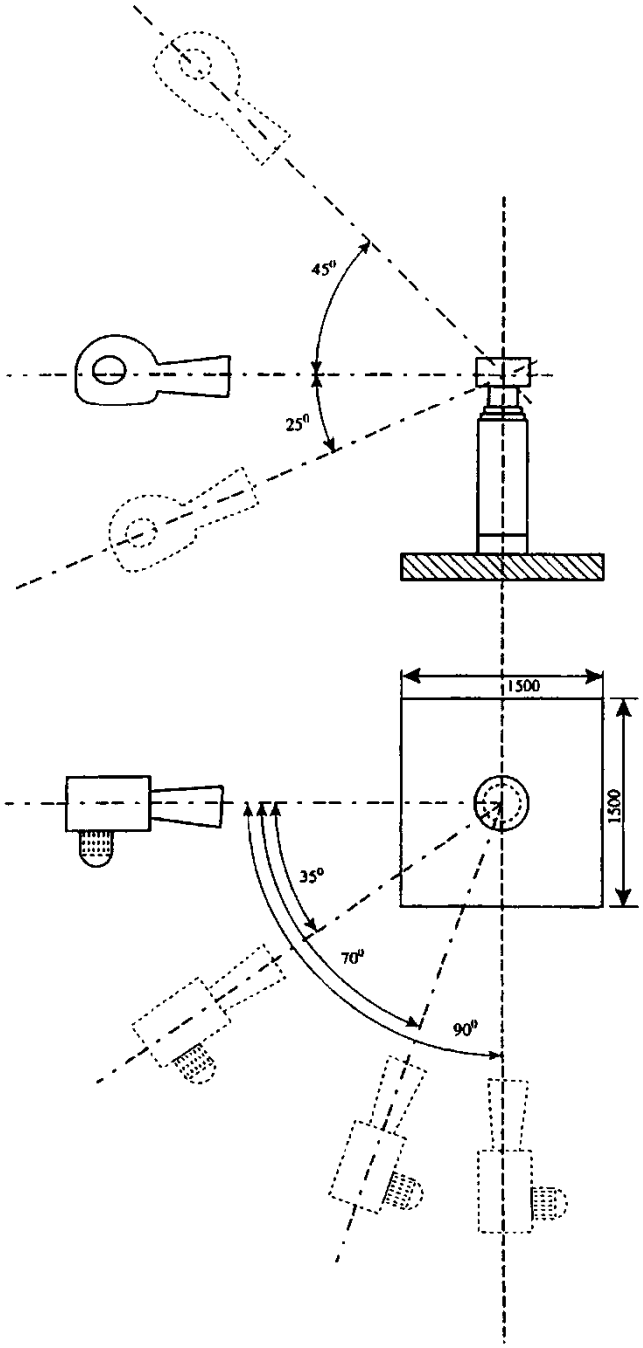


Figure 12 – Test rig for type C_3 and C_9 appliances for installation in flat roofed buildings

Dimensions in millimetres (mm)

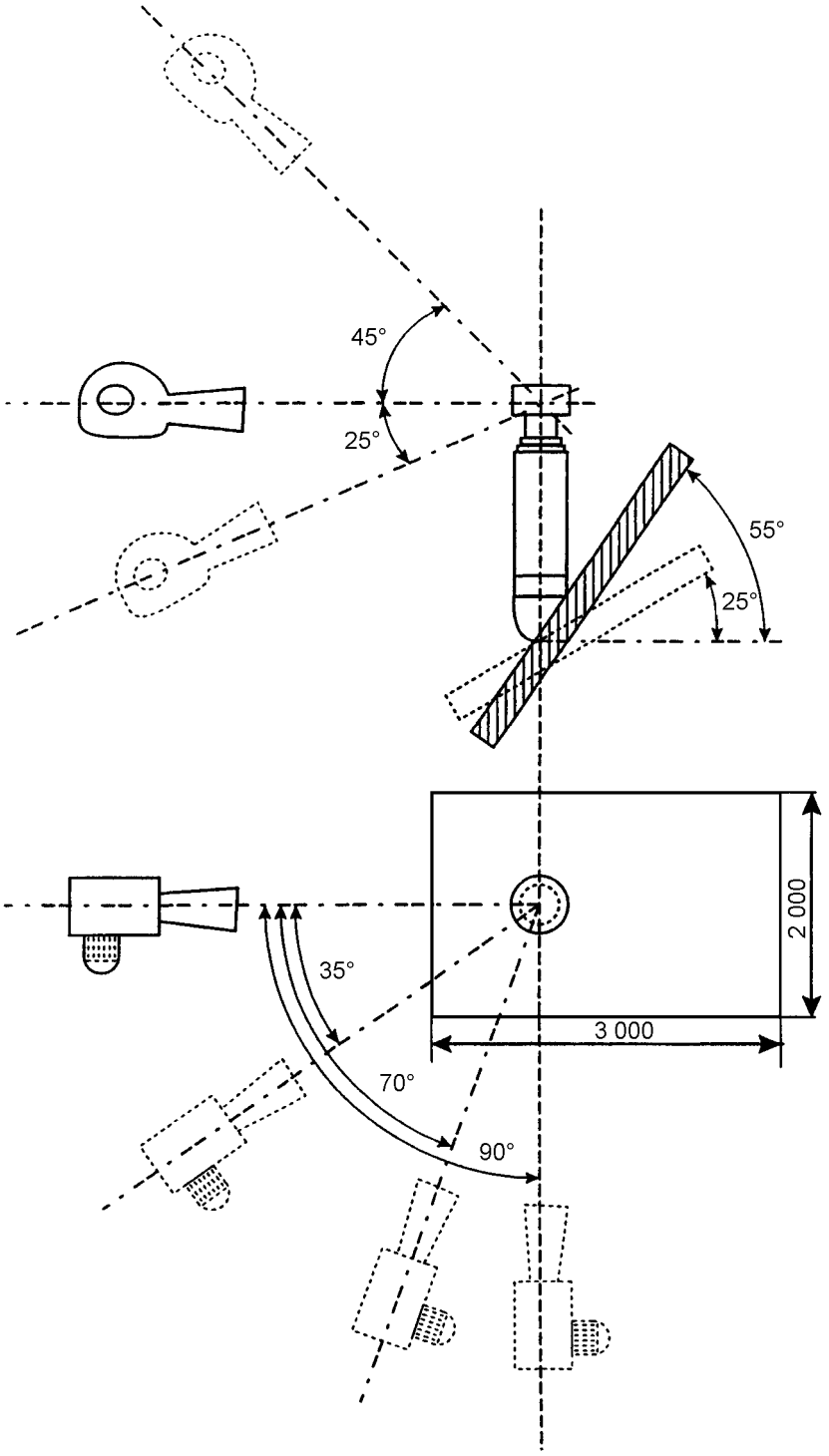


Figure 13 – Test rig for type C_3 and C_9 appliances for installation in buildings with tilted roof

a) 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 Figure 10 to Figure 13 depending on the mCHP appliance 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 concentration (for evaluating 6.4.3.3);

– the three combinations are found for which the highest CO concentration are measured, in the dry air-free combustion products (for evaluating 6.8.1.3).

b) Second test series:

The mCHP appliance is in thermal equilibrium.

For each of the nine combinations that produce the lowest CO_2 concentration, noted in the first test series, it is checked that the requirements of 6.4.3.3 are met.

c) Third test series:

If a provision for a terminal guard is foreseen, this terminal guard 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 7.8.1.3.3.

7.4.3.3.3 Type C_4 mCHP appliances

The mCHP appliance is installed with the shortest ducts specified in the appliance instructions. A suction of 0,5 mbar is applied to the combustion products evacuation duct.

It is checked that the requirements of 6.4.3.3 are met.

7.4.3.3.4 Type C_5 mCHP appliances

The mCHP appliance is installed with the shortest ducts specified in the appliance instructions. A suction of 2,0 mbar is applied to the combustion products evacuation duct.

It is checked that the requirements of 6.4.3.3 are met.

7.4.3.3.5 Type C_6 mCHP appliances

Type C_6 mCHP appliance are fitted with restrictors enabling the minimum and maximum duct pressure losses specified in the appliance instructions to be simulated. A further test is done with a suction of 0,5 mbar applied to the combustion products evacuation duct.

It is checked that the requirements of 6.4.3.3 are met.

7.4.3.3.6 Type C_8 mCHP appliances

The mCHP appliance is installed with the shortest ducts specified in the installation instructions. A suction of 2,0 mbar is applied to the combustion products evacuation duct.

It is checked that the requirements of 6.4.3.3 are met.

7.4.3.3.7 Type B_2, B_3 mCHP appliances

Test no 1

The mCHP appliance is installed with 0,5 m duct. For type B_3 mCHP appliance, this is a completely surrounded combustion circuit. A suction of 0,5 mbar is applied to the combustion products evacuation duct while the appliance is running.

It is checked that the requirements of 6.4.3.3 are met.

Test no 2

The flue outlet is progressively blocked until the pressure at the flue outlet of the mCHP appliance has reached the value of 0,5 mbar.

For mCHP appliances intended to operate with a pressurized flue duct, designated by a “P”, this value is raised to the maximum nominal overpressure declared in the installation instructions, which has not to be greater than 2 mbar.

It is checked that the requirements of 6.4.3.3 are met.

7.4.3.3.8 Type B_5 mCHP appliances

The mCHP appliance is installed in accordance with the information in the technical instructions. The tests are carried out with the shortest and longest air supply and combustion products evacuation ducts on the applicable test situation given in Figure 10 to Figure 13 depending on the direction of the terminal (horizontal or vertical) and the roof situation (flat or pitched).

The terminal is subjected successively to winds of three different speeds of 1 m/s, 2,5 m/s and 12,5 m/s and with directions in three planes as given in the applicable figures. For each of the three planes of incidence, the three combinations of wind speed and angle of incidence are found giving the lowest and highest CO_2 concentration.

With the mCHP appliance in thermal equilibrium, it is checked, that the requirements of 6.4.3.3 are met for each of these combinations.

7.4.3.4 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 the nominal heat input.

For mCHP appliances without a pressure regulator or fitted with an air/gas or gas/air ratio control, the supply pressure is set to the minimum pressure.

For mCHP appliances fitted with a gas pressure regulator, the pressure downstream of the pressure regulator is reduced, if necessary, to the value corresponding to 90 % of the nominal heat input for first family gases, 92,5 % of the nominal heat input for second family gases and 95 % of the nominal heat input for third family gases.

By means of an appropriate adjuster in the gas supply line to the ignition burner, the rate is reduced progressively to give the minimum energy necessary to keep the gas path to the burner open.

It is then checked that ignition of the burner by the ignition burner takes place in the conditions specified by 6.4.3.4. For ignition burners having several distinct ports, the ports of the ignition burners are sealed except for that of the flame heating the sensor element.

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

7.4.3.5 Reduction of the gas pressure

With the mCHP appliance installed as stated in 7.4.3.2 the mCHP appliance supply pressure is reduced, in 1 mbar steps, from 70 % of the normal pressure to 0 mbar.

At each step it is checked that the requirement of 6.4.3.5 is satisfied or that at least safety shutdown occurs.

Incomplete cross lighting of the burner is however tolerated if the combustible gas concentration, measured at the flue outlet, is below the lower flammability limit of the reference gas used.

7.4.3.6 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 gas valve immediately upstream of the main burner is kept open artificially.

The mCHP appliance is supplied with the reference gas or a distributed gas at the normal pressure.

Under these conditions, it is checked that the requirement of 6.4.3.6 is met.

7.4.3.7 Defective operation of the valve controlling the supply of ignitable mixture for ICE engine

The mCHP appliance is supplied with the reference gas or a distributed gas at the normal pressure.

Under these conditions, it is checked that the requirement of 6.4.3.7 is met.

7.4.3.8 Resistance to draught for type B mCHP appliance

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

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

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

It is checked that the requirement of 6.4.3.8 is met.

7.4.4 Pre-purge

7.4.4.1 Pre-purge under normal conditions

The pre-purge volume or the pre-purge time are determined as follows:

– pre-purge volume:

- the rate is measured at the outlet of the combustion products evacuation duct, at ambient temperature;
- the mCHP appliance is at ambient temperature and not operating. The fan is supplied with electricity under actual pre-purge conditions;
- the rate, measured with a limit of error of ± 5 %, is corrected to reference conditions;
- the volume of the combustion circuit given by the design documentation;

– pre-purge time:

- the mCHP appliance is installed as stated in 7.1.3;
- the time between the fan starting and the ignition device being energized is determined.

It is checked that the requirements of 6.4.4.1 are satisfied.

7.4.4.2 Pre-purge after safety shut-down or reset from lock-out

The mCHP appliance is installed as indicated in 7.1.3. The mCHP appliance is supplied successively with each of the reference gases of the mCHP appliance category, at normal pressure.

A series of tests is carried out with gas admitted to the mCHP appliance at the maximum nominal heat input of the mCHP appliance in the hot condition. The ignition sequence is deactivated. The first test is carried out by supplying gas for a period of 1 s after which the ignition sequence, including any delay times within the sequence, is activated. Subsequent tests are carried out by increasing the time up to the end of the time given by the sum of the (T_{SE} or T_{SA}*Q_{IGN}/Q_n whichever is longer) and the valve(s) closing time declared in the installation instructions. At the end of each period of time, the ignition sequence, including any delay times within the sequence, is activated.

It is checked that the requirement of 6.4.4.2 is met.

7.4.4.3 Verification of the protected nature of a combustion chamber

The mCHP appliance is supplied with one of the reference gases at the normal test pressure; it is installed as stated in 7.1.3 and connected to the longest ducts specified in the installation instructions.

With the mCHP appliance at ambient temperature, a combustible air-gas mixture that is within the flammability limits of the gas used is introduced upstream of the burner surface or head. The burner could be used for this purpose if it supplies a fully mixed air/gas mixture.

The igniter is put into service after the time required for filling the combustion chamber and combustion products evacuation circuit with a combustible gas/air mixture.

It is checked visually that the requirements of 6.4.4.3 are met.

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

The mCHP appliance is installed in accordance with the conditions of 7.1.3.

The ignition burner is adjusted using the reference gases at the normal pressure in accordance with the appliance 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 mCHP appliance at ambient temperature, the ignition burner is ignited and kept in operation for 1 h.

It is checked that the requirement of 6.4.4.4 is met.

7.4.4.5 Verification of normal ignition in a combustible air/gas mixture for type C_1 appliances incorporating a fan

The mCHP appliance is supplied with one of the reference gases at the normal test pressure; it is installed as stated in 7.1.3 and connected to the longest ducts specified in the appliance instructions.

With the mCHP appliance at ambient temperature, a combustible air-gas mixture that is within the flammability limits of the gas used is introduced upstream of the burner surface or head. The mCHP appliance burner could be used for this purpose if it supplies a fully mixed air-gas mixture.

The test is carried out by putting the mCHP appliance into service in accordance with its normal ignition procedure.

It is checked that the conditions of 6.4.4.5 are fulfilled.

7.4.5 Process gas purge

It shall be checked that the amount of process gas is not larger than the process gas purge circuit and that the process cycling time cannot lead to more than the amount of cycles given in 6.4.5.

If this is not the case then it shall be checked that the two class C valves, according to the timing diagram, are not energized for more cycles then given in 6.4.5.

7.5 Start / Release and adjusting, control and safety devices

7.5.1 General

Where the devices are tested separately, they shall be mounted in a position identical to that which they occupy on the mCHP appliance. The test rigs are the appropriate rigs specified in EN 88-1, EN 125, EN 126, EN 161, EN 298, EN 12067-2 or EN 13611.

The maximum temperature is that to which the device is subjected in the mCHP appliance, adjusted to the nominal heat input with the reference gas when thermal equilibrium is reached, with an adjustable thermostat set to the position corresponding to the maximum water temperature.

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

7.5.2 Combination mCHP appliances

7.5.2.1 Safety of the domestic hot water circuit

7.5.2.1.1 Instantaneous and storage types

7.5.2.1.1.1 Soundness of parts containing domestic water

The domestic water circuit is subjected to a pressure of 1,5 times the maximum water service pressure given on the data plate for 10 min.

It is checked that the requirements of 6.5.2.1.1.1 are met.

7.5.2.1.1.2 Overheating of the domestic hot water by the heating circuit

The mCHP appliance is supplied with one of the reference gases. The central heating circuit thermostat is set at its maximum position.

The appliance operates continuously for 1 h at the nominal heat input in the central heating mode, without drawing domestic hot water. A draw off at the lowest possible rate where the mCHP appliances is still operating is then carried out and the requirement of 6.5.2.1.1.2 is checked.

7.5.2.1.1.3 Failure of the domestic hot water temperature control device

The requirement of 6.5.2.1.1.3 is checked after the control device of the domestic hot water circuit has been put out of operation:

a) for mCHP appliances in which the domestic hot water circuit does not come into contact with the combustion products, testing is carried out according to the tests methods relating to the limit thermostat (see 6.4.2.3.2.1) or the safety temperature limiter (see 6.4.2.3.2.2). If the mCHP appliance is fitted with a device to adjust to the installation's heat demand, the tests are performed at the maximum adjustable heat input in heating mode;

b) for mCHP appliances in which the domestic hot water circuit does come into total or partial contact with the combustion products, the mCHP appliance's hot water tapping rate is progressively decreased until the point is reached where the burner is shut off.

Where the mCHP appliance is fitted with a range-rating device, the test is carried out at the maximum adjusted heat input in the central heating mode.

7.5.2.1.2 Instantaneous type

7.5.2.1.2.1 Maximum temperature of the domestic hot water

The mCHP appliance is supplied with one of the reference gases and is operated at the nominal domestic hot water heat input with a domestic water supply pressure of 2 bar.

Starting with this 2 bar supply pressure, the pressure is progressively reduced until the burners are extinguished. The water outlet temperature is measured continuously with a low inertia thermometer. The maximum temperature is measured and shall satisfy the requirements of 6.5.2.1.2.1.

