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Interested committees:

Title: Draft BS EN 16905-4 Gas-fired endothermic engine driven heat pumps. Part 4: Test methods.

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

English Version

Gas-fired endothermic engine driven heat pumps - Part 4: Test methods

Pompes à chaleur à moteur endothermique alimenté
au gaz - Partie 4 : Méthodes d'essai

Gasbefeuerte endothermische Motor-Wärmepumpen -
Teil 4: Prüfverfahren

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 299.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

This document (prEN 16905-4:2022) has been prepared by Technical Committee CEN/TC 299 “Gas-fired sorption appliances, indirect fired sorption appliances, gas-fired endothermic engine heat pumps and domestic gas-fired washing and drying appliances”, the secretariat of which is held by UNI.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 16905-4:2017.

In comparison with the previous edition, the following technical modifications have been made:

- Editorial and technical changes throughout the draft and in Annex ZA, ZB in order to align the text to the Ecodesign Requirements of Commission Regulation (EU) No 813/2013;
- Addition of Annex ZC in order to align the text to the Ecodesign Requirements of Commission Regulation (EU) No 2016/2281.

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

For relationship with EU Directive(s) / Regulation(s), see informative Annex ZA, ZB or ZC, which is an integral part of this document.

Introduction

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

Single split and multisplit systems are covered by this document.

The GEHP appliances can have one or more primary or secondary functions.

This document specifies the requirements, test methods and test conditions concerning, in particular, the construction, safety, fitness for purpose, and rational use of energy, for the rating and performance calculation of air conditioners and heat pumps using either air, water or brine as heat transfer media, with gas-fired endothermic engine driven compressors when used for space heating, cooling and refrigeration, hereafter referred to as “GEHP appliance”.

EN 16905 comprises the following parts under the general title, Gas-fired endothermic engine driven heat pumps:

- Part 1: Terms and definitions;
- Part 2: Safety;
- Part 3: Tests conditions;
- Part 4: Tests methods;
- Part 5: Calculation of seasonal performances in heating and cooling mode.

prEN 16905-4:2022 has been prepared to address the essential requirements of the European Regulation (EU) 2016/426 relating to appliances burning gaseous fuels and repealing Directive 2009/142/EC (see prEN 16905-4:2022, Annex ZA).

EN 16905-1:2017, prEN 16905-2:2021, EN 16905-3:2017, prEN 16905-4:2022 and prEN 16905-5:2021 are linked to the Energy Related Products Directive (2009/125/EC) in terms of tests conditions, tests methods and seasonal performances calculation methods under Mandate M/535; (see EN 16905- 3:2017, Annex ZA, prEN 16905-4:2022, Annex ZA, prEN 16905-5:2021, Annex ZA and prEN 16905-2:2021, Annexes ZB and ZC).

These documents will be reviewed whenever new mandates could apply.

1 Scope

This document specifies the requirements, test methods and test conditions for the rating and performance calculation of gas-fired endothermic engine driven heat pumps for heating and/or cooling mode including the engine heat recovery, to be used outdoor.

This document specifies the test conditions tests methods and seasonal performances calculation methods.

This document is to be used in conjunction with:

- a) the terms and conditions, EN 16905-1:2017
- b) the safety, prEN 16905-2:2021
- c) the test conditions, EN 16905-3:2017
- d) the calculation of seasonal performances in heating and cooling mode, prEN 16905-5:2021
- e) the heat pump standards, EN 14511-2:2018, EN 14511-3:2018 and EN 14825:2022.

This document only applies to appliances with a maximum heat input (based on net calorific value) not exceeding 70 kW at standard rating conditions.

This document only applies to appliances under categories I_{2H}, I_{2E}, I_{2Er}, I_{2R}, I_{2E(S)B}, I_{2L}, I_{2LL}, I_{2ELL}, I_{2E(R)B}, I_{2ESi}, I_{2E(R)}, I_{3P}, I_{3B}, I_{3B/P}, II_{2H3+}, II_{2Er3+}, II_{2H3B/P}, II_{2L3B/P}, II_{2E3B/P}, II_{2ELL3B/P}, II_{2L3P}, II_{2H3P}, II_{2E3P} and II_{2Er3P} according to EN 437:2021.

This document only applies to appliances having:

- a) gas fired endothermic engines under the control of fully automatic control systems;
- b) closed system refrigerant circuits in which the refrigerant does not come into direct contact with the fluid to be cooled or heated;
- c) where the temperature of the heat transfer fluid of the heating system (heating water circuit) does not exceed 105 °C during normal operation;
- d) where the maximum operating pressure in the:
 - 1) heating water circuit (if installed) does not exceed 6 bar;
 - 2) domestic hot water circuit (if installed) does not exceed 10 bar.

This document applies to GEHP appliances only when used for space heating or space cooling or for refrigeration, with or without heat recovery.

This document is applicable to GEHP appliances that are intended to be type tested. Requirements for GEHP appliances that are not type tested would need to be subject to further consideration.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 437:2021, *Test gases - Test pressures - Appliance categories*

EN 14511-3:2018, *Air conditioners, liquid chilling packages and heat pumps for space heating and cooling and process chillers, with electrically driven compressors - Part 3: Test methods*

EN 16905-1:2017, *Gas-fired endothermic engine driven heat pumps - Part 1: Terms and definitions*

prEN 16905-2:2021,¹ *Gas-fired endothermic engine driven heat pumps — Part 2: Safety*

EN 16905-3:2017, *Gas-fired endothermic engine driven heat pumps - Part 3: Test conditions*

prEN 16905-5:2021,² *Gas-fired endothermic engine driven heat pumps — Part 5: Calculation of seasonal performances in heating and cooling mode*

FprEN 12102-1:2022,³ *Air conditioners, liquid chilling packages, heat pumps, process chillers and dehumidifiers with electrically driven compressors - Determination of the sound power level - Part 1: Air conditioners, liquid chilling packages, heat pumps for space heating and cooling, dehumidifiers and process chillers*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 16905-1:2017 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at <https://www.iso.org/obp>

— IEC Electropedia: available at <http://www.electropedia.org/>

4 Test methods

4.1 General

A steady-state or transient or cyclical operation test could be applied for 100 % load tests or for reduced load tests.

The sound power level is measured in the standard rating conditions as given in EN 16905-3:2017 with the corresponding test methods according to FprEN 12102-1:2022 considering that this standard, dedicated to determination of the sound power level could be used with appliances covered in the scope of EN 16905-1:2017; prEN 16905-2:2021; EN 16905-3:2017 and prEN 16905-5:2021.

¹ Currently in preparation.

² Currently in preparation.

³ Currently in preparation.

4.2 Basic principles method of calculation for the determination of capacities

4.2.1 Capacity

4.2.1.1 Measured capacity

The measured cooling or heating capacity of air-to-air or water (brine)-to-air GEHP shall be determined by measurements in a calorimeter room (see Annex A) or by the air enthalpy method (see Annex B).

The measured cooling or heating capacity of air-to-water (brine) or water (brine)-to-water (brine) GEHP shall be determined in accordance with the water enthalpy method (see Annex D).

The measured heat recovery capacity of all GEHP shall be determined in accordance with the water enthalpy method (see Annex D).

4.2.1.2 Effective capacity

4.2.1.2.1 Effective cooling capacity

The effective cooling capacity is the measured cooling capacity corrected for the heat from the device (pump(s) or fan(s)) responsible for circulating the heat transfer medium through the indoor heat exchanger:

- a) if the fan(s) or pump(s) is (are) an integral part of the appliance, the capacity correction due to the device, $C_{\text{device-indoor}}$, calculated according to 4.2.4.3.3.1 or 4.2.4.4.2.1, which is excluded from the total power input shall be added to the cooling capacity (the correction is positive). The effective heating capacity shall be determined using the following formula:

$$Q_{Ec} = Q_c + Abs(C_{\text{device_indoor}}) \quad (1)$$

- b) if the fan(s) or pump(s) is (are) not an integral part of the appliance, the capacity correction due to the device, $C_{\text{device-indoor}}$, calculated according to 4.2.4.3.3.2 or 4.2.4.4.2.2, which is added to the total electrical power input shall be subtracted from the cooling capacity (the correction is negative). The effective cooling capacity shall be determined using the following formula:

$$Q_{Ec} = Q_c - Abs(C_{\text{device_indoor}}) \quad (2)$$

where:

Q_{Ec}	is the effective cooling capacity, in kilowatt;
Q_c	is the measured cooling capacity, in kilowatt;
$C_{\text{device_indoor}}$	is the capacity correction due to the device(s) (fan(s) or pump(s)) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatt.