7.5.2.1.2.2 Overheating of the domestic hot water

The mCHP appliance is supplied with one of the reference gases and is operated at the nominal domestic hot water heat input. The water rate (and, where appropriate, any water temperature control) is adjusted to obtain the maximum water temperature at the nominal domestic hot water heat input.

After the mCHP appliance has operated for 10 min, the hot water delivery tap is turned off quickly. After 10 s the tap is turned on quickly and the highest temperature at the centre of the flow, as close as possible to the mCHP appliance outlet, is measured by means of a low inertia thermometer. The mCHP appliance remains in operation until it has again reached its steady state condition. The same measurements are made during similar operating cycles, but with the time that the draw off is stopped increased each time by 10 s, until the maximum temperature is obtained.

It is checked that the requirement of 6.5.2.1.2.2 is met.

7.5.2.1.3 Storage type

7.5.2.1.3.1 Maximum temperature of the domestic hot water

The mCHP appliance is supplied with one of the reference gases and is operated at the nominal domestic hot water heat input with the domestic water thermostat at its maximum position. A draw off is carried out immediately after the burner has been shut down by the controls. The maximum temperature measured shall meet the requirement of 6.5.2.1.3.1.

7.5.2.1.3.2 Overheating of the domestic hot water

The test commences after the tank or the thermal store has reached temperature and after the burner has been shut down a second time by the controls. Water is drawn off several times at a rate corresponding to 5 % of the water capacity of the tank, in litres per minute.

On each occasion, water is drawn until the burner ignites and at least 95 % of the nominal domestic hot water heat input is obtained. The next draw off then takes place immediately after the burner shuts down, and so on until the maximum temperature is obtained.

For modulating burners or burners with several rates, the next draw off takes place when the gas rate has decreased at least to 50 % of the maximum domestic hot water heat input reached.

As each draw off commences, the temperature of the delivered water is measured and it is checked that the requirement of 6.5.2.1.3.2 is met.

7.5.2.1.3.3 Temperature of the domestic hot water

Where applicable, the temperature adjuster is placed in the position as stated in the technical specifications / instructions. After a controlled shutdown of the mCHP appliance, a draw off is carried out for 10 min at a rate equivalent to 5 % of the water capacity of the tank per minute or at the minimum rate

as stated in the technical specifications / instructions which allows burner ignition if this is greater than 5 % of the capacity of the tank per minute. After 1 min, it is checked that the requirements of 6.5.2.1.3.3 are met.

7.5.3 Control devices

7.5.3.1 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 7.1.2.4 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 in the appliance instructions.

It is checked that the requirement of 6.5.3.1 is satisfied.

7.5.3.2 Automatic burner / engine control system

7.5.3.2.1 Ignition safety time (T_{SA})

The mCHP appliance being adjusted to its nominal heat input, the ignition safety time ($T_{SA,max}$) is checked with reference gas under extreme conditions of electrical supply (85 % to 110 % nominal voltage) and water temperature (at ambient temperature and at thermal equilibrium).

It is checked that the requirements of 6.5.3.2.1 are satisfied.

7.5.3.2.2 Extinction safety time (T_{SE})

The mCHP appliance is supplied successively with each of the reference gases for the mCHP appliance category. The mCHP appliance 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 flame of the ignition burner, main burner or internal combustion engine 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 or the internal combustion engine running, 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 requirements of 6.5.3.2.2 are met.

7.5.3.2.3 Spark restoration

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

If spark restoration takes place it is checked that the requirements of 6.5.3.2.3 are satisfied.

7.5.3.2.4 Recycling

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

If recycling takes place it is checked that the requirements of 6.5.3.2.4 are satisfied.

7.5.4 Gas pressure regulator

If the mCHP appliance is fitted with a pressure regulator, an adjustment is made, if necessary, to give the nominal heat input with the reference gas at the normal pressure given in 7.1.2.4 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 family gases without a pressure couple,
- upper p_n and upper p_{max} for second and third family gases with a pressure couple,
- p_{min} and p_{max}, for third family gases without a pressure couple.

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

It is checked that the requirements of 6.5.4 are satisfied.

7.5.5 Air proving device

7.5.5.1 General

The mCHP appliance is installed as stated in 7.1.3. The mCHP appliance is supplied with one of the reference gases for the category to which it belongs.

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

The CO concentration is determined as stated in 7.8.1.

7.5.5.2 Supervision of the combustion air or the combustion products rate

The test is carried out when the mCHP appliance is in thermal equilibrium, at the nominal heat input, or for modulating mCHP appliances at the maximum and the minimum heat input and at 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.

If the mCHP consists of more than one heat generator the test shall be done as specified above with each of the heat generators and combinations of the several heat generators.

The CO and CO_2 concentrations are measured continuously.

The means of carrying out the blockage shall not give rise to recirculation of the products of combustion.

It is checked that the requirements of 6.5.5.2 are met.

7.5.5.3 Gas/air ratio controls

7.5.5.3.1 Leakage of non-metallic control tubes

The mCHP appliance is installed as stated in 7.1.3.

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

The requirements of 6.5.5.3.1 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.

7.5.5.3.2 Safety of operation

The test is carried out when the mCHP appliance is in thermal equilibrium, at the nominal heat input, or for modulating mCHP appliances at the maximum and the minimum heat input. When several rates are provided, supplementary tests are needed at each of these rates.

The CO and CO_2 concentrations are measured continuously.

The means of carrying out the blockage shall not give rise to recirculation of the products of combustion.

It is checked that the requirements of 6.5.5.3.2 are met.

7.5.5.3.3 Adjustment of the air/gas or gas/air ratio

The test of 7.5.5.3.2 shall be repeated under the following conditions:

a) Adjust the CO_2 at maximum heat input to the maximum CO_2 value and at the minimum heat input to the minimum CO_2 value;

b) Adjust the CO_2 at maximum heat input to the minimum CO_2 value and at the minimum heat input to the maximum CO_2 value.

It is checked that the requirements of 6.5.5.3.3 are met.

7.5.6 Functioning of the fan of a type C_4 mCHP appliance

The mCHP appliance is brought to controlled shutdown. It is checked that the requirement of 6.5.6 is met.

After restart the mCHP appliance is brought to safety shutdown. It is checked that the requirement of 6.5.6 is satisfied.

7.5.7 Delayed ignition

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

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

- the mCHP appliance is installed as indicated in 7.1.3. It is connected to the longest duct(s) for combustion air supply and removal of the products of combustion indicated in the appliance instructions;
- with the mCHP appliance at ambient temperature, an ignition spark is produced each second from 0 s to $T_{SA,max}$.

For the fuel processing system of a fuel cell mCHP appliance an inflammable gas/air mixture with ignition limits in between those of the gas normally used is injected at the surface or at the burner head at ambient temperature. To achieve this, the burner may be used if it can deliver such a gas/air mixture.

It is checked that the requirement of 6.5.7 is satisfied.

7.5.8 Common flue evacuation duct

The mCHP appliance and the ducts are installed in accordance with the technical instructions.

The mCHP appliance is supplied with one of the reference gases for its category at the nominal heat input and at the minimum heat input.

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

It is checked that the requirements of 6.5.8 are satisfied when the heat sources are operating individually or in any combination.

7.5.9 Leak tightness of the back-flow valve

The back-flow valve shall be tested as a part of the appliance and it should be connected as described in the installation instructions for this specific case, if applicable. The fitting pieces are not connected to the appliance. A pressure difference of circa 20 Pa is put on the appliance and the air flow through the valve is measured. The pressure difference is increased with steps of circa 20 Pa. At each step the air flow through the valve is measured. The pressure difference is increased up to the maximum pressure difference at start, with a minimum of 100 Pa.

It is checked that the requirements of 6.5.9 are satisfied.

7.5.10 Functional durability of the back-flow valve

A long term test consist of

- 2 500 open-close cycles at the nominal working temperature at the position of the back-flow valve,
- 45 000 open-close cycles at ambient temperature,
- 2 500 open-close cycles at nominal working temperature at the position of the back-flow valve.

At the beginning of the test and after the test has been completed the leak tightness of the valve shall fulfil the requirement of 6.5.9.

7.6 Efficiency

7.6.1 Efficiency (H_i)

The mCHP appliance is installed as stated in 7.1.3, connected to the insulated test rig and supplied with the reference gas for the mCHP appliance category.

The tests shall be performed for condensing appliances at the water temperature regime of 60 °C/40 °C and for non-condensing at 80 °C/60 °C at nominal heat output (100 % CHP + 100 % Sup).

The test at (100 % CHP + 0 % Sup) shall be performed with the flow rate

- maintained at the same flow rate and for condensing of 30 °C and for non-condensing of 47°C return temperature as during the tests at nominal heat output, or
- if the appliance is equipped with an integrated variable speed pump, adjusted according to the appliance instructions, or
- adjusted to a value which allows a difference between flow and return water temperature of a minimum of 6 K.

The 6 K minimum is needed to reach acceptable accuracy values with best available temperature measurement. If a smaller delta T is needed for the appliance, alternative test methods should be considered, such as the indirect method (measuring over the secondary cooling water with a lower flow on a calibrated test rig) or a method where a low flow of cold water is injected into the cooling system. Both methods can provide sufficient accuracy.

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

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

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

Mass m_1 of water is collected during the 10 min of the test. A further 10 min wait is required in order to evaluate the evaporation corresponding to the test period. Mass m_2 is obtained.

$m_1 - m_2 = m_3$, the quantity of which note has to be taken 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 mCHP appliance 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 mCHP appliance outlet.

The overall, thermal and electrical efficiencies are determined by means of the following formulas using the test rig as given in 7.1.6:

– nominal heat output CHP_100 % + Sup 100 % = useful heat output produced by 100 % CHP + 100 % Supplementary

  For range rated units the 100 % represents the arithmetic mean of the maximum and minimum nominal heat input of the mCHP appliance

  Overall efficiency

$$\eta_{\text{CHP\_100+Sup\_100}} = \frac{4{,}186 \times m \times (t_2 - t_1) + 3\ 600 \times W_{\text{el}} + D_{\text{p}}}{10^3 \times V_{\text{r(10)}} \times H_{\text{i}}} \times 100$$

  Thermal efficiency

$$\eta_{\text{th,CHP\_100+Sup\_100}} = \frac{4{,}186 \times m \times (t_2 - t_1) + D_{\text{p}}}{10^3 \times V_{\text{r(10)}} \times H_{\text{i}}} \times 100$$

  Electrical efficiency

$$\eta_{\text{el,CHP\_100+Sup\_100}} = \frac{3\ 600 \times W_{\text{el}}}{10^3 \times V_{\text{r(10)}} \times H_{\text{i}}} \times 100$$

– nominal heat output CHP = useful heat output produced by 100 % CHP + 0 % Supplementary

  Overall efficiency

$$\eta_{\text{CHP\_100+Sup\_0}} = \frac{4{,}186 \times m \times (t_2 - t_1) + 3\ 600 \times W_{\text{el}} + D_{\text{p}}}{10^3 \times V_{\text{r(10)}} \times H_{\text{i}}} \times 100$$

  Thermal efficiency

$$\eta_{\text{th,CHP\_100+Sup\_0}} = \frac{4{,}186 \times m \times (t_2 - t_1) + D_{\text{p}}}{10^3 \times V_{\text{r(10)}} \times H_{\text{i}}} \times 100$$

  Electrical efficiency

$$\eta_{\text{el,CHP\_100+Sup\_0}} = \frac{3\ 600 \times W_{\text{el}}}{10^3 \times V_{\text{r(10)}} \times H_{\text{i}}} \times 100$$

where

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);

H_i is the net calorific value of the gas used, in mega-Joule per cubic metre (MJ/m³) at 15 °C, 1 013,25 mbar, dry gas;

m is the corrected quantity of water expressed in kilogram (kg);

t_1 is the temperature at the cold water inlet in Kelvin (K);

t_2 is the temperature at the mCHP appliance outlet in Kelvin (K);

$V_{r(10)}$ is the gas consumption in m³ measured during the test corrected to 15 °C, 1 013,25 mbar;

W_{el} is the net AC electric energy of the primary heat & power generator (see 3.3) expressed in kilowatt-hours (kWh);

η_{CHP} is the efficiency in percent.

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

The test points are indicated in Figure 14.

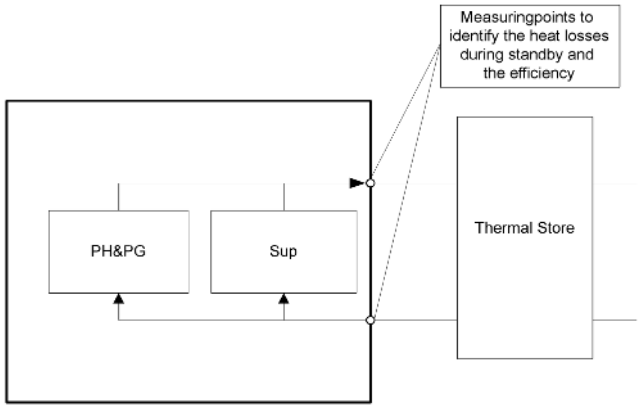


Figure 14 – Measuring points for the stand-by heat losses

7.6.2 Seasonal space heating energy efficiency (ErP[1])

7.6.2.1 Conversion to gross calorific efficiency

Because ErP is calculating on gross calorific values, all measured efficiencies are converted from net calorific value (NCV) to gross calorific value (GCV).

$$\eta_{Hs,CHP\_100+Sup\_100} = \frac{H_i}{H_s} \times \eta_{CHP\_100+Sup\_100}$$

$$\eta_{Hs,th,CHP\_100+Sup\_100} = \frac{H_i}{H_s} \times \eta_{th,CHP\_100+Sup\_100}$$

$$\eta_{Hs,el,CHP\_100+Sup\_100} = \frac{H_i}{H_s} \times \eta_{el,CHP\_100+Sup\_100}$$

[1] See COMMISSION REGULATION (EU) No 813/2013 and COMMISSION DELEGATED REGULATION (EU) No 811/2013

$$\eta_{\text{Hs,CHP\_100+Sup\_0}} = \frac{H_i}{H_s} \times \eta_{\text{CHP\_100+Sup\_0}}$$

$$\eta_{\text{Hs,th,CHP\_100+Sup\_0}} = \frac{H_i}{H_s} \times \eta_{\text{th,CHP\_100+Sup\_0}}$$

$$\eta_{\text{Hs,el,CHP\_100+Sup\_0}} = \frac{H_i}{H_s} \times \eta_{\text{el,CHP\_100+Sup\_0}}$$

7.6.2.2 Equivalent space heating efficiency

The equivalent space heating efficiency η_{eq} for each test point is calculated as:

- for values of $\eta_{\text{Hs,el}} \leq \frac{75}{CC}$:

$$\eta_{eq,CHP+Sup} = \frac{\eta_{Hs,th,CHP\_100+Sup\_100}}{100 - CC \times \eta_{Hs,el,CHP\_100+Sup\_100}} \times 100\%$$

$$\eta_{eq,CHP} = \frac{\eta_{Hs,th,CHP\_100+Sup\_0}}{100 - CC \times \eta_{Hs,el,CHP\_100+Sup\_0}} \times 100\%$$

- for values of $\eta_{\text{Hs,el}} > \frac{75}{CC}$:

$$\eta_{eq,CHP+Sup} = 4 \cdot \left(\eta_{Hs,CHP_{100}+Sup_{100}} - \frac{75}{CC}\right) + 0{,}16 \cdot \left(CC \cdot \eta_{Hs,CHP_{100}+Sup_{100}} - 100\right) \cdot \left(\eta_{Hs,el,CHP_{100}+Sup_{100}} - \frac{75}{CC}\right)$$

$$\eta_{eq,CHP} = 4 \cdot \left(\eta_{Hs,CHP_{100}+Sup_0} - \frac{75}{CC}\right) + 0{,}16 \cdot \left(CC \cdot \eta_{Hs,CHP_{100}+Sup_0} - 100\right) \cdot \left(\eta_{Hs,el,CHP_{100}+Sup_0} - \frac{75}{CC}\right)$$

where

CC is the conversion coefficient for electrical energy used in ErP (currently 2,5);

$\eta_{\text{eq,CHP+Sup}}$ is the equivalent heating efficiency in the test point (100 % CHP + 100 % Sup) in % [H_s];

$\eta_{\text{eq,CHP}}$ is the equivalent heating efficiency in the test point (100 % CHP + 0 % Sup) in % [H_s].

7.6.2.3 Seasonal space heating energy efficiency in active mode

The seasonal space heating energy efficiency in active mode η_{son} is expressed in % GCV and calculated as:

$$\eta_{son} = F_{CHP} \cdot \eta_{eq,CHP} + (1 - F_{CHP}) \cdot \eta_{eq,CHP+Sup}$$

with F_{CHP} taken from Table 18 [derived from ErP Lot 1 energy labeling document, supplementing Directive 2010/30/EU C(2013) 817 final from 18.2.2013].

For reasons of consistency and comparability this weighting formula for ErP follows the simplified mathematical linear method for use by the dealer throughout the legal ErP Lot 1 energy labelling document to calculate the seasonal space heating energy efficiency of a package. Although this is an approximation, this standard has to follow the same procedure to maintain comparability between packages or integrated appliances which are packaged by the supplier and packages which are composed by the dealer. Consistency and comparability have to go above accuracy here.

The accurate weighting method would have given $\frac{1}{\frac{F_{CHP}}{\eta_{eq,CHP}}+\frac{(1-F_{CHP})}{\eta_{eq,CHP+Sup}}}$.

Table 18 – Weighting factor F_{CHP} for weighting $\eta_{eq,CHP}$ in the η_{son} calculation*

P_{chp} / $P_{chp+sup}$**	mCHP appliance not including hot water storage tank	mCHP appliance including hot water storage tank
0***	0	0
0,1	0,30	0,37
0,2	0,55	0,70
0,3	0,75	0,85
0,4	0,85	0,94
0,5	0,95	0,98
0,6	0,98	1,00
≥ 0,7	1,00	1,00

* The intermediate values are calculated by linear interpolation between the two adjacent values.