4.2.1.2.2 Effective heating capacity

The effective heating capacity is the measured heating capacity corrected for the heat from the device (pump(s) or fan(s)) responsible for circulating the heat transfer medium through the indoor heat exchanger:

- a) if the fan(s) or pump(s) is (are) an integral part of the appliance, the capacity correction due to the device, $C_{\text{device_indoor}}$, calculated according to 4.2.4.3.3.1 or 4.2.4.4.2.1, which is excluded from the total electrical power input shall also be subtracted from the heating capacity (the correction is negative). The effective heating capacity shall be determined using the following formula:

$$Q_{Eh} = Q_h - Abs(C_{\text{device_indoor}}) \quad (3)$$

- b) if the fan(s) or pump(s) is (are) not an integral part of the appliance, the capacity correction due to the device, $C_{\text{device_indoor}}$, calculated according to 4.2.4.3.3.2 or 4.2.4.4.2.2, which is added to the total electrical power input shall be also added to the heating capacity (the correction is positive). The effective heating capacity shall be determined using the following formula:

$$Q_{Eh} = Q_h + Abs(C_{\text{device_indoor}}) \quad (4)$$

where

Q_{Eh}	is the effective heating capacity, in kilowatt;
Q_h	is the measured heating capacity, in kilowatt;
$C_{\text{device_indoor}}$	is the capacity correction due to the device(s) (fan(s) or pump(s)) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatt.

4.2.1.3 Rating capacity

4.2.1.3.1 Rating cooling capacity

The rating cooling capacity shall be determined using the following formula:

$$Q_{Rc} = Q_c \times \frac{Q_{grc}}{Q_{gmc}} \pm Abs(C_{\text{device_indoor}}) \quad (5)$$

where

Q_{Rc}	is the rating cooling capacity, in kilowatt;
Q_c	is the measured cooling capacity, in kilowatt;
Q_{grc}	is the rating gas heat input in cooling mode, in kilowatt;
Q_{gmc}	is the measured gas heat input in cooling mode, in kilowatt;
$C_{\text{device_indoor}}$	is the capacity correction due to the device(s) (fan(s) or pump(s)) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatt.

NOTE For more explanation about the capacity correction due to the device responsible for circulating the heat transfer medium through the indoor heat exchanger, see 4.2.1.2.1.

4.2.1.3.2 Rating heating capacity

The rating heating capacity shall be determined using the following formula:

$$Q_{Rh} = Q_h \times \frac{Q_{grh}}{Q_{gmh}} \pm Abs(C_{device_indoor}) \quad (6)$$

where

- Q_{Rh} is the rating heating capacity, in kilowatt;
- Q_h is the measured heating capacity, in kilowatt;
- Q_{grh} is the rating gas heat input in heating mode, in kilowatt;
- Q_{gmh} is the measured gas heat input in heating mode, in kilowatt;
- C_{device_indoor} is the capacity correction due to the device(s) (fan(s) or pump(s)) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatt.

NOTE For more explanation about the capacity correction due to the device responsible for circulating the heat transfer medium through the indoor heat exchanger, see 4.2.1.2.2.

4.2.2 Engine heat recovery capacity

4.2.2.1 Effective engine heat recovery capacity

The effective engine heat recovery capacity is the measured engine heat recovery capacity corrected for the heat from the device (pump(s)) of the engine heat recovery circuit (measured in any condition):

- a) if this (these) pump(s) is (are) an integral part of the appliance, the capacity correction due to the pump(s), C_{device_hr} , calculated according to 4.2.4.4.2.1 which is excluded from the total electrical power input shall be also subtracted from the engine heat recovery capacity (the correction is negative).
- b) if this(these) pump(s) is (are) not an integral part of the appliance, capacity correction due to the pump(s), C_{device_hr} , calculated according to 4.2.4.4.2.2, which is added to the total electrical power input shall be also added to the engine heat recovery capacity (the correction is positive).

The effective engine heat recovery capacity shall be determined using the following formula, which is applicable to either heating or cooling mode:

$$Q_{Ehr} = Q_{hr} \pm Abs(C_{device_hr}) \quad (7)$$

where

- Q_{Ehr} is the effective engine heat recovery capacity, in kilowatt;
- Q_{hr} is the measured engine heat recovery capacity, in kilowatt;
- C_{device_hr} is the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the engine heat recovery exchanger, in kilowatt.