** For range rated units $P_{chp+sup}$ represents the arithmetic mean of the maximum and minimum nominal heat output of the mCHP appliance

*** 0 is only listed for the purpose of interpolation.

7.6.2.4 Seasonal space heating energy efficiency

The seasonal space heating energy efficiency η_s is expressed in % GCV and calculated as

$$\eta_s = \eta_{son} - \sum_{i=1}^{4} F(i)$$

where the correction terms for respectively:

$F(1)$ controls (a fixed correction according to ErP which can be earned back as a contribution by adding appropriate temperature controls in a package with a mCHP appliance),

$F(2)$ auxiliary electricity consumption,

$F(3)$ standby heat losses and

$F(4)$ permanent ignition burner consumption

are calculated as follows.

$$F(1) = 3\%$$

$$F(2) = \frac{CC \cdot ((1 - F_{CHP}) \cdot P_{auxmax} + F_{CHP} \cdot P_{auxmin} + 1{,}3 \cdot b \cdot P_{SB})}{((1 - F_{CHP}) \cdot P_{CHP+Sup} + F_{CHP} \cdot P_{CHP}} \cdot 100\%$$

where

P_{auxmax} is the average electric auxiliary energy consumed by the mCHP appliance excluding the central heating pump in the test point 100 % CHP + 100 % Sup, expressed in kW, determined according to 7.6.3.3;

P_{auxmin} is the average electric auxiliary energy consumed by the mCHP appliance excluding the central heating pump in the test point 100 % CHP + 0 % Sup, expressed in kW, determined according to 7.6.3.4;

NOTE: P_{auxmin}, P_{auxmax} = electrical auxiliary consumption of the support controls needed for the thermal management to support the PH&PG.

P_{SB} is the average electric auxiliary energy consumed by the mCHP appliance in standby mode, expressed in kW, determined according to 7.6.3.5;

$P_{CHP+Sup}$ is the heat output of the mCHP appliance in the test point 100 % CHP + 100% Sup, expressed in kW and calculated as

$$P_{CHP+Sup} = \eta_{th,CHP_{100}+Sup\_100} \cdot Q_{CHP_{100}+Sup\_100}$$

with both $\eta_{th,CHP_{100}+Sup\_100}$ and $Q_{CHP_{100}+Sup\_100}$ (see 7.3.1) expressed in NCV;

P_{CHP} is the heat output of the mCHP appliance in the test point 100% CHP + 0% Sup, expressed in kW and calculated as

$$P_{CHP} = \eta_{th,CHP_{100}} \cdot Q_{CHP_{100}+Sup\_0}$$

with both $\eta_{th,CHP_{100}}$ and $Q_{CHP_{100}+Sup\_0}$ (see 7.3.1) expressed in NCV;

b is the weighting factor reflecting the relative stand-by time of the mCHP appliance, which is dependent of the ratio between minimum heat output and nominal heat output. This weighting factor is calculated as

$$b = 0{,}5 \cdot \frac{P_{min}}{P_{CHP+Sup}}$$

where P_{min} is the minimum sustained controlled heat output (which is sustained over a long period at minimum heat demand) of the mCHP appliance, determined according to 7.6.6, expressed in kW.

$$F(3) = b \cdot \frac{P_{stby}}{P_{CHP+Sup}} \cdot 100\%$$

where

P_{stby} is the standby heat loss determined according to 7.6.4, expressed in kW

$$F(4) = 0{,}5 \cdot b \cdot \frac{Q_{pilot}}{P_{CHP+Sup}} \cdot 100\%$$

where

Q_{pilot} is the permanent ignition burner heat input determined according to 7.6.5, expressed in kW [H_s].

7.6.3 Electric auxiliary energy consumption for ErP

7.6.3.1 General

The auxiliary energy consumption has to be determined according to this subclause.

7.6.3.2 System boundaries

The system boundary contains all electrical components between the manual shut-off device (for water and fuel) and the flue outlet of the combustion circuit, but excluding:

- the primary heat and power generator;
- the circulation pump(s) for the central heating circuit.

7.6.3.3 Auxiliary energy at nominal input P_{auxmax}

Under the test conditions of 7.6.1 for the nominal heat output CHP_100 % + Sup 100 % = useful heat output produced by 100 % CHP + 100 % Supplementary, the auxiliary energy consumed over a representative test period expressed in kilowatt (kW), shall be recorded and the average consumption determined.

7.6.3.4 Auxiliary energy at part load P_{auxmin}

Under the test conditions of 7.6.1 for nominal heat output CHP = useful heat output produced by 100 % CHP + 0 % Supplementary, the auxiliary energy consumed over a representative test period expressed in kilowatt (kW), shall be recorded and the average consumption determined.

7.6.3.5 Auxiliary energy at stand-by P_{SB}

During the measurement in stand-by the auxiliary energy consumed over a representative test period, expressed in kilowatt (kW), shall be recorded.

The power input is measured during operation in stand-by. The mCHP appliance is operated in accordance with the appliance instructions.

7.6.4 Stand-by heat loss P_{stby}

7.6.4.1 General

The measurement of the Stand-by heat loss P_{stby} shall ensure that the heat losses during stand-by for both heat generators are covered or the two individual losses (P_{stby_CHP}, P_{stby_Sup}) are provided.

7.6.4.2 Measurement of stand-by losses of the mCHP appliance

The mCHP-appliance is installed in accordance with the technical instructions and fitted to the test rig shown schematically in Annex I, or to other equipment giving comparable results and equivalent measurement uncertainties.

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 mCHP appliance is fitted with a largest diameter test flue as stated in the instruction manuals. The mCHP appliance water temperature is brought to a mean temperature of (30 ± 5) K above ambient temperature.

The gas supply is then shut off, the pump (**11**) and the mCHP appliance pump, if any, are stopped, 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 auxiliary electric mCHP appliance (**6**) is adjusted so as to obtain, in the steady state condition, a difference of (30 ± 5) K between the mean water temperature and the ambient temperature. Throughout the test, the variation in room temperature shall not exceed 2 K per hour.

The following values are noted:

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

T the mean water temperature at the return and the flow of the mCHP appliance on test, in °C;

T_A the ambient temperature during the test, in °C.

7.6.4.3 Thermal losses of the mCHP appliance

The corrected thermal losses P_{stby}, or $P_{stby\_CHP,}$ *and* P_{stby_Sup} expressed for a mean water temperature T of 50 °C and an ambient temperature T_A of 20 °C, are given, in kilowatts (kW), by:

For the calculation according ErP the following equations are applicable

$$P_{stby} = Pm * \left(\frac{30}{T - T_A} \right)^{1,25} \text{ or}$$

$$P_{stby} = P_{stby\_CHP} + P_{stby\_Sup}$$

$$P_{stby\_CHP} = Pm_{\_CHP} * \left(\frac{30}{T - T_A} \right)^{1,25}$$

$$P_{stby\_Sup} = Pm_{\_Sup} * \left(\frac{30}{T - T_A} \right)^{1,25}$$

NOTE For the calculation according EPBD (European Directive Energy Performance of Buildings) the individual heat losses may be of interest.

7.6.5 Permanent ignition burner heat input Q_{pilot}

If the mCHP appliance contains a permanent ignition burner, the permanent ignition burner heat input Q_{pilot} shall be determined in accordance with 7.3.1, with the mCHP appliance in stand-by mode.

The resulting heat input Q_C shall be recalculated to GCV by:

$$Q_{pilot} = \frac{H_s}{H_i} \cdot Q_C$$

NOTE The Q_{Pilot} is equivalent to P_{ign} used in ErP.

7.6.6 Minimum sustained controlled heat output

The test is carried out under the test conditions of and in accordance with 7.6.1 for nominal heat output CHP = useful heat output produced by 100 % CHP + 0 % Supplementary, but the appliance is set to the minimum sustained controlled heat output that can be sustained indefinitely at minimum heat demand, as given in the product documentation, which will be obtained in practice by normal operation of the controls. The minimum sustained controlled heat output P_{min}, expressed in kW, is calculated as

$$P_{min} = \frac{4{,}186 \times m \times (t_2 - t_1) + D_p}{\tau}$$

where

τ is the measurement time in s.

7.7 Operation

It is checked that the requirements in 6.7 are met.

7.8 Combustion

7.8.1 Carbon monoxide

7.8.1.1 General

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

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

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

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

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

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, in percent, of $(CO_2)_N$ for the test gases are given in Table 19.

Table 19 – $(CO_2)_N$ concentration of the combustion products, in percent

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

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

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

where

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

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

7.8.1.2 Limit conditions

The tests are carried out under the following conditions:

- at maximum pressure for mCHP appliances without a gas pressure regulator or with gas/air ratio controls;
- at 1,07 times the nominal heat input for mCHP appliances with a gas pressure regulator using first family gas;
- at 1,05 times the nominal heat input for mCHP appliances with a gas pressure regulator using second and third family gas.

It is checked that the requirements of 6.8.1.2 are met.

7.8.1.3 Special conditions

7.8.1.3.1 Incomplete combustion

The adjustment is modified as follows:

- mCHP appliances without gas pressure regulator are adjusted to 1,075 times the nominal heat input;
- mCHP appliances with gas/air ratio controls are adjusted to the nominal heat input;
- mCHP appliances with gas pressure regulator or mCHP appliances which are intended to be installed solely on a gas installation with a governed meter, are adjusted to 1,05 times the nominal heat input.

The reference gas is then replaced by the incomplete combustion limit gas.

It is checked that the requirements of 6.8.1.3 are met.

7.8.1.3.2 Combustion test with flame lift gas

The adjustment is modified as follows:

- mCHP appliances without gas pressure regulator are adjusted to the minimum heat input; the pressure at the mCHP appliance inlet is reduced to the minimum pressure given in 7.1.2.4;
- mCHP appliances with gas/air ratio controls are adjusted to the minimum heat input;
- mCHP appliances with gas pressure regulator are adjusted to a heat input equal to 0,95 times the minimum heat input.

The reference gas is then replaced by the flame lift limit gas.

It is checked that the requirements of 6.8.1.3 are met.

7.8.1.3.3 Type C_1, C_3 and C_9 mCHP appliances

The test is carried out as stated in the first and third test series in 7.4.3.3.2, 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 6.8.1.3 are met.

7.8.1.3.4 Type C_4 mCHP appliances

Under the test conditions of 7.4.3.3.3, it is checked that the requirements of 6.8.1.3 are met.

7.8.1.3.5 Type C_5 mCHP appliances

Under the test conditions of 7.4.3.3.4, it is checked that the requirements of 6.8.1.3 are met.

7.8.1.3.6 Type C_6 mCHP appliances

In accordance with 4.2.2.8 these mCHP appliances are intended to be connected to a separately approved and marketed system for the supply of combustion air and discharge of the combustion products.

Type C_6 mCHP appliances are fitted with a restriction to simulate the minimum pressure loss stated in the appliance instructions.

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 recirculated to the air supply.

It is checked that the requirements of 6.8.1.3 are met.

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

If the mCHP appliance 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 mCHP 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 6.8.1.3 are met.

7.8.1.3.7 Type C_8 mCHP appliances

Under the test conditions of 7.4.3.3.6 it is checked that the requirements of 6.8.1.3 are met.

7.8.1.3.8 Supplementary test for fan assisted mCHP appliances

Fan assisted mCHP appliances are supplied with the reference gases for the category to which they belong at normal pressure.

It is checked that the requirements of 6.8.1.3 are met when the supply voltage is varied between 85 % and 110 % of the nominal voltage stated in the appliance instructions.

7.8.1.4 Sooting

The mCHP appliance is adjusted as stated in 7.8.1.3.1. The incomplete combustion limit gas is replaced by the sooting limit gas and the mCHP appliance is operated for 1 h.

It is checked that the requirements of 6.8.1.4 are met.

7.8.2 NO_X (Other pollutants)

7.8.2.1 General

For mCHP appliances intended to use second family gases, the tests are carried out with reference gas G 20.

For mCHP appliances intended to use only G 25, the tests are carried out with reference gas G 25.

For mCHP appliances 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 mCHP appliances 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.

The mCHP appliance or its tested heat generator is adjusted to its nominal heat input for a return water temperature according to 7.6.1 ± 2 °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 formula:

$$T_r = 0{,}2\ Q + 20$$

where

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

Q is the partial heat input, expressed in percent of Q_n.

The flow is kept constant.

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

No wet meters are used.

The reference conditions for the combustion air are

– temperature: 20 °C,

– humidity: 10 g H_2O/kg air.

If the test conditions are different to these reference conditions, it will be necessary to correct the NO_x values as specified below.

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

where

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

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

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

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

It is checked that the NO_x values comply with the values of Table 11 of 6.8.2, depending on the NO_x class chosen.

7.8.2.2 Weighting

7.8.2.2.1 General

The calculation of the overall NO_X emissions $NO_{x,pond}$ which will be used as NO_{x_mCHP} for selecting the NO_x class according to Table 11 is specified for three different applications of the mCHP appliance in the system.

For appliances intended to meet the full heat requirement of a system and:

- Intended to meet the heat demand instantaneously, method A (see 7.8.2.2.2) shall be used.
- Decoupled from the heat load by a heat storage device and:
  - Comprising multiple heat generators, method B (see 7.8.2.2.3) shall be used,
  - Comprising only one heat generator, method C (see 7.8.2.2.4) shall be used.

For appliances intended to be installed as the primary heater in a cascade, method C (see 7.8.2.2.4) shall be used.

7.8.2.2.2 Method A

The weighting of the NO_x measured values shall be on the basis of the values in Table 20.

Table 20 – Weighting factors

Partial heat input Q_{pi} as a % of Q_n	70	60	50	40	30	20	10
Weighting factor F_{pi}	0,082	0,121	0,148	0,165	0,171	0,165	0,148

For range rated mCHP appliances Q_n is replaced by Q_a, the arithmetic mean of the maximum and the minimum heat input, as stated in the appliance instructions.

The performance of mCHP appliances will be dependent on the functionality of the internal control system. Care should be taken to ensure that the modulation of the PH&PG and supplementary heat generator to meet the partial heat input in the laboratory replicates that likely to occur in a real installation. Typically, the PH&PG will operate at its maximum continuous output and the supplementary heater will modulate to meet the remaining portion of the partial heat input desired.

If the minimum heat is higher than 10 % the factors F_{pi} should be added to the lowest possible minimum heat input.

The following symbols are used:

– $NO_{x,mes}$ the measured (and possibly corrected) value: at the partial heat input;

– $NO_{x,pond}$ the weighted value of the NO_x concentration, in milligrams per kilowatt-hour (mg/kWh). which will be used for allocating the NO_X class according to Table 11;

– Q_n the nominal heat input, expressed in kilowatts (kW);

– Q_{pi} the partial heat input for weighting, expressed in percent of Q_n.

The NO_x concentration and the electrical energy generation is measured (and possibly corrected as specified) at the partial heat inputs specified in Table 20.

The NO_x value is weighted as specified below:

$$NO_{x,pond} = 0{,}082\ NO_{x,mes(70)} + 0{,}121\ NO_{x,mes(60)} + 0{,}148\ NO_{x,mes(50)} + 0{,}165\ NO_{x,mes(40)} + 0{,}171\ NO_{x,mes(30)} + 0{,}165\ NO_{x,mes(20)} + 0{,}148\ NO_{x,mes(10)}$$

7.8.2.2.3 Method B

The weighting of the NO_x measured values of the supplementary heat generator shall be on the basis of the values given in Table 21.

Table 21 – Weighting factors

Partial heat input Q_{pi} as a % of Q_{n_Sup}	70	60	40	20
Weighting factor F_{pi}	0,15	0,25	0,30	0,30

For range rated supplementary heat generators Q_{n_Sup} is replaced by Q_{a_Sup}, the arithmetic mean of the maximum and the minimum heat input of the supplementary heat generator, as stated in the technical specifications / instructions.

The following symbols are used:

Q_{n_Sup} the nominal heat input of the supplementary heat generator, expressed in kilowatts (kW);

Q_{pi} the partial heat input for weighting, expressed in percent of Q_{n_Sup};

F_{pi} the weighting factor corresponding to the partial heat input Q_{pi};

$NO_{x,Sup}$ the weighted value of the NO_x concentration of the supplementary heat generator in milligrams per kilowatt-hour (mg/kWh);

$NO_{x,mes}$ the measured (and possibly corrected) value at the partial heat input: $NO_{x,mes(70)}$, $NO_{x,mes(60)}$, $NO_{x,mes(40)}$, $NO_{x,mes(20)}$

The NO_x value of the supplementary heat generator is weighted as specified below:

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

The NO_X of the CHP part of the mCHP appliance is measured at the operation mode according to 7.3.1 b) as $NO_{X,CHP}$.

The $NO_{X,pond}$ shall be calculated by weighting $NO_{X,sup}$ and $NO_{X,CHP}$ according to Table 18 :

$$NO_{x,pond} = F_{CHP} \cdot NO_{x,CHP} + (1 - F_{CHP}) \cdot NO_{x,Sup}$$

The following symbol is used:

– $NO_{x,pond}$ the weighted value of the NO_x concentration, in milligrams per kilowatt-hour (mg/kWh). which will be used for allocating the NO_X class according to Table 11;

7.8.2.2.4 Method C

$NO_{x,pond}$ is the value of the $NO_{x,CHP}$.

– $NO_{X,CHP}$ NO_X of the PH&PG measured according to 7.3.1 b) (and possibly corrected) expressed in mg/kWh;

7.8.2.2.5 $NO_{x,pond}$ conversion to gross calorific efficiency used in ErP

Because ErP is calculating on gross calorific values, the weighted $NO_{x,pond}$ is converted from NCV to GCV as $NO_{x,pond,Hs}$.

$$NO_{x,pond,Hs} = \frac{H_i}{H_s} \times NO_{x,pond}$$

7.8.3 Supplementary test for condensing mCHP appliance

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

The condensate discharge is blocked. The mCHP appliance is operated with the temperature and heat input conditions specified for the category to which it belongs so that condensate is produced.

It is checked that the requirements of 6.8.3 are satisfied.

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

7.9 Resistance of the 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, 7.9.3 and 7.9.4.

The test pressure is maintained for at least 10 min.

7.9.2 mCHP appliance of pressure class 1

The test pressure is 1,5 bar.

It is checked that the requirements of 6.9.2 are satisfied.

7.9.3 mCHP appliance of pressure class 2

The test pressure is 4,5 bar.

It is checked that the requirements of 6.9.3 are satisfied.

7.9.4 mCHP appliance of pressure class 3

7.9.4.1 mCHP appliance of sheet metal or non-ferrous metals

The test pressure is (2 × PMS) bar.

It is checked that the requirements of 6.9.4.1 are satisfied.

7.9.4.2 mCHP appliance of cast iron and cast materials

7.9.4.2.1 mCHP unit body

The test pressure is (2 × PMS) bar, with a minimum of 8 bar.

It is checked that the requirements of 6.9.4.2.1 are satisfied.

7.9.4.2.2 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 requirements of 6.9.4.2.2 are satisfied.

7.9.4.2.3 Tie bars

It is checked by calculation that the requirements of 6.9.4.2.3 are satisfied for a pressure of (4 × PMS) bar.

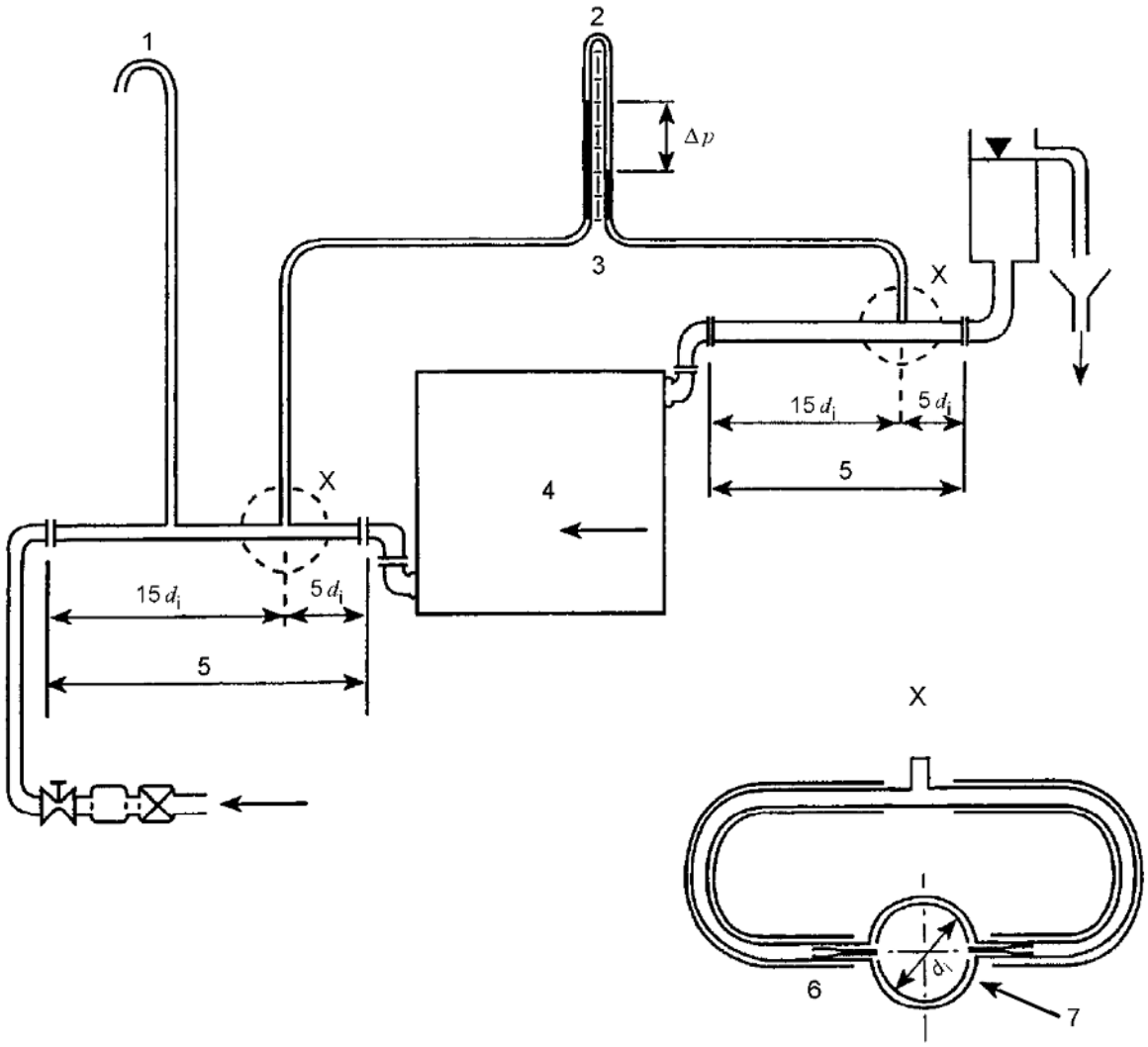
7.10 Hydraulic resistance

The hydraulic resistance of a mCHP appliance (measured in mbar) has to be determined for the water flow rate corresponding to operation of the mCHP appliance at the nominal heat input with a water flow temperature of 60 °C and a temperature difference between the flow and the return water of 20 K generally, or that stated in the appliance instructions.

The test is carried out with the water at ambient temperature.

The test rig is specified in Figure 15. 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 curve of available pressures given in the appliance instructions for mCHP appliances with integral pumps is checked.



Key

1 ventilation
2 differential pressure gauge
3 flexible hoses
4 appliance
5 test pipe
6 flexible hose
7 drilled hole of 3 mm diameter, internally burred
X cross section, turned by 90°

Figure 15 – Test rig for the determination of hydraulic resistance

7.11 Formation of condensate

The mCHP appliance is installed according the conditions of 7.1.3 and at the maximum flue length as stated in the instruction

A condensing mCHP appliance shall operate continuously for 4 h under the test conditions of 7.6.

It is verified that the requirements of 6.11 are fulfilled.

7.12 Designation and measurement of reference temperatures of flue systems

7.12.1 Nominal working combustion products temperature

During the control thermostat tests, according to 6.4.2.2 with the thermostat set at the maximum setting temperature, the temperature of the combustion products is recorded continuously until the thermostat operates. The declared nominal working combustion products temperature should be higher or equal to the maximum temperature recorded.

7.12.2 Overheat combustion products temperature

During the overheating tests, according to 6.4.2.3, the temperature of the combustion products is recorded continuously until the temperature ceases to increase after the safety temperature limiter or the overheat cut-off device causes non-volatile lockout of the mCHP appliance. The declared overheat combustion products temperature should be higher or equal to the maximum temperature recorded.

7.13 Mechanical resistance and stability of ducts, terminal and fitting pieces

7.13.1 General

7.13.2 Compressive strength

7.13.2.1 Duct sections and fittings

The longest vertical ducts, fitting pieces and terminal as specified in the installation instructions are installed. If this becomes impractical, length might be simulated by adding appropriate weight.

It is checked that the requirement of 6.13.2.1 is met. Also it is verified that a deformation during work cannot influence the function of the mCHP appliance.

7.13.2.2 Ducts support

The appliance is installed with the longest vertical ducts, the fitting pieces and the terminal as specified in the installation instructions. If this becomes impractical, length might be simulated by adding appropriate weight. The test is conducted at the conditions of nominal working combustion products temperature. The test shall be continued until equilibrium is reached. Equilibrium is deemed to be achieved when the rate of the combustion temperature does not exceed 1 K per 30 min.

It is checked that the requirement of 6.13.2.2 met.

7.13.2.3 Vertical terminals

The terminal is installed in accordance with the technical specifications/instructions. A vertical load is evenly distributed to the top of the terminal. This load is maintained for 5 min. The load is 7 [N/mm] x D_N, where D_N is the internal diameter of the flue in mm, but not more than 750 N.

It is checked that the requirements of 6.13.2.3 are in met.

7.13.3 Lateral strength

7.13.3.1 Flexural tensile strength

The ducts, fitting pieces and terminal are installed with the minimum inclination to the horizontal and the maximum distance between adjacent supports as specified in the installation instructions.

It is checked that the requirement of 6.13.3.1 is met.

7.13.3.2 Components subject to wind load

The terminal, including the ducts penetrating the roof or wall with the maximum lengths of external ducts as specified in the installation instructions, is installed.

An evenly distributed load is applied to the external part of the mCHP appliance duct and terminal and increased uniformly up to (1,5 ± 0,04) kN/m².

NOTE A method for applying an evenly distributed load is described in informative Annex H of EN 1859:2000. Other methods using a vertical assembly may also be used.

The test load is applied by a number of individual evenly distributed loads equally spaced from the freestanding end at not more than 0,2 m ± 0,01 m intervals. The individual loads do not vary by more than 1 %.

It is checked that the requirement of 6.13.3.2 is met.

7.13.4 Flexible metallic liners

Flexible metallic liners have to meet the requirements of EN 1856-2:2009, 6.1.2.6.

7.14 Requirements for plastic in the combustion product evacuation ducts, terminals and fitting pieces for mCHP appliances

7.14.1 Thermal resistance

The verification of the thermal resistance value shall be performed by testing with an overheat combustion temperature in accordance with EN 13216-1:2004, Clause 5.

7.14.2 Materials

7.14.2.1 Characterization

The density shall be determined in accordance with EN ISO 1183 (all parts).

Prior to the characterizations the test pieces shall be conditioned at least for 24 h in air with a relative humidity of 50 % and a temperature of 23 °C.

7.14.2.2 Long-term resistance to thermal load

To determine the long-term resistance to thermal load the test pieces are exposed to hot air in a forced air circulation oven, which meets the following conditions:

a) The exhaust rate is at least one oven chamber volume in 10 min,

b) The temperature varies no more than 1,5 K within the oven volume and 1 K over time.

Metal parts that come into contact with test pieces are lined with fluorocarbon film or other materials that have no effect on the oxidative stability of the material to be tested. The exposure time of the test pieces is dependent upon the test temperature as given in Table 22.

Table 22 – Exposure time in weeks at raised temperatures

	Nominal working combustion products temperature					
.	**80 °C**	**100 °C**	**120 °C**	**140 °C**	**160 °C**	**200 °C**
Test Temperature						
80°C	21,9					
85°C	13,0					
88°C	10,0					
100°C		17,2				
105°C		10,8				
106°C		10,0				
120°C			14,4			
124°C			10,0			
140°C				12,6		
143°C				10,0		
160°C					11,4	
162°C					10,0	
200°C						10,0

It is checked that the requirement of 6.14.2.2 is met.

7.14.2.3 Long-term resistance to condensate exposure

To determine the long-term resistance to condensate exposure the test pieces are fully immersed in test condensate.

The composition of test condensate is in accordance with following Table 23.

Table 23 – Composition of test condensate for corrosion

Component	**Concentration** mg/l
Chloride	30
Nitrate	200
Sulphate	50

The test condensate shall be prepared using hydrochloric acid (HCl), nitric acid (HNO_3) and sulphuric acid (H_2SO_4). The condensate temperature shall be 90 °C.

If the nominal working combustion products temperature is below 90 °C the test shall be carried out at the nominal working combustion products temperature.

The duration of the exposure to condensate is 10 weeks.

At the conclusion of the test, the requirement of 6.14.2.3 is checked.

7.14.2.4 Resistance to condensing/non-condensing cycling

The flue ducts to be tested shall be assembled consisting of all different parts according to the appliance instructions. Flue ducts for installation with enclosure shall be built with an enclosure. If the ducts are intended to be insulated they are to be installed in that way.

The length of the flue duct shall be 4,5 m at least or if shorter the longest combination according the appliance instructions.

The top of the flue duct shall be subjected to a vertical load representative of the weight of the maximum flue height as specified in the installation instructions.

The natural gas used for the test shall contain 60 mg/m^3 sulphur and 25 ppm Cl.

The mCHP appliance shall be operated for

- 10 min under the conditions 100 % CHP + 100 % Sup,
- 10 min under 30 % part load conditions (contributed from CHP and Sup.) and
- during 10 min,
    - in standby mode for mCHP appliance which can operate in a cycling mode or
    - in minimum achievable load CHP + 0 % Sup for mCHP appliance which cannot operate in a cycling mode.

The cycling time is to be equal or more than 84 days.

(Alternatively the test may be carried out in accordance with 7.7.5 of EN 14471:2013.)

At the conclusion of the test, the requirement of 6.14.2.4 is checked.

7.14.2.5 Resistance to ultraviolet radiation (UV)

The artificial weathering test is carried out in accordance with EN 513.

The apparatus is adjusted as follows:

a) intensity of light: 30 W/m^2;

b) exposure time: 1330 h;

c) relative humidity: (65 ± 5) %;

d) black standard temperature: (50 ± 3) °C;

e) spray cycle: 18/102 (time of spraying = 18 min, dry interval between spraying = 102 min);

f) no rotation of test pieces;

g) overall radiation shall amount to 0,144 GJ/m^2.

The tests of the mechanical properties shall be carried out in such a way that the maximum stress will occur at the radiated side of the test pieces.

It is checked that the requirements of 6.14.2.5 are met.

7.14.2.6 Geometrical stability

To determine the geometrical stability, 3 flue sections / segments with a length of 20 cm are coupled together with each other by the joints as specified in the design documentation, or three samples without coupling, are tested in accordance with 7.14.2.2.

The test pieces are placed in a horizontal position. The three sections are conditioned for a period of 48 h at the nominal working combustion products temperature.

It is checked that the requirements of 6.14.2.6 are met.

7.14.2.7 Reaction to fire

The reaction to fire shall be tested according to EN 13501-1.

It is checked that the requirement of 6.14.2.7 is met.

7.15 Tests for elastomeric seals and elastomeric sealants in the combustion product evacuation ducts, terminals and fitting pieces

7.15.1 Characterization

To characterize the material the following properties are determined:

a) hardness in accordance with ISO 7619 (all parts) on a minimum of 6 test pieces;
b) density in accordance with ISO 2781 on a minimum of 6 test pieces;
c) compression set in accordance with ISO 815 (all parts) on a minimum of 3 test pieces;
d) tensile strength in accordance with ISO 37 on a minimum of 6 test pieces;
e) stress at 100 % of elongation in accordance with ISO 37 on a minimum of 6 test pieces.

7.15.2 Long-term resistance to thermal load

The test pieces are exposed for 56 days in air at the nominal working combustion products temperature.

The test is carried out in accordance with ISO 188.

After exposure, it is checked that the requirements of 6.15.2 are met, where:

a) hardness is determined in accordance with ISO 7619 (all parts) on a minimum of 6 test pieces;

b) tensile strength is determined in accordance with ISO 37 on a minimum of 6 test pieces;

c) stress at 100 % of elongation is determined in accordance with ISO 37 on a minimum of 6 test pieces.

7.15.3 Long-term resistance to condensate exposure

The test pieces are exposed for 56 days in test condensate at 90 °C for class K2 and at 60 °C for class K1.

The composition of the test condensate is given in Table 24.

Table 24 – Condensate composition, related to construction classes

Chemical component	**Concentration for class K2** mg/l	**Concentration for class K1** mg/l
Chloride	30	30
Nitrate	200	50

Sulphate	50	50

The test is carried out in accordance with ISO 1817.

After exposure, it is checked that the requirements of 6.15.3 are met, where:

a) hardness is determined in accordance with ISO 7619 (all parts) on a minimum of 6 test pieces,

b) tensile strength is determined in accordance with ISO 37 on a minimum of 6 test pieces,

c) volume is determined in accordance with ISO 1817 on a minimum of 6 test pieces,

d) stress at 100 % of elongation is determined in accordance with ISO 37 on a minimum of 6 test pieces.

7.15.4 Cyclic condensate resistance test

This test comprises the following 24 h cycle:

At least 6 test pieces are mounted on a base plate in such a way that they have an elongation of 25 % and that one side of the test pieces is in contact with the base plate. Throughout the full test sequence the base plate is kept horizontal with the test pieces on top. The base plate shall consist of a material that is sufficiently resistant to the influence of condensate and shall have a maximum surface roughness of 5 µm.

Alternatively at least 3 flue pipe assemblies including one seal each may be used.

The test pieces mounted on the base plate are immersed in condensate for 6 h at 60 °C. Alternatively the flue pipe assemblies, filled with condensate in such a way that the level of the condensate is higher than all parts of the seal, are exposed for 6 h at 60 °C.

The composition of the test condensate shall be in accordance with Table 23**.**

After the exposure to condensate the test pieces mounted on the base plate are removed from the condensate.

The flue pipe assemblies are emptied of condensate. It is important not to dry the test pieces or the flue pipe assemblies before immediately transferring them to a ventilated oven.

The oven is operated for 0,5 h at a temperature of 60 °C and for 17,5 h at the nominal working temperature with a maximum of 110 °C.

The 24 h cycle is repeated 12 times.

After exposure, it is checked that the requirements of 6.15.4 are met.

7.15.5 Relaxation behaviour

The test is carried out in accordance with ISO 6914.

The test pieces are exposed for 3 weeks in air, at nominal working combustion products temperature at 50 % elongation.

It is checked that the requirement of 6.15.5 is met.

7.15.6 Compression set

The test is carried out in accordance with ISO 815 (all parts) on a minimum of 6 test pieces.

The test pieces are exposed for 24 h in air at nominal working combustion products temperature.

It is checked that the requirement of 6.15.6 is met.