4.2.2.2 Rating engine heat recovery capacity in cooling mode

The rating engine heat recovery capacity shall be determined using the following formula:

$$Q_{Rhrc} = Q_{hr} \times \frac{Q_{grhrc}}{Q_{gmhr}} \pm Abs(C_{device_hr}) \quad (8)$$

where

- Q_{Rhrc} is the rating engine heat recovery capacity in cooling mode, in kilowatt;
- Q_{hr} is the measured engine heat recovery capacity, in kilowatt;
- Q_{grhrc} is the rating engine heat recovery gas heat input in cooling mode, in kilowatt;
- Q_{gmhr} is the measured engine heat recovery gas heat input, in kilowatt;
- C_{device_hr} is the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger, in kilowatt.

NOTE 1 For more explanation about the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger, see 4.2.2.1.

NOTE 2 The rating heat recovery heat input in cooling mode is equal to the rating heat recovery heat input in heating mode.

4.2.2.3 Rating engine heat recovery capacity in heating mode

The rating engine heat recovery capacity shall be determined using the following formula:

$$Q_{Rhrh} = Q_{hr} \times \frac{Q_{grhrh}}{Q_{gmhr}} \pm Abs(C_{device_hr}) \quad (9)$$

where

- Q_{Rhrh} is the rating engine heat recovery capacity in heating mode, in kilowatt;
- Q_{hr} is the measured engine heat recovery capacity, in kilowatt;
- Q_{grhrh} is the rating engine heat recovery gas heat input in heating mode, in kilowatt;
- Q_{gmhr} is the measured engine heat recovery gas heat input, in kilowatt;
- C_{device_hr} is the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger, in kilowatt.

NOTE For more explanation about the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger, see 4.2.2.1.

4.2.3 Heat input

4.2.3.1 General conditions for operation of the gas-fired part of the appliance

Tests are carried out with the appropriate reference gas(es) for the category to which the appliance belongs (see EN 437:2021), supplied at the corresponding normal pressure indicated in EN 437:2021.

4.2.3.2 Measurement of heat inputs under test conditions

The appliance is installed as described in prEN 16905-2:2021 and adjusted as described in 4.2.4.1 and then operated at the heat input imposed by control system of the appliance. The heat input measurement is carried out when thermal “equilibrium” conditions have been achieved under the particular test conditions.

NOTE 1 It is important to note that the rating heating, cooling or heat recovery heat input is determined in accordance with the method given in prEN 16905-2:2021, but that the measured heat input achieved under particular test conditions is different and determined in a different way. This is described below.

Air pressure at inlet and outlet of the gas engine shall be balanced to avoid under/over pressure of the gas engine.

The heat input under the test conditions (Q_{gm}) in kilowatt is given by the formula:

$$Q_{gm} = 0,278 \cdot \frac{\sum_{j=1}^n (Mc_j * H_{iM(T)j})}{n} \quad (10)$$

or

$$Q_{gm} = 0,278 \cdot \frac{\sum_{j=1}^n (Vc_j * H_{iV(T)j})}{n} \quad (11)$$

where

- j is the scan number;
- n is the number of scan of the data collection period;
- Q_{gm} is the measured heat input, in kilowatt;
- $H_{iM(T)j}$ is the net calorific value of the test gas at the considered scan, in megajoule per kilogram;
- Mc_j is the mass flow rate of dry test gas at the considered scan, in kilogram per hour;
- $H_{iV(T)j}$ is the net calorific value of the test gas at the considered scan, in megajoule per cubic meter (dry gas, 15 °C, 1 013,25 mbar);
- Vc_j is the volumetric flow rate of dry test gas corrected to 1013,25 mbar and 15 °C at the considered scan, in cubic meter per hour and derived from the following formula:

$$Vc_j = V_{mj} \cdot \frac{p_{aj} + pj - p_{wj}}{1\,013,25} \cdot \frac{288,15}{273,15 + t_{gj}} \quad (12)$$

where

- V_{mj} is the measured gas flow rate at the considered scan, in cubic meter per hour;
- p_{aj} is the atmospheric pressure at the considered scan, in millibar;
- pj is the gas supply pressure at the gas meter at the considered scan, in millibar;

p_{wj} is the partial (water) vapour pressure in the gas used at the considered scan, in millibar;

t_{gj} is the gas temperature at the gas meter at the considered scan, in degrees Celsius.

NOTE 2 It is important to note that gas supply pressure at the gas meter is different from gas supply pressure of the appliance.

NOTE 3 Alternative expression of heat inputs.