7.15.7 Low temperature resistance

The test is carried out in accordance with ISO 815 (all parts) on a minimum of 6 test pieces.

The test pieces are exposed for 72 h in air at a temperature of – 20 °C.

It is checked that the requirement of 6.15.7 is met.

7.15.8 Joints in elastomeric seals

7.15.8.1 Durability

It is checked that the requirement in 6.15.8.1 is met.

7.15.8.2 Strength

Three test pieces including the joint are 100 % elongated and exposed for 1 h in air at 23 °C and 50 % humidity.

After exposure, it is checked that the requirements in 6.15.8.2 are met.

7.16 Special provisions for mCHP appliances intended to be installed in a partially protected place

7.16.1 Frost protection system for mCHP appliances intended to be installed in a partially protected place

The mCHP appliance is placed in a climate chamber at ambient temperature. The mCHP appliance – in stand-by condition – is connected to a system containing not more than 100 l of water. The temperature of the climate chamber is reduced from ambient temperature to the "minimum declared installation temperature for mCHP appliances in partially protected places" (see definition) in not less than 1 h. The test will last until a steady condition or a steady repetition of cycles has been reached. It is checked that the requirements as given in 6.16.1 are met.

7.16.2 Protection against the ingress of rain

The test is carried out according to 14.2.4 of EN 60529:1991.

8 EMC / electrical requirements

8.1 Relevant for the Gas safety

The mCHP appliance shall comply with EN 60335-2-102 concerning the risks based on the electrical energy.

8.2 Relevant for the Electrical safety related to the grid with indirect effect to gas safety

The connection of the mCHP in parallel with public low-voltage distribution networks shall comply with EN 50438 or CLC/TS 50549-1.

8.3 Relevant for the EMC

Related to EMC, the mCHP appliance shall comply with the following standards as far as they are applicable:

– EN 55014-1;

– EN 55014-2;

– EN 61000-3-2;

– EN 61000-3-3;

– EN 61000-3-11;

– EN 61000-3-12;

– EN 61000-6-1;

– EN 61000-6-3.

9 Marking, installation and operating instructions

9.1 mCHP appliance marking

9.1.1 Data plate

Each appliance shall carry an indelible data plate which is visible on installation, possibly after the removal of a part of the housing, which is solidly fixed and durable.

The mCHP appliance data plate(s) shall give the following information:

– name of manufacturer[4)] or his identifying symbol;

– serial number;

– trade name of the mCHP appliance;

– CE label with identification number of the notified body responsible for EC surveillance;

– the last two digits of the year when the CE mark was affixed (i.e. the year of manufacture);

– the country(-ies) of destination, in accordance with EN ISO 3166-1

– the appliance category(ies) in relation to the direct country(ies) of destination. Any category shall be specified in accordance with EN 437;

– the gas supply pressure in millibars, if several normal pressures can be used for the same group. They are indicated by their numerical value and the unit “mbar”;

– the mCHP appliance type(s). The type(s) shall be specified in accordance with 4.2;

– the nominal useful heat output or for range rated mCHP appliance the maximum and the minimum useful heat output (if applicable) in kilo watts, given by the symbol “P_{th}”, followed by the equals sign, the numeric value(s) and the unit “kW”;

– the nominal electric power output and the maximum and the minimum electric power output (if applicable) in kilo watts, given by the symbol P_{el_n} , $P_{el_{max}}$, $P_{el_{min}}$ as relevant followed by the equals sign, the numeric value(s) and the unit “kW”;

– the nominal heat input or for range-rated mCHP appliances the maximum and the minimum heat input (if applicable) in kilo watts, given by the symbol “Q”, followed by the equals sign, the numeric value(s) and the unit “kW”;

– the maximum water pressure at which the appliance can be used, in bars given by the symbol “PMS”, followed by the equals sign, the numerical value and the unit “bar”;

– for the heating circuit: maximum flow temperature with the unit “°C”;

– the electrical supply voltage;

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

- the nominal voltage in Volts given by the numerical value and followed by the unit “V”;
- the nature of the electrical supply given by the symbol “~” or “=”;
- in case of AC current (~) the nominal frequency in Hertz given by the numerical value and followed by the unit “Hz”;
- power consumption (if necessary) in Watts given by the numerical value and followed by the unit “W” (if applicable);
- nominal heat input for combination mCHP appliances in the domestic hot water mode (Q_{nw}), in kilowatts (kW), if there are different nominal heat inputs for the central heating and domestic water modes;
- maximum water service pressure for combination mCHP appliances for the domestic water circuit (PMW), in bar

The indelibility of markings shall be checked by a test carried out in accordance with EN 60335-1.

9.1.2 Supplementary markings

On an additional data plate, the mCHP appliance shall carry visible and indelible information relating to its state of adjustments (if applicable):

- the direct country(ies) of destination in accordance with the symbols in 9.1.1;
- the gas group or range, the symbol of the gas type, the gas supply pressure and/or the pressure couple in accordance with the column on marking in Table 25.

Table 25 – Supplementary markings

Gas family	Category index	State of adjustment			Marking
		Gas group or range of gases	Symbol of gas	Gas pressure(s) 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 30/G 31 – 50/67 mbar
		3+	G 30/G 31	112/148	3+ – G 30/G 31 – 112/148 mbar

This information may be carried on the data plate.

9.1.3 Packaging

The packaging shall carry the category(-ies), the mCHP appliance type and information given on the additional data plate (see 9.1.2) as well as warnings in accordance with 9.1.4.

9.1.4 Warnings on the mCHP unit and the packaging

One or more labels shall give at least the following warnings, such that they are visible and readable for the user:

– read the technical instruction before installing the mCHP appliance;

– read the users instructions before first start-up of the mCHP appliance.

9.1.5 Other information

No other information shall be carried on the mCHP unit or the packaging if it is likely to create confusion in the relation to the actual state of adjustment of the mCHP unit, the corresponding category(ies) and the direct country(ies) of destination.

9.2 Installation instructions

9.2.1 Technical instructions

9.2.1.1 Introduction

A detailed manual with the technical instructions for installation, use and maintenance, intended for the installer shall be provided with each mCHP appliance.

These instructions shall at least include the following instructions stated in 9.2.1.2 to 9.2.1.6.

9.2.1.2 General

- The information of the data plate, with exception of the serial number and the year of manufacture (see 9.1.1).
- The meaning of the symbols used on the mCHP appliance and its packaging, in accordance with 9.1.1 and 9.1.2.
- Reference to certain standards and/or particular regulations if these prove to be necessary for the correct installation and the use of the mCHP appliance.
- Information (if necessary – see 6.4.1.3 and 6.4.1.4).
    - About the minimum distances to be met from inflammable materials.
    - That walls sensitive for heat, for example wood, shall be protected by suitable insulation (if necessary).
- A general description of the appliance, with an illustration of the principle parts (sub-assemblies) which shall be removed to rectify operational faults.
- The servicing necessary and the recommended service interval.
- Indication that, following the installation of the mCHP appliance, the installer shall instruct the user in the operation of the mCHP appliance and the safety devices (if applicable) and shall give at least the users instructions to the user.
- The NO_X class of the mCHP appliance.

For storage type combination mCHP appliances:

- where necessary, describe how the mCHP appliance and the tank are connected;
- indicate that it will be necessary to fit safety devices specified in local installation regulations, if they have not been fitted on the mCHP appliance;

For instantaneous type combination mCHP appliances:

- the minimum pressure at the inlet to the domestic water circuit.

9.2.1.3 Installation and adjustment of the gas carrying circuit

- check that the information of 9.1.2 concerning the state of adjustment given on the data plate or on the additional data plate shall be compatible with the local supply conditions.
- Adjustment instructions for mCHP appliances which are adjustable by the installer, incorporating an adjustment table in which the volume or the mass rates are stated in m³/h or kg/h, or the burner pressure in relation to the possible adjustment data in accordance with the category(ies) (if applicable); the reference conditions are 15 °C, 1013,25 mbar, dry gas.
- For mCHP appliances capable of operating on several gases, information of the operations required to convert from one gas to another and indication that the adjustments and modifications

shall only be carried out by a competent person; when an adjustment is carried out by a competent person, the adjustment device shall be sealed after adjustment.

– For mCHP appliances fitted with gas/air ratio controls, a clear statement on whether or not the gas/air ratio control settings are intended to be adjustable by the installer and/or a service operative. If the gas/air ratio control is to be adjustable then the adjustment method shall be described. Information shall include a CO_2 and/or O_2 value to be used for setting the gas/air ratio control. This value should be accompanied by the acceptable tolerances on the CO_2 and/or O_2 value. A maximum permitted value for CO should also be given.

9.2.1.4 Installation of the central heating circuit

– Information about the maximum water temperature in °C.

– An indication of the controls which can be used.

– The precautions to be taken to limit the level of operating noise of the installation (if required).

– For sealed systems, instructions concerning the installation of a pressurized expansion vessel when the mCHP appliance is not originally fitted with such a device.

– Information on

  - either the characteristic curve of the water pressure head available at the mCHP appliance outlet connection if the mCHP appliance has an integral pump,
  - or the pressure loss as a function of water rate, in graphical or tabular form, for a mCHP appliance supplied without a pump.

– For mCHP appliances complying with 5.21.5.2, information that they shall only be installed with a central heating system with an open expansion vessel.

9.2.1.5 Installation of the combustion circuit

– Information about the type of installation for which the mCHP appliance is approved.

– The instruction that the mCHP appliance has to be installed with the necessary accessories (e.g. ducts, terminal, fitting piece) supplied with the mCHP appliance or give the specification of the necessary accessories that shall be fitted.

– The instruction for the installation of parts intended to be fitted to the mCHP appliance.

– 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.

– The particular characteristics of the terminal guard, where provision for this is made, and information on its installation relative to the terminal.

– The reaction to fire Class see 6.14.2.7.

– For type C_1 mCHP appliances:
  - the information if and how the terminal shall be placed on the wall and/or on the roof;
  - the instruction that the terminal outlets from separate ducts shall fit inside a square of 500 mm.

– For type C_3 mCHP appliances:
  - the instruction that the terminal outlets from separate ducts shall fit inside a square of 500 mm;
  - the instruction that the distance between the planes of the two orifices shall be at least 500 mm.

– For type C_4 mCHP appliances:
  - nominal working combustion products temperature and mass flow rate;
  - overheat combustion products temperature;
  - 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;
  - minimum combustion products temperature and mass flow rate at the minimum heat input with the maximum length of ducts, if necessary;
  - the characteristics of the common duct systems to which the mCHP appliance can be connected.

– For type C_5 mCHP appliances:
  - the instruction that the terminals for the supply of combustion air and for the evacuation of combustion products shall not be installed on opposite walls of the building.

– For type C_6 mCHP appliances:
  - nominal working combustion products temperature and mass flow rate;
  - overheat combustion products temperature;
  - minimum combustion products temperature and mass rate at the minimum heat input;
  - maximum allowable draught and maximum allowable pressure difference between combustion air inlet and flue gas outlet (including wind pressures);
  - instruction that the mCHP appliance shall only be installed with a terminal that complies with the requirements of EN 1856-1;
  - 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.

– For type C_8 mCHP appliances:
  - nominal working combustion products temperature and mass flow rate;
  - overheat combustion products temperature;
  - minimum combustion products temperature and mass rate at the minimum heat input;
  - the characteristics of the chimney to which the mCHP appliance can be connected.

– For type C_9 mCHP appliances:
  - the minimum usable diameter / cross section area of the vertical duct supplying the combustion air shall be specified.

9.2.1.6 Electrical installation

– The information to consider certain standards and/or particular (national/regional) regulations, if these prove to be necessary for the correct installation with the electrical grid.

– The obligation to earth mCHP appliances incorporating mains supplied electrical equipment.

– A circuit diagram with terminals (including those for external control).

9.2.2 Supplementary marking and instructions in the case of mCHP appliance to be installed in partially protected places

9.2.2.1 General information

For mCHP appliance intended to be installed in a partially protected place the installation instructions shall specify , the minimum and maximum ambient temperatures at which the mCHP appliance is designed to operate.

9.2.2.2 Warning on the mCHP appliance and the packaging

Additional to the existing requirements of 9.1.4 the information shall be added that the mCHP appliance is intended to be installed in a partially protected place.

9.2.2.3 Technical instructions

Additional to the existing requirements of 9.2 more information shall be added concerning the installation in a partially protected place. All necessary instructions and requirements for a correct installation location, including exterior pipe work, shall be specified.

The frost protection system, if any, shall be described in general terms in the technical instructions for the installer. It shall be included in the technical instructions for the installer that materials used in the installation of the mCHP appliance should be such as to maintain their function within the declared installation temperatures (see 9.2.2.1).

9.3 Operating instructions (i.e. users' instructions)

Each mCHP appliance shall be accompanied by instructions intended for the user. They shall include the necessary information on using and maintaining the mCHP appliance and incorporate at least the following:

– point out that a competent person should be called on to install, convert and adjust the mCHP appliance where appropriate;

– specify the operations to start-up, turn off and shut down the mCHP appliance;

– specify that it is necessary to abide by the warnings;

– explain the operations necessary for normal operation, cleaning and day-today maintenance of the mCHP appliance;

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

– warn against incorrect use;

– forcibly warn against any interference with a sealed component (if applicable);

– point out that the mCHP appliance should be checked and maintained periodically by a competent person.

9.4 Conversion instructions

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

The instructions shall

- specify the parts and/or procedures 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 (if applicable),
- describe procedures necessary for conversion (if applicable),
- specify that any broken seals shall be re-made and/or any adjusters shall be sealed,
- state that for a mCHP appliance operating with a pressure couple, any gas pressure 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 mCHP appliance shall be supplied with the parts and the conversion instructions. It shall be possible to state on this label the marking specified in 9.1.2 for which the mCHP appliance has been adapted, indicating

- the gas group or range,
- the gas type,
- the gas supply pressure and/or the pressure couple.

9.5 Presentation

All the information of 9.1, 9.2, 9.3 and 9.4 shall be given in the language(s) and in accordance with the practice of the country(ies) in which the mCHP appliance is intended to be installed.

Annex A
(informative)

Different gas connections in common use in the various countries

Different gas connections in common use in the various countries are given in Table A.1.

Table A.1 – Gas connections conditions in common use in the various countries

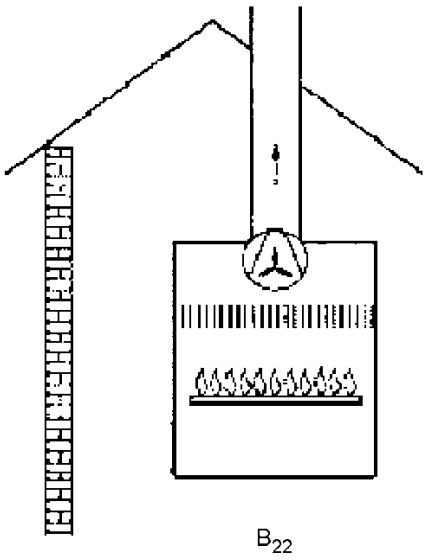
	Category I_3						Other categories				
Country code	Threaded connections		Plain connections	Compression joints	Other connections in …	Flanges	Threaded connections		Plain connections	Compression joints	Flanges
	ISO 7-1 [a]	EN ISO 228-1	EN 1057			ISO 7005-1	ISO 7-1 [a]	EN ISO 228-1	EN 1057		ISO 7005-1
AT	Yes				Yes		Yes				
BE	Yes			Yes	Yes		Yes				
CH					Yes		Yes				
DE	Yes	Yes			Yes		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											
PT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SE											

[a] Tapered male threads and parallel female threads.

Annex B
(informative)

Classification of type B and type C mCHP appliances

The figures in this annex are purely illustrations; they are intended to be neither technically perfect nor complete in themselves. The figures are based on CEN/TR 1749.



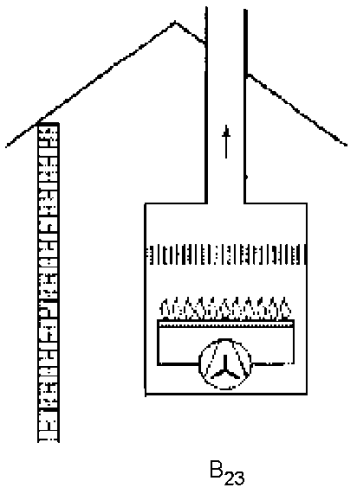


Figure B.1 – Type B_2

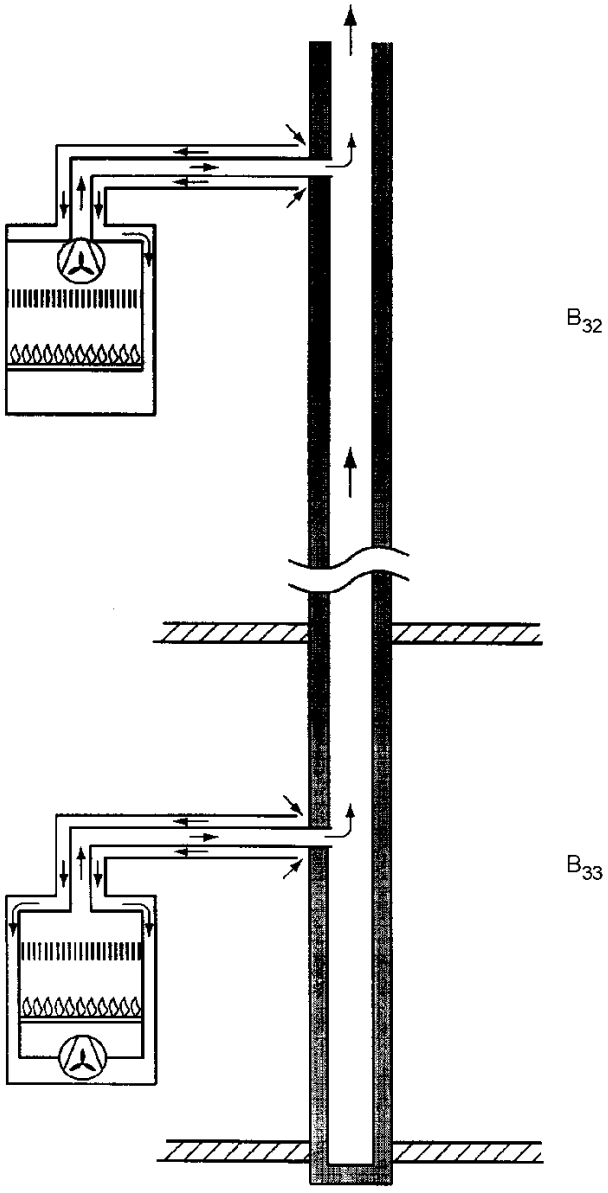
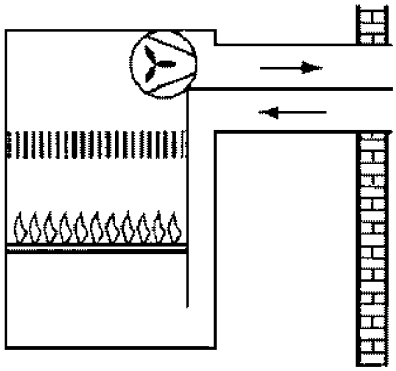
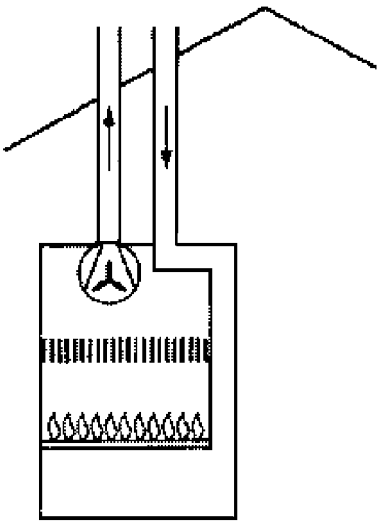


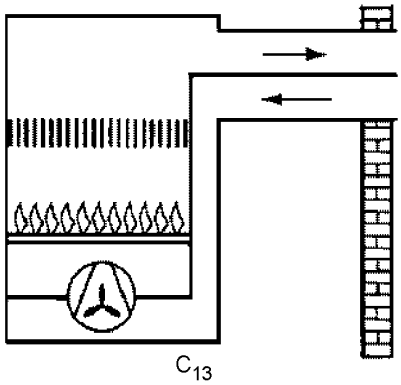
Figure B.2 – Type B_3



C_{12}



C_{32}



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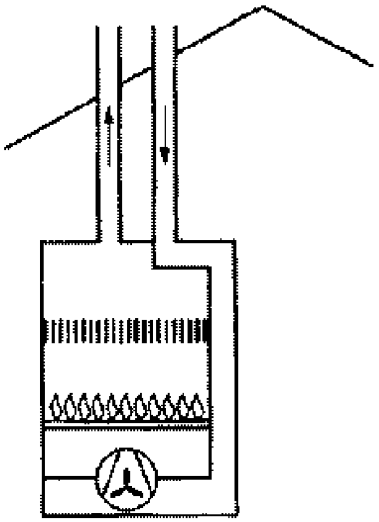
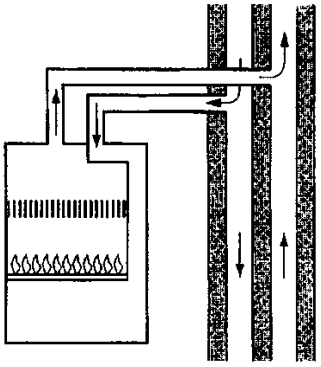


C_{33}

Figure B.3 – Type C_1

Figure B.4 – Type C_3



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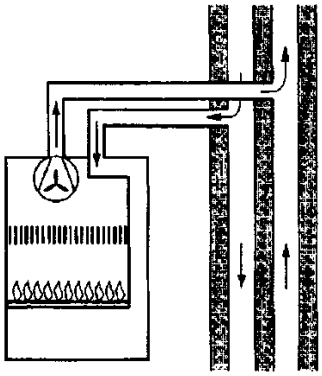
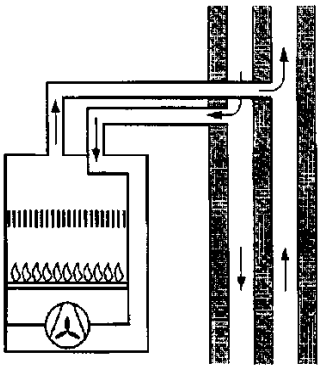
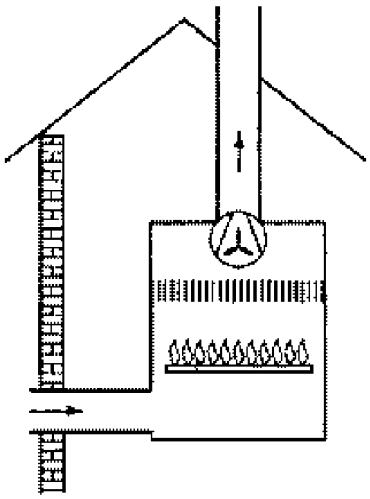


C_{42}

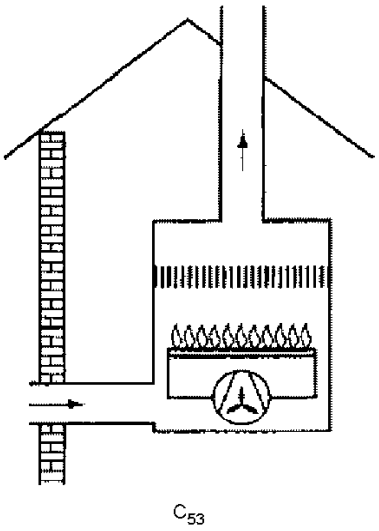


C_{43}

Figure B.5 – Type C_4

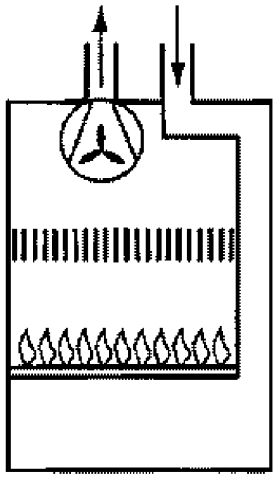


C_{52}

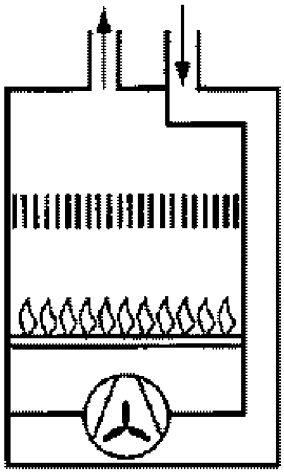


C_{53}

Figure B.6 – Type C_5

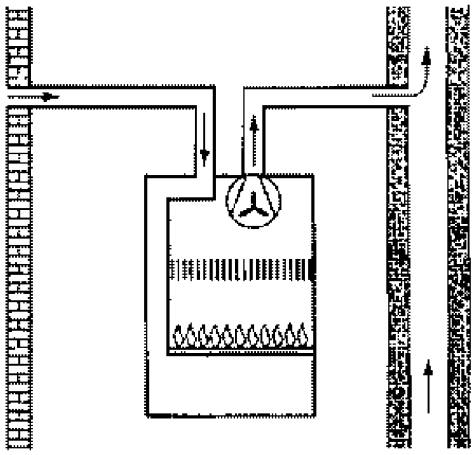


C_{62}

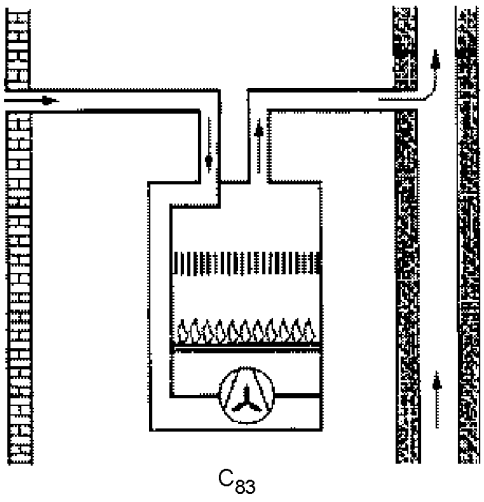


C_{63}

Figure B.7 – Type C_6

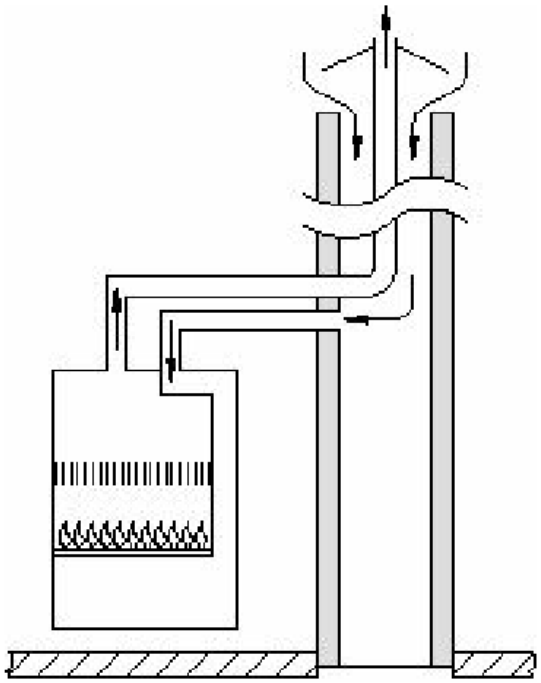


C_{82}

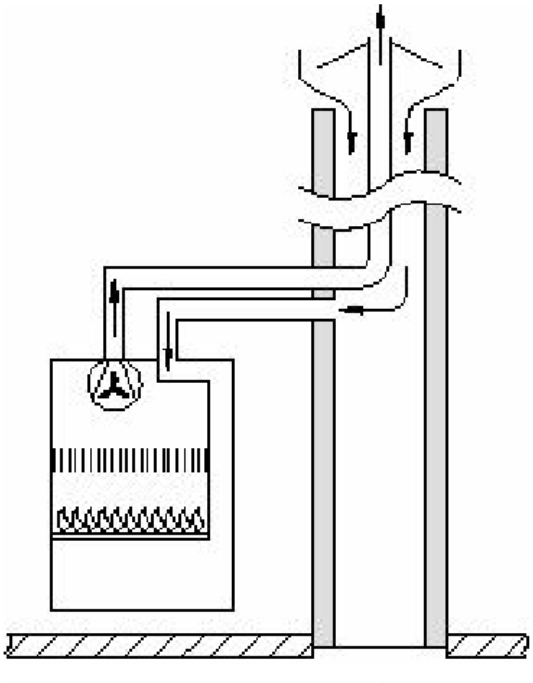


C_{83}

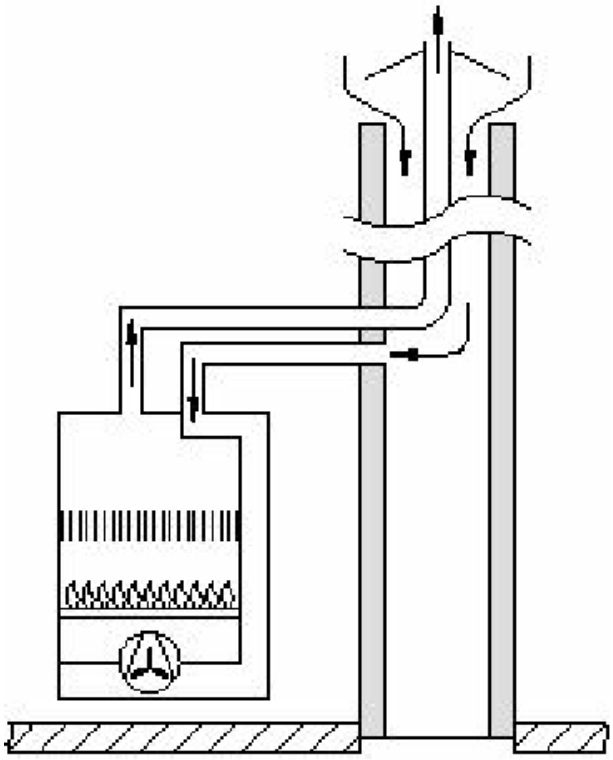
Figure B.8 – Type C_8



C_{91}



C_{92}



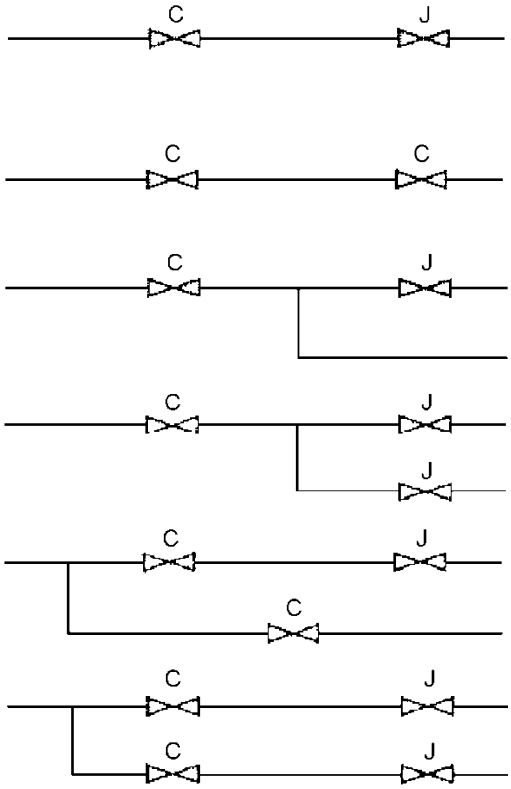
C_{93}

Figure B.9 – Type C_9

Annex C
(informative)

Composition of the gas circuit

C.1 Minimum requirements for mCHP unit with fan, with ignition burner or pre-purge



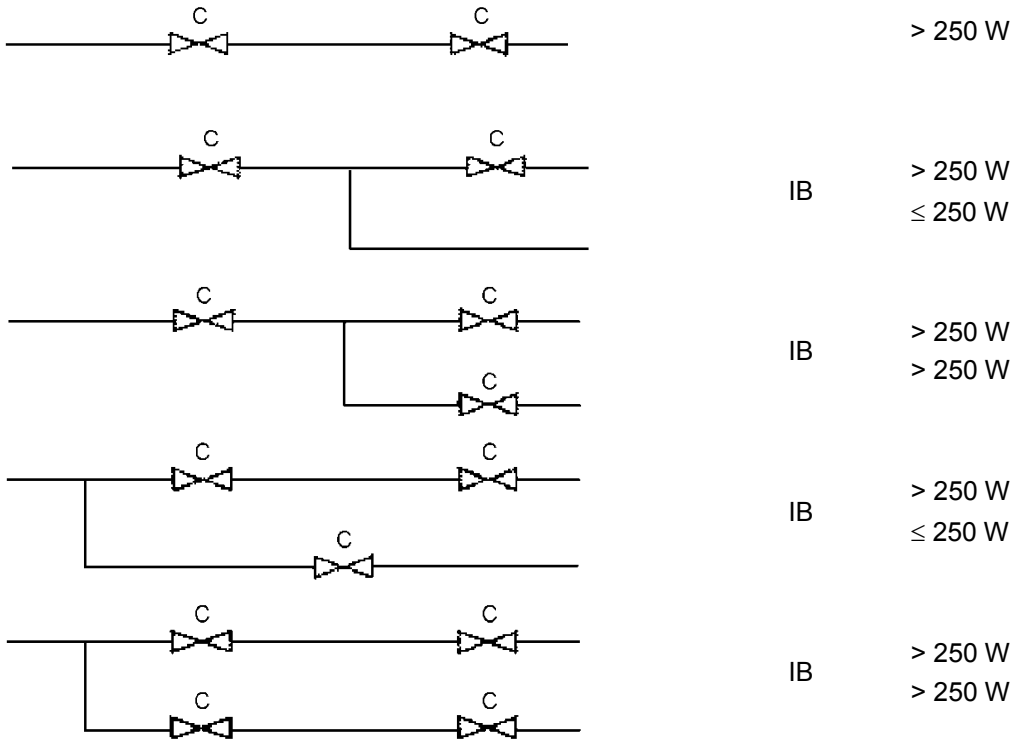
	> 250 W	Simultaneous closure
	> 250 W	No simultaneous closure
IB	> 250 W ≤ 250 W	No simultaneous closure
IB	> 250 W > 250 W	
IB	> 250 W ≤ 250 W	
IB	> 250 W > 250 W	

Key
IB ignition burner
C and J valve classification according to EN 161

Figure C.1 – Automatic gas shut off valves in the gas supply line for mCHP appliances

C.2 Minimum requirements for mCHP units with fan, without permanent or alternating ignition burner and without pre-purge

Two class C gas valves in line may be replaced by one class B and one class J valve. Gas valves placed in line shall close simultaneously. All valve classification are according to EN 161.



Key
IB ignition burner
C and J valve classification according to EN 161

Figure C.2 – Automatic gas shut off valves in the gas supply line for permanent or alternating mCHP appliances

Annex D
(informative)

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

Substitute for the mCHP appliance (1) (see Figure I.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 shall be connected to mains supply via a continuously variable transformer and a Watt-hour meter. Adjust the transformer so that the temperature of the circulating water reaches equilibrium (this may take 4 h or more). Note the ambient temperature and measure the heat input. A series of tests at different temperatures will give the test rig heat losses over various temperature rises above ambient.

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

Annex E
(informative)

A-deviations

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

This European Standard does not fall under any Directive of the EU.

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.