In recognition that in several European markets and in recent European Norms and Regulations, the use of the gross calorific value is becoming increasingly diffused, the alternative calculation and publication of heat input (Q_g) on the basis of the gross calorific value is allowed only when the reference GCV is explicitly stated beside the value.

EXAMPLE Q_g : 23 kW_{GCV}.

Elsewhere, the heat input (Q_g) is always to be understood as based on net calorific value (NCV) as per 4.2.3.2.

4.2.4 Electrical power input

4.2.4.1 General condition for operation of the electrical part of the appliance

Tests are carried out with the nominal voltage.

The “global” electrical power input correction depends on the design of each appliance. Its “global” correction is the sum of appropriate “individual” corrections (see Annex G).

4.2.4.2 Effective electrical power input

The effective electrical power input shall be determined using the following formula:

$$P_E = \frac{\sum_{j=1}^n (P_{Tj})}{n} \pm Abs(C_{device_indoor}) \pm Abs(C_{device_outdoor}) \pm Abs(C_{device_hr}) \quad (13)$$

where

j is the scan number;

n is the number of scan of the data collection period;

P_E is the effective electrical power input, in kilowatt;

P_{Tj} is measured (total) electrical power input at the considered scan, in kilowatt;

C_{device_indoor} is the electrical power input correction due to the device(s) (fan(s) or pump(s)) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatt;

$C_{device_outdoor}$ is the electrical power input correction due to the device(s) (fan(s) or pump(s)) responsible for circulating the heat transfer medium through the outdoor heat exchanger, in kilowatt;

C_{device_hr} is the capacity correction due to the pump(s) responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger, in kilowatt.

NOTE The effective electrical power input is not corrected to heat recovery pump contribution as long as the heat recovery is not taken into account in calculation procedure of the Energy Related Products Directive (2009/125/EC).

4.2.4.3 Electrical power input correction of fan(s)

4.2.4.3.1 General

The following corrections of the electrical power input of fan(s) shall be made for fan(s) responsible for circulating the heat transfer medium through the indoor or outdoor heat exchanger, where applicable.

4.2.4.3.2 Electrical power input correction of fan(s) for appliances without duct connection

4.2.4.3.2.1 Electrical power input correction for appliances with at least one internal fan

In the case of appliances which are not designed for duct connection, i.e. which do not permit any external pressure differences, and which are equipped with integral fan(s), the electrical power absorbed by the fan(s) shall be included in the effective electrical power absorbed by the appliance (no correction).

4.2.4.3.2.2 Electrical power input correction for appliances without internal fan

If no fan is provided with the appliance, the part of the electrical power input which is to be included in the effective electrical power absorbed by the appliance shall be calculated using the following formula (the correction is positive):

$$C_{device_indoor} \text{ or } C_{device_outdoor} = \frac{q \times (-\Delta p_i)}{\eta * 1\,000} \quad (14)$$

where

C_{device_indoor} is the electrical correction due to fan(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatt;

$C_{device_outdoor}$ is the electrical correction due to fan(s) responsible for circulating the heat transfer medium through the outdoor heat exchanger, in kilowatt;

η is the efficiency of the fan(s);

Δp_i is the measured internal static pressure difference, expressed in Pascal;

q is the measured air flow rate at standard air conditions, in cubic meters per second.

NOTE The efficiency of the fan(s) given in a report edited by an accredited laboratory is used. Otherwise, the efficiency of the fan(s) is equal to 0,3 by convention.

4.2.4.3.3 Electrical power input correction of fan(s) for appliances with duct connection

4.2.4.3.3.1 Electrical power input correction for appliances with at least one internal fan

If the fan(s) is (are) an integral part of the appliance, only a part of the electrical power input of the fan motor(s) shall be included in the effective electrical power absorbed by the appliance. The part that is to be excluded (subtracted) from the total electrical power absorbed by the appliance shall be calculated using the following formula (the correction is negative):

$$C_{device_indoor} \text{ or } C_{device_outdoor} \text{ or } C_{device_hr} = \frac{q \times \Delta p_e}{\eta * 1\,000} \quad (15)$$

where

C_{device_indoor} is the electrical correction due to fan(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatt;

$C_{device_outdoor}$ is the electrical correction due to fan(s) responsible for circulating the heat transfer medium through the outdoor heat exchanger, in kilowatt;

η is the efficiency of the fan(s);

Δp_e is the measured external static pressure difference, expressed in Pascal;

q is the measured air flow rate at standard air conditions, in cubic meters per second.

NOTE The efficiency of the fan(s) given in a report edited by an accredited laboratory is used. Otherwise, the efficiency of the fan(s) is equal to 0,3 by convention.

4.2.4.3.3.2 Electrical power input correction for appliances without internal fan

If no fan is provided with the appliance, the part of the electrical power input which is to be included in the effective electrical power absorbed by the appliance shall be calculated using the following formula (the correction is positive):

$$C_{device_indoor} \text{ or } C_{device_outdoor} = \frac{q \times (-\Delta p_i)}{\eta * 1\,000} \quad (16)$$

where

C_{device_indoor} is the electrical correction due to fan(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatt;

$C_{device_outdoor}$ is the electrical correction due to fan(s) responsible for circulating the heat transfer medium through the outdoor heat exchanger, in kilowatt;

η is the efficiency of the fan(s);

Δp_i is the measured internal static pressure difference, expressed in Pascal;

q is the measured air flow rate at standard air conditions, in cubic meters per second.

NOTE The efficiency of the fan(s) given in a report edited by an accredited laboratory is used. Otherwise, the efficiency of the fan(s) is equal to 0,3 by convention.

4.2.4.4 Electrical power input correction of pumps

4.2.4.4.1 General

The following correction of the electrical power input of pump(s) shall be made to both pumps responsible for circulating the heat transfer medium through the indoor heat exchanger, pumps responsible for circulating the heat transfer medium through the outdoor heat exchanger and pumps dedicated to engine heat recovery heat exchanger, where applicable. When the pump is integrated to the appliance, it shall be connected for operation; when the pump is delivered by the manufacturer apart from the appliance, it shall be connected for operation according to the installation instructions and be considered as an integral part of the appliance.

4.2.4.4.2 Pump(s) responsible for circulating the heat transfer medium through the outdoor or indoor heat exchanger

4.2.4.4.2.1 Electrical power input correction for appliances with at least one internal pump

If the pump(s) is (are) an integral part of the appliance, only a part of the electrical power input to the pump motor(s) shall be included in the effective electrical power absorbed by the appliance. The part which is to be excluded (subtracted) from the total electrical power absorbed by the appliance shall be calculated using the following formula (the correction is negative):

$$C_{device_indoor} \text{ or } C_{device_outdoor} \text{ or } C_{device_hr} = \frac{q \times \Delta p_e}{\eta * 1\,000} \quad (17)$$

where

- C_{device_indoor} is the electrical correction due to pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatt;
- $C_{device_outdoor}$ is the electrical correction due to pump(s) responsible for circulating the heat transfer medium through the outdoor heat exchanger, in kilowatt;
- C_{device_hr} is the electrical correction due to pump(s) responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger, in kilowatt;
- η is the efficiency of the pump calculated according to Annex F;
- Δp_e is the measured external static pressure difference, expressed in pascal;
- q is the measured water flow rate, in cubic meters per second.

4.2.4.4.2.2 Electrical power input correction for appliances without internal pump

If no pump is provided with the appliance, the part of the electrical power input which is to be included in the effective electrical power absorbed by the appliance, shall be calculated using the following formula (the correction is positive):

$$C_{device_indoor} \text{ or } C_{device_outdoor} \text{ or } C_{device_hr} = \frac{q \times (-\Delta p_i)}{\eta * 1\,000} \quad (18)$$

where

- C_{device_indoor} is the electrical correction due to pump(s) responsible for circulating the heat transfer medium through the indoor heat exchanger, in kilowatt;
- $C_{device_outdoor}$ is the electrical correction due to pump(s) responsible for circulating the heat transfer medium through the outdoor heat exchanger, in kilowatt;
- C_{device_hr} is the electrical correction due to pump(s) responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger, in kilowatt;
- η is the efficiency of the pump calculated according to Annex F;
- Δp_i is the measured internal static pressure difference, expressed in pascal;
- q is the measured water flow rate, in cubic meters per second.

4.2.4.4.3 Engine heat recovery pump(s) responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger

4.2.4.4.3.1 Electrical power input for appliances with internal pump(s) responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger

If the engine heat recovery pump(s) is (are) an integral part of the appliance, 4.2.4.4.2.1 applies for C_{device_hr} .

4.2.4.4.3.2 Electrical power input for appliances without internal pump(s) responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger

If there is no engine heat recovery pump: C_{device_hr} equal to 0.