Clause	Deviation
6	**Switzerland**
	In deviation to the requirements of Clause 6 the limit values for the energy requirements (flue losses, standby losses) and for the emission of CO and NO_x of the Swiss law (Luftreinhalte-Verordnung, LRV) of 1985-12-16 (state from 1992-01-01) are applicable.

_____

Annex F
(informative)

Main symbols and abbreviations used

Table F.1 – Main symbols and abbreviations used

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 gas rate under test conditions		V
Volumetric gas 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_l
Useful heat output		P_{th}
Nominal heat output		P_{th_n}
Electric output		P_{el}
Nominal electric power output		P_{el_n}
Overall efficiency		η_{CHP}
Ignition safety time		T_{SA}
Maximum ignition safety time		$T_{SA,max}$
Extinction safety time		T_{SE}

Annex G
(informative)

Examples for marking

G.1 Data-plate (see 9.1.1)

Table G.1 – Category(ies), direct and indirect country(ies) of destination

II_{2H3P}	$II_{2H3B/P}$	$II_{2L3B/P}$	$II_{2ELL3B/P}$	$III_{1c2E+3+}$	$III_{1ac2H3+}$
GB	CH	NL	DE	FR	ES

G.2 Additional data-plate (see 9.1.2)

Table G.2 – Example 1: Possibilities for the second gas family

CH – DE – ES – FR	
2H – 2E 2E+	G 20 – 20 mbar G 20/G 25 - 20/25 mbar

NL	
2L	G 25 – 25 mbar

DE – FR	
2E 2E+	G 20 – 20 mbar G 20/G 25 - 20/25 mbar

DE	
2LL	G 25 – 20 mbar

CH – ES – GB	
2H	G 20 – 20 mbar

FR	
2E+	G 20/G 25 20/25 mbar

Table G.3 – Example 2: Possibilities for the third gas family

CH – DE	
3B/P	G 30/G 31 50 mbar

NL	
3B/P	G 30/G 31 30 mbar

Annex H
(informative)

Calculation of conversions of NO_x

Table H.1 – Conversion of the emission value of NO_x for second family gases

1 ppm = 2,054 mg/m³		G 20		G 25	
(1 ppm = 1 cm³/m³)		mg/kWh	mg/MJ	mg/kWh	mg/MJ
O_2 = 0 %	1 ppm = 1 mg/m³ =	1,764 0,859	0,490 0,239	1,797 0,875	0,499 0,243
O_2 = 3 %	1 ppm = 1 mg/m³ =	2,059 1,002	0,572 0,278	2,098 1,021	0,583 0,284

Table H.2 – Conversion of the emission value of NOx for third family gases

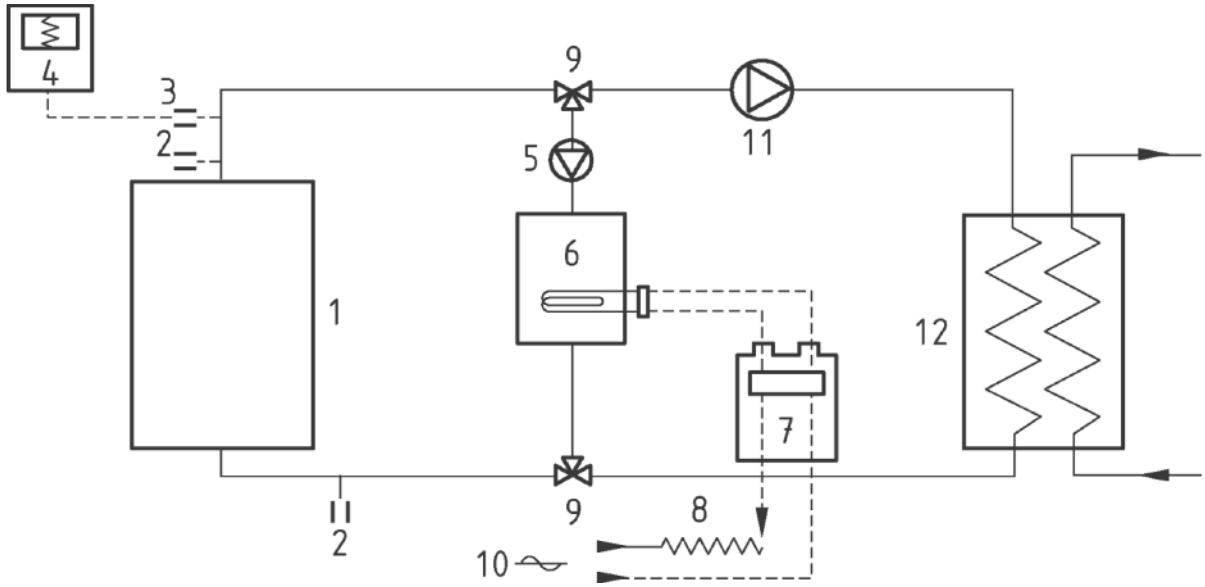
1 ppm = 2,054 mg/m³		G 30		G 31	
(1 ppm = 1 cm³/m³)		mg/kWh	mg/MJ	mg/kWh	mg/MJ
O_2 = 0 %	1 ppm = 1 mg/m³ =	1,792 0,872	0,498 0,242	1,778 0,866	0,494 0,240
O_2 = 3 %	1 ppm = 1 mg/m³ =	2,091 1,018	0,581 0,283	2,075 1,010	0,576 0,281

Annex I
(informative)

Test rig for the measurement of the stand-by heat losses

I.1 Test rig for the measurement of the stand-by heat losses

The mCHP appliance is fitted to the test rig as shown in Figure I.1 and the flow and return pipes are connected directly.



Key

1 mCHP appliance under test
2 temperature probe
3 low inertia thermocouple
4 recorder
5 pump with a rate such that the temperature difference is between 2 K and 4 K at the maximum test temperature
6 auxiliary electric mCHP appliance
7 device for measuring the electric power
8 voltage regulator
9 1/4 Turn valves
10 electrical supply
11 additional pump (if necessary)
12 cooling system on principle of exchange or mixing

Figure I.1 – Test rig

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

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

The values (T - T_A) are measured in the steady state.

The measured value is expressed in watts (W), as a function of the value of (T - T_A), expressed in Kelvin (K).

The measured value 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).

I.2 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 mCHP appliance is fitted to the test rig as shown in Figure I.1 and the flow and return pipes are connected directly.

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

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

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

a) without electrical contribution from the mCHP appliance (6);

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

(T - T_A) of (40 ± 5) K,

c) with an electrical contribution from the mCHP appliance (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 mCHP appliance 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 Kelvin (K).

It can be considered to be a straight line.

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

Annex CC
(normative)

Test methods to determine the effects of long-term thermal load, long-term condensate exposure, condensing/ non- condensing cycling and resistance to UV radiation

Methods to determine the change in properties before and after exposure:

a) impact strength in accordance with EN ISO 179-1 (un-notched test bars, Charpy impact strength);

b) if execution meets with problems, the impact strength may be determined in accordance with EN ISO 8256 (un-notched test bars, tensile-impact strength);

c) tensile modulus in accordance with EN ISO 527-1 and EN ISO 527-2;

d) yield stress in accordance with EN ISO 527-1 and EN ISO 527-2;

e) density in accordance with EN ISO 1183 (all parts);

f) in the case of thermosetting plastics:

   1) flexural modulus and flexural strength in accordance with EN ISO 178;

g) in the case of flexible pipes:

   1) impact strength, tensile modulus and yield stress shall be carried out on rigid test pieces, manufactured as close as possible to the original manufacturing process;

   2) ring stiffness in accordance with EN ISO 9969.

NOTE Deterioration of mechanical properties of plastics is often caused by surface attack. Miniature cracks at the surface may result in brittling of the material. This notching effect shows best under a rapid flexural load.

Any changes in tensile modulus and yield stress are relatively easy to determine and give an indication of all kinds of attack.

Any changes in volume (e.g. shrinking) shall be minor. In the case of a flexible tube ribs, if any, are essential to its flexibility and ring stiffness. At too high temperatures any residual strains may cause ribs to disappear (shrinking).

Annex DD
(informative)

Variations in gas quality

DD.1 Introduction

The scope of this standard specifies:

This European Standard does not cover all the requirements for appliances that are intended to be connected to gas grids where the quality of the distributed gas is likely to vary to a large extent over the lifetime of the appliance.

The purpose of this annex is to explain the background of this limitation of the scope, and which aspects should be considered if appliances are intended to be connected to gas grids where the quality of the distributed gas is likely to vary to a large extent.

This European Standard for mCHP appliances is the result of the introduction of the GAD in the EU. In the pre-GAD period many countries had national certification procedures. The national procedures had in common that:

a) A reference gas is defined that can be used for tests to be performed at “the normal distribution conditions”.

b) The limit gases (of EN 437) are extreme gases intended specially for the judgment of the quality of the combustion and the smooth ignition of an appliance.

The relation between the (extreme) limit gases (ELG) and the actual nationally defined “normal variations of the distribution gases” has always been considered a matter for the member states to decide.

The approach that the reference gas is the realistic representation of the “normal distribution gases” has been assumed in the current standard and has its history in the national standards used in the pre-gad period.

Figure DD.1 schematically shows the relation between the reference gas (RG), the (extreme) limit gases (ELG) and the “normal distribution gases” (NDG) and the safety margin required to make sure that testing to this standard results in a safe use of the appliance in combination with the “normal distribution gases”. This safety margin is necessary to ensure safe use of the appliance during its life cycle. This safety margin accommodates:

1) wear and tear,

2) the tolerance of the nominal load of the appliance (see 6.3.1),

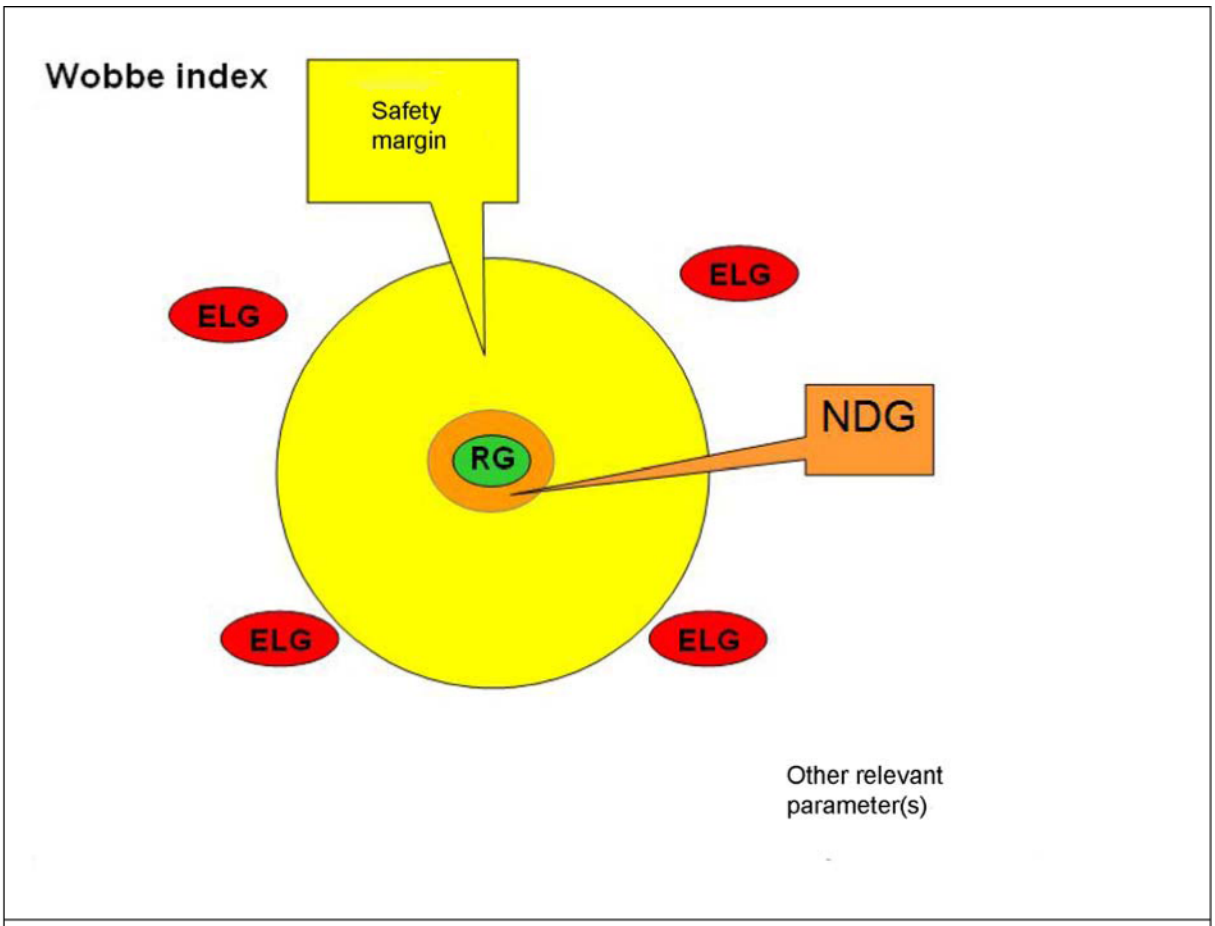
3) the variation of the gas and combustion air temperature, humidity, and atmospheric pressure.

4) the tolerances resulting from adjustment procedure for the appliance using the normally distributed gas.

However the boundary between the normal distribution gases and the safety margin is not clearly defined on a European level. Some member states may have clear specifications for that, other may not.

In spite of possible different safety margins in different countries, it is clear that the (extreme) limit gases of the EN 437 (the ELG) are not to be construed as “the limits of the normally distributed gases”. The standard is written with Figure DD.1 in mind.

mCHP appliances have to specify on the data plate the gas the appliance is intended for. It is common practice to specify the reference gas the appliance is set for. For example G20 or G25. However it is understood that small variations around this reference gas are acceptable as NDG without making the appliance unsafe.



The relation between the (extreme) limit gases (ELG), the reference gas (RG), and the normal distribution gas (NGD) the appliance is designed for. The current standard assumes that the normal distribution is close to the reference gas.

Figure DD.1

DD.2 Considerations if mCHP appliances are intend to be used with larger variations in the gas quality.

DD.2.1 Specification of the acceptable variations

The acceptable variations should be specified. How to specify the variation is not standardized yet. One of the options would be to specify the range of normal variations in:

- The Wobbe Index
- A parameter characterizing flame stability, using the laminar burning velocity at a relevant gas/air ratio
- The fraction of higher hydrocarbons, for example expressed as an (equivalent) propane content
- The H_2 content
- The CO_2 content
- The methane number
- The supply pressure of the appliance
- Etc.

For clarity there could be two types of range specified, which have different meanings:

1) The range around a set value: This is the range of gases that the mCHP appliance is capable of using as “normal distribution gas” without adjusting the appliance.

2) A range of settings: There may be more settings possible for a mCHP appliance. Each setting will result in its own range around a set value, which could be used as “normal distribution gas” without further adjusting the appliance.

DD.2.2 Impact of the claimed range around a set value for the normal distributed gases

In this European Standard it is assumed that the reference gas is a good representation of the gases the appliance may encounter during its lifetime. However, if the manufacturer claims that the appliance is capable of using a larger range of normal distribution gases without adjusting the mCHP appliance, this is no longer a correct assumption. In that case, it has to be ensured that the appliance can operate safely over the whole range of normal distribution gases that the appliance claims to be suitable for without adjusting the appliance.

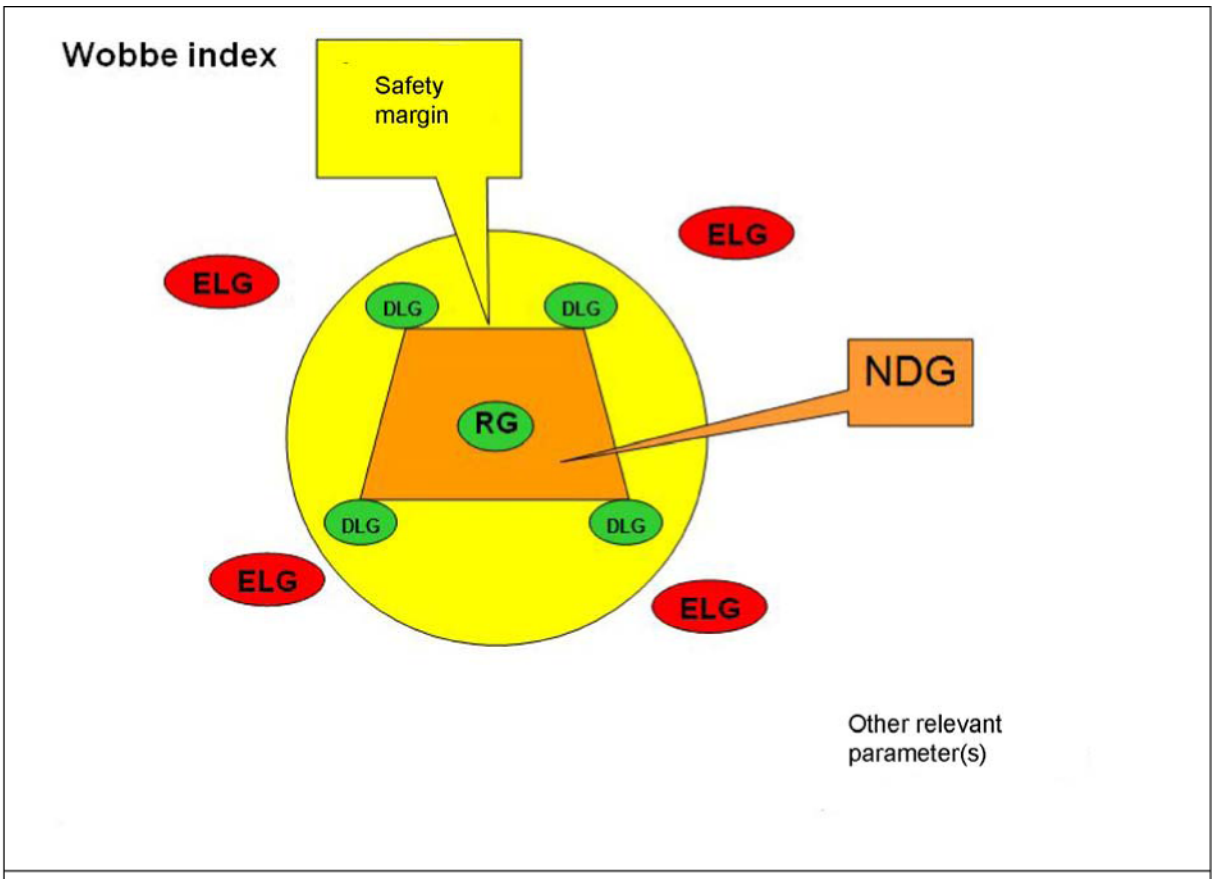
One method of assuring this will be:

a) To define normal distribution limit gases (DLG) that are good representation of the limits that the appliance may encounter during its lifetime. (See Fig DD.2).

b) Based on the DLG decide on the ELG’s (See also par DD.2.4).

c) For each test in this European Standard using the reference gas, it should be decided whether it is necessary to additionally perform the same test using one or more of the DLG gases.

d) If more than one setting is possible (there is a range of settings) the process should be repeated for each setting.