4.2.5 Gas utilization efficiency (GUE)

4.2.5.1 Cooling mode

The gas utilization efficiency in cooling mode shall be determined using the following formula:

$$GUE_c = \frac{Q_{Ec}}{Q_{gmc}} \quad (19)$$

where

GUE_c is the cooling gas utilization efficiency, in kilowatt per kilowatt;

Q_{Ec} is the effective cooling capacity, in kilowatt;

Q_{gmc} is the measured gas heat input, in kilowatt.

4.2.5.2 Heating mode

The gas utilization efficiency in heating mode shall be determined using the following formula:

$$GUE_h = \frac{Q_{Eh}}{Q_{gmh}} \quad (20)$$

where

GUE_h is the heating gas utilization efficiency, in kilowatt per kilowatt;

Q_{Eh} is the effective heating capacity, in kilowatt;

Q_{gmh} is the measured gas heat input, in kilowatt.

4.2.5.3 Simultaneous heating and cooling mode

The gas utilization efficiency in simultaneous heating and cooling mode shall be determined using the following formula:

$$GUE_{shc} = \frac{Q_{Eh} + Q_{Ec}}{Q_{gmhc}} \quad (21)$$

where

GUE_{shc} is the heating and cooling gas utilization efficiency, in kilowatt per kilowatt;

Q_{Eh} is the effective heating capacity, in kilowatt;

Q_{Ec} is the effective cooling capacity, in kilowatt;

Q_{gmhc} is the measured gas heat input, in kilowatt.

4.2.6 Engine heat recovery efficiency (EHRE)

4.2.6.1 Cooling mode

The engine heat recovery efficiency gas in cooling mode is determined using the following formula:

$$EHRE_c = \frac{Q_{EHRc}}{Q_{gmc}} \quad (22)$$

where

$EHRE_c$ is the effective engine heat recovery efficiency gas in cooling mode, in kilowatt per kilowatt;

Q_{EHRc} is the effective engine heat recovery capacity in cooling mode, in kilowatt;

Q_{gmc} is the measured gas heat input in cooling mode, in kilowatt.

The engine heat recovery efficiency electricity in cooling mode is determined using the following formula:

$$EHREelec_c = \frac{Q_{EHRc}}{P_{Ec}} \quad (23)$$

where

$EHREelec_c$ is the effective engine heat recovery efficiency electricity in cooling mode, in kilowatt per kilowatt;

Q_{EHRc} is the effective engine heat recovery capacity in cooling mode, in kilowatt;

P_{Ec} is the effective electrical power input in cooling mode, in kilowatt.

4.2.6.2 Heating mode

The engine heat recovery efficiency gas in heating mode is determined using the following formula:

$$EHRE_h = \frac{Q_{EHRh}}{Q_{gmh}} \quad (24)$$

where

$EHRE_h$ is the engine heat recovery efficiency gas in heating mode, in kilowatt per kilowatt;

Q_{EHRh} is the effective engine heat recovery capacity in heating mode, in kilowatt;

Q_{gmh} is the measured gas heat input in heating mode, in kilowatt.

The engine heat recovery efficiency electricity in heating mode is determined using the following formula:

$$EHREelec_h = \frac{Q_{EHRh}}{P_{Eh}} \quad (25)$$

where

$EHREelec_h$ is the engine heat recovery efficiency electricity in heating mode, in kilowatt per kilowatt;

Q_{EHRh} is the effective engine heat recovery capacity in heating mode, in kilowatt;

P_{Eh} is the effective electrical power input in heating mode, in kilowatt.

4.2.6.3 Simultaneous heating and cooling mode

The engine heat recovery efficiency gas in simultaneous heating and cooling mode is determined using the following formula:

$$EHRE_{shc} = \frac{Q_{EHRshc}}{Q_{gmshc}} \quad (26)$$

where

$EHRE_{shc}$ is the effective engine heat recovery efficiency gas in simultaneous heating and cooling mode, in kilowatt per kilowatt;

Q_{EHRshc} is the effective engine heat recovery capacity in simultaneous heating and cooling mode, in kilowatt;

Q_{gmshc} is the measured gas heat input in simultaneous heating and cooling mode, in kilowatt.

The engine heat recovery efficiency electricity in simultaneous heating and cooling mode is determined using the following formula:

$$EHRE_{elec_{shc}} = \frac{Q_{EHRshc}}{P_{Eshc}} \quad (27)$$

where

$EHRE_{elec_{shc}}$ is the effective engine heat recovery efficiency electricity in simultaneous heating and cooling mode, in kilowatt per kilowatt;

Q_{EHRshc} is the effective engine heat recovery capacity in simultaneous heating and cooling mode, in kilowatt;

P_{Eshc} is the effective electrical power input in simultaneous heating and cooling mode, in kilowatt.