The relation between the (extreme) limit gases (ELG), the reference gas (RG), the distribution limit gases (DLG), and the normal distribution gas (NGD) the appliance is designed for. The DLG are to be considered if the normal distribution gas may vary to a large extent over the lifetime of the appliance.

Figure DD.2

DD.2.3 Impact of the declared values

Some performance requirements and declarations (like efficiency, NO_X levels and CO levels) depend on the gas quality**.** At the time of publication of this Standard it is not clear what performance value should be declared:

- The value if the mCHP appliance is supplied with the reference gas.
- The value that will be obtained over the whole range of the gases the appliance is designed for.

The declaration of the manufacturer shall at least make clear what value is declared. The practice current at the time of publication of this Standard is to only declare the performance using the reference gas.

DD.2.4 Relation between the RG, the DLG and the ELG

The presumption of this European Standard is that the normally distributed gas has a more or less constant quality. In other words, it is assumed that the whole range of the normal distributed gases can be represented with only one DLG, the reference gas (RG).

Some aspects are considered to be in the safety margin between the DLG and the ELG. If the gas quality can vary to a larger extent, it shall be ensured that the safety margin between the DLG and the ELG is sufficient. Aspects at least to be considered:

a) The nominal load of the appliance. According to 6.3.1 the nominal load of the mCHP appliance may vary within production tolerances between -5 % and +5 %. In this European Standard it is assumed

that the impact of this variation is included in the safety margin. If the variation of the gas quality increases, it should be verified that the safety margin is still adequate.

b) The variation of the gas and combustion air temperature humidity and atmospheric pressure. All tests are performed under laboratory conditions. In this European Standard it is assumed that the variation -which will occur in the field where the mCHP appliance is used - is included in the safety margin. If the variation of the normally distributed gas quality increases, it should be verified that the safety margin is still adequate.

c) Wear and Tear. In this European Standard it is assumed that normal wear and tear is included in the safety margin. If the variation of the normally distributed gas quality increases, it should be verified that the safety margin is still adequate. Special attention should be given to fouling of the burner and the heat exchanger that may occur in the period between normal maintenance intervals.

d) If there is an adjustment procedure for the appliance using the normal distributed gas, the impact of gas quality variations on this procedure should be investigated. For example, if the appliance is set on a “low Wobbe index day” what will be the result on a “High Wobbe index day”? Relevant is whether the gas company makes the actual value of the Wobbe index available to the user/installer for adjustment purposes or not.

NOTE The impression is that a safety margins in the Wobbe index of about 5 % to 9 % between ELGs and the DLGs could cover the 4 aspects. However, this will depend on climate conditions and the design of the appliance. There are no public research reports available to verify this impression.

DD.2.5 Self adapting appliances

An appliance may have an active mechanism adapting to the gas quality. From a technical point of view there is always a maximum speed of variation this mechanism can follow.

This maximum speed should be specified.

Annex EE
(informative)

Calculation of the efficiency for ErP

EE.1 Introduction

This European Standard describes in 7.6.2 how to calculate the seasonal space heating energy efficiency of a mCHP appliance for use in ErP Ecodesign and Energy Labelling Lot 1, Eco-design Directive (2009/125/EC) and Energy labelling directive (2010/30/EC). This annex explains the backgrounds of the calculation method.

The objective of ErP Lot 1 is to provide comparable information on the specific energy consumption of heat generators, which should influence the end-user's choice in favour of those products which consume or indirectly result in consuming less energy. The information is given in the form of a seasonal space heating efficiency value and a label class.

Because a mCHP appliance generates not only heat, but also electicity, its seasonal space heating energy efficiency has been calculated in such a way that this can be compared with the heating efficiency of other heat generators, not producing electricity. The calculation gives the equivalent heating efficiency, producing equal efficiency values for equal energy savings. This efficiency – being a relative value – relates to the same energy output as for other heat generators, i.e. the heat output. This is a basic requirement for comparability.

The equivalent heating efficiency is calculated as the heating efficiency of an appliance which only produces heat, combined with power from the power plant, and gives an equal primary energy consumption for the same total output as the mCHP appliance produces.

EE.2 Calculation approach

The energy outputs and primary energy inputs of a mCHP appliance and a heating-only appliance combined with power from the power plant are shown in Table EE.1.

Table EE.1 – Energy outputs and primary energy inputs.

	mCHP	Heating-only to be combined with power plant
Thermal output	P	
Electrical output	$\frac{P}{\eta_{thermal}} * \eta_{el}$	
Primary input heater	$\frac{P}{\eta_{thermal}}$	$\frac{P}{\eta_{equiv.heating}}$
Additional primary input for electricity	0	$2{,}5 * \frac{P}{\eta_{thermal}} * \eta_{el}$
Total primary energy consumption	$\frac{P}{\eta_{thermal}}$	$\frac{P}{\eta_{equiv.heating}} + 2{,}5 * \frac{P}{\eta_{thermal}} * \eta_{el}$

NOTE In this table the conversion coefficient (CC) value of 2,5 from the 2012 ErP documents is taken; this can be generalized to the parameter CC for future use.

The calculation formula for the equivalent heating efficiency is derived by equating the total primary energy consumptions from the table:

$$\frac{P}{\eta_{thermal}} = \frac{P}{\eta_{equiv.heating}} + CC * \frac{P}{\eta_{thermal}} * \eta_{el} \Leftrightarrow$$

$$\frac{1}{\eta_{equiv.heating}} = \frac{1}{\eta_{thermal}} - CC * \frac{1}{\eta_{thermal}} * \eta_{el} = \frac{1 - CC * \eta_{el}}{\eta_{thermal}} \Leftrightarrow$$

$$\eta_{equiv.heating} = \frac{\eta_{thermal}}{1 - CC * \eta_{el}}$$

EE.3 Asymptote and approximation

In the formula for the equivalent heating efficiency an issue occurs when the electrical efficiency of the CHP approaches the grid efficiency 1/CC: the equivalent heating efficiency value goes to an infinite value. For even higher electrical CHP efficiencies the value turns discontinuously negative. An asymptote occurs at η_{el} = 1/CC.

Physically this is understandable: when the mCHP electrical efficiency is at grid efficiency, the heat is – energetically speaking – for free. And when the electrical efficiency is above grid efficiency, it is already energetically attractive to run the mCHP, even if the heat cannot be used.

But for labelling purposes infinite and negative values are undesired. To solve this issue a conservative approximation has been used for electrical efficiency values above 75 % of the grid efficiency value.

The original equivalent heating efficiency curve is followed until η_{el} = 0,75/CC. From this value upward the linear extrapolation of the curve for constant total efficiency η_{tot} is followed, see Figure EE.1.

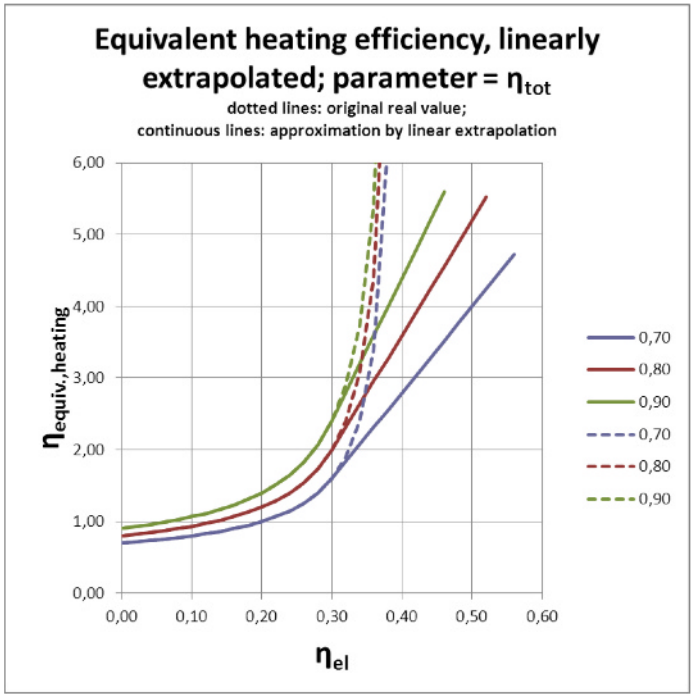


Figure EE.1 – Equivalent heating efficiency and linear extrapolation from η_{el}= 0,75/CC.

EE.4 Derivation of the linear extrapolation of the equivalent heating efficiency curve

The linear extrapolation formula can be derived in the following way.

The equivalent heating efficiency formula is:

$$\eta_{equiv,heating} = \frac{\eta_{thermal}}{1 - CC \cdot \eta_{el}} = \frac{\eta_{tot} - \eta_{el}}{1 - CC \cdot \eta_{el}}$$

The derivative of this formula with constant η_{tot} (so η_{tot} independent of η_{el}) is:

$$\frac{d\eta_{equiv,heating}}{d\eta_{el}} = \frac{(1 - CC.\eta_{el}) \cdot (-1) - (\eta_{tot} - \eta_{el}) \cdot (-CC)}{(1 - CC \cdot \eta_{el})^2} = \frac{CC \cdot \eta_{tot} - 1}{(1 - CC \cdot \eta_{el})^2}$$

The tangent line departing from the footpoint $\eta_{el,foot}$ is given by:

$$\eta_{equiv,heating,tangent} = \frac{\eta_{tot} - \eta_{el,foot}}{1 - CC \cdot \eta_{el,foot}} + \frac{CC \cdot \eta_{tot} - 1}{\left(1 - CC \cdot \eta_{el,foot}\right)^2} \cdot (\eta_{el} - \eta_{el,foot})$$

When the $\eta_{el,foot}$ is chosen as a fraction of 1/CC, in our case $\eta_{el,foot} = \frac{0,75}{CC}$, then the tangent line formula turns to:

$$\eta_{equiv,heating,tangent} = \frac{\eta_{tot} - \frac{0,75}{CC}}{1 - CC \cdot \frac{0,75}{CC}} + \frac{CC \cdot \eta_{tot} - 1}{\left(1 - CC \cdot \frac{0,75}{CC}\right)^2} \cdot \left(\eta_{el} - \frac{0,75}{CC}\right) =$$

$$= \frac{\eta_{tot} - \frac{0,75}{CC}}{0,25} + \frac{CC \cdot \eta_{tot} - 1}{0,25^2} \cdot \left(\eta_{el} - \frac{0,75}{CC}\right)$$

For CC = 2,5 so $\eta_{el,foot}$ = 0,75/2,5 = 0,30, this produces:

$$\eta_{equiv,heating,tangent} = 4 \cdot \eta_{tot} - 1,2 + (40 \cdot \eta_{tot} - 16) \cdot (\eta_{el} - 0,3)$$

Annex ZZ
(informative)

Coverage of Essential Requirements of EU Directives

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and supports essential requirements of EU Directive 2009/142/EC (Gas Appliances Directive (GAD)).

The following clauses of this European Standard are likely to support requirements of the Gas Appliance Directive.

Compliance with these clauses of this European Standard provides one means of conformity with the specified essential requirements of the Directive concerned and associated EFTA regulations.

Table ZZ.1 – Clauses of this European Standard addressing essential requirements or other provisions of EC Directives

GAD Annex I Clause	Essential requirement (Annex I of the Gas Appliance Directive)	Relevant clauses in this Standard
1	**GENERAL CONDITIONS**	
1.1	design and construction	1, 5
1.2	marking and instructions installation instructions user´s instructions warning notices on appliance warning notices on packaging official language	9.1 9.2 9.3 9.1.5 9.1.4, 9.1.5 9.5
1.2.1	instructions installer contain: type of gas gas supply pressure flow of fresh air for combustion supply danger unburned gas (3.2.3) dispersal combustion products forced draught burners	 9.2.1 9.2.1 9.2.1 9.2.1 n/a 9.2.1 n/a
1.2.2	instructions user contain: all instructions restrictions on use	 9.3 9.3
1.2.3	warning notices with type of gas gas supply pressure restrictions	 9.2, 9.3 9.2, 9.3 9.2, 9.3
1.3	fittings: instructions	 n/a

Table ZZ.1 – Clauses of this European Standard addressing essential requirements or other provisions of EC Directives *(continued)*

GAD Annex I Clause	Essential Requirement (Annex I of the Gas Appliance Directive)	Relevant clauses in this Standard
2	**MATERIAL**	
2.1	appropriate for their purpose	5.1, 5.3.3, 5.4.1, 5.13, 5.14, 5.16, 5.18, 5.19.2, 5.21.1
2.2	properties of the materials	5.1, 5.3.3, 5.4.1, 5.13, 5.14, 5.16, 5.18, 5.19.2, 5.21.1
3	**DESIGN AND CONSTRUCTION**	
3.1	General	
3.1.1	safety of construction	5.1, 5.13, 5.17
3.1.2	condensation	5.5.3, 5.7, 5.17.4, 5.18.1, 5.18.2, 5.18.3, 6.8.3
3.1.3	risk of explosion at event of external fire	5.4
3.1.4	water/air penetration in gas circuit	5.4, 5.19
3.1.5	normal fluctuation of auxiliary energy	5.21.3, 6.5.1, 7.8.1.3.8, 8
3.1.6	abnormal fluctuation or failure of auxiliary energy	5.10, 6.5.1
3.1.7	hazards of electrical origin	8.1 and 8.2
3.1.8	pressurised parts	6.9
3.1.9	failure of devices gas circuit automatic shut-off valves flame supervision device combustion products discharge safety device air proving device automatic burner control system thermostat/overheat protection gas pressure regulator multifunctional controls:	8.1 and 8.2 5.19 5.16, 5.19.4 6.4.3.2, 6.4.3.4 n/a 5.8, 6.5.4, 7.2.2.3.2, 7.5.4 5.21.4.2 6.4.2 5.21.2.4, 6.5.3 5.21
3.1.10	overruling safety devices	5.21
3.1.11	adjustment protection	5.21.2
3.1.12	clear marking of devices	5.19.3
3.2	unburned gas release	
3.2.1	risk of gas leakage	5.4
3.2.2	risk of gas accumulation - during ignition - during re-ignition - after extinction	 5.21.3.4, 5.21.4, 6.5.2 6.5.2 6.5.2
3.2.3	safety device fitted rooms with sufficient ventilation	 n/a

Table ZZ.1 – Clauses of this European Standard addressing essential requirements or other provisions of EC Directives *(continued)*

GAD Annex I Clause	Essential Requirement (Annex I of the Gas Appliance Directive)	Relevant clauses in this Standard
3.3	ignition - ignition - re-ignition - cross-lighting	 6.5.2 6.4.3 6.4.3
3.4	combustion	
3.4.1	flame stability unacceptable concentrations harmful to health	6.4.3
3.4.2	no accidental release of combustion products	5.4, 6.8.1
3.4.3	no release in dangerous quantity	5.4.2, 6.2.2
3.4.4	CO concentration	6.5.4.2, 6.5.4.3, 6.8
3.5	rational use of energy	6.6
3.6	temperatures	6.4.1
3.6.1	floor and adjacent walls	6.4.1
3.6.2	knobs and levers	6.4.1
3.6.3	external parts	6.4.1
3.7	foodstuffs and water used for sanitary purposes	5.13.1

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

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[4] EN 15502-1, *Gas-fired heating boilers - Part 1: General requirements and tests*

[5] EN 15502-2-1, *Gas-fired central heating boilers - Part 2-1: Specific standard for type C appliances and type B2, B3 and B5 appliances of a nominal heat input not exceeding 1 000 kW*

[6] IEC/TS 62282-1:2013, *Fuel cell technologies – Part 1: Terminology*

[7] ISO 3046 (all parts), *Reciprocating internal combustion engines - Performance*

[8] ISO 7005-1, *Pipe flanges - Part 1: Steel flanges for industrial and general service piping systems*

[9] *Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment*, OJ L 181, 9.7.1997, p. 1–55

[10] *Directive 2012/27/EC of the European Parliament and of the Council of 25 October 2012 on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending Directive 92/42/EEC*, OJ L 52, 21.2.2004, p. 50–60

[11] *Directive 2009/142/EC of the European Parliament and of the Council of 30 November 2009 relating to appliances burning gaseous fuels,* OJ L 330, 16.12.2009, p. 10–27

[12] *Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products (ErP)*

[13] *COMMISSION REGULATION (EU) No 813/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for space heaters and combination heaters*

[14] *Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings (EPBD)*

[15] *Directive 2010/30/EU of the European Parliament and of the Council of 19 May 2010 on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products*

[16] *COMMISSION DELEGATED REGULATION (EU) No 811/2013 of 18 February 2013 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to the energy labelling of space heaters, combination heaters, packages of space heater, temperature control and solar device and packages of combination heater, temperature control and solar device*

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