4.2.7 Total gas utilization efficiency (GUE_T)

4.2.7.1 Cooling mode

The total gas utilization efficiency in cooling mode shall be determined using the following formula:

$$GUE_{Tc} = GUE_c + EHRE_c \quad (28)$$

where

GUE_{Tc} Is the total cooling gas utilization efficiency, in kilowatt per kilowatt;

GUE_c is the cooling gas utilization efficiency, in kilowatt per kilowatt;

$EHRE_c$ is the effective engine heat recovery efficiency gas in cooling mode, in kilowatt per kilowatt

4.2.7.2 Heating mode

The total gas utilization efficiency in heating mode shall be determined using the following formula:

$$GUE_{Th} = GUE_h + EHRE_h \quad (29)$$

where

GUE_{Th} is the total heating gas utilization efficiency, in kilowatt per kilowatt;

GUE_h is the heating gas utilization efficiency, in kilowatt per kilowatt;

$EHRE_h$ is the effective engine heat recovery efficiency gas in heating mode, in kilowatt per kilowatt

4.2.7.3 Simultaneous heating and cooling mode

The total gas utilization efficiency in simultaneous heating and cooling mode shall be determined using the following formula:

$$GUE_{Tshc} = GUE_{shc} + EHRE_{shc} \quad (30)$$

where

GUE_{Tshc} is the total simultaneous heating and cooling gas utilization efficiency, in kilowatt per kilowatt;

GUE_{shc} is the simultaneous heating and cooling gas utilization efficiency, in kilowatt per kilowatt;

$EHRE_{shc}$ is the effective engine heat recovery efficiency gas in simultaneous heating and cooling mode, in kilowatt per kilowatt

4.2.8 Auxiliary energy factor (AEF)

4.2.8.1 Cooling mode

The auxiliary energy factor in cooling mode is determined using the following formula:

$$AEF_c = \frac{Q_{Ec}}{P_{Ec}} \quad (31)$$

where

AEF_c is the cooling auxiliary energy factor, in kilowatt per kilowatt;

Q_{Ec} is the effective cooling capacity, in kilowatt;

P_{Ec} is the effective electrical power input in cooling mode, in kilowatt.

4.2.8.2 Heating mode

The auxiliary energy factor in heating mode is determined using the following formula:

$$AEF_h = \frac{Q_{Eh}}{P_{Eh}} \quad (32)$$

where

AEF_h is the heating auxiliary energy factor, in kilowatt per kilowatt;

Q_{Eh} is the effective heating capacity, in kilowatt;

P_{Eh} is the effective electrical power input in heating mode, in kilowatt.

4.2.8.3 Simultaneous heating and cooling mode

The auxiliary energy factor in simultaneous heating and cooling mode is determined using the following formula:

$$AEF_{shc} = \frac{Q_{Eh} + Q_{Ec}}{P_{Eshc}} \quad (33)$$

where

- AEF_{shc} is the heating and cooling auxiliary energy factor, in kilowatt per kilowatt;
- Q_{Eh} is the effective heating capacity, in kilowatt;
- Q_{Ec} is the effective cooling capacity, in kilowatt;
- P_{Eshc} is the effective electrical power input in simultaneous heating and cooling mode, in kilowatt.

4.2.9 Auxiliary energy engine heat recovery factor (AEHRF)

4.2.9.1 Cooling mode

The auxiliary energy engine heat recovery factor in cooling mode is determined using the following formula:

$$AEHRF_c = \frac{Q_{ERHc}}{P_{Ec}} \quad (34)$$

where

- $AEHRF_c$ is the cooling auxiliary energy engine heat recovery factor, in kilowatt per kilowatt;
- Q_{ERHc} is the effective engine heat recovery capacity in cooling mode, in kilowatt;
- P_{Ec} is the effective electrical power input in cooling mode, in kilowatt.

4.2.9.2 Heating mode

The auxiliary energy engine heat recovery factor in heating mode is determined using the following formula:

$$AEHRF_h = \frac{Q_{EHRh}}{P_{Eh}} \quad (35)$$

where

- $AEHRF_h$ is the heating auxiliary energy engine heat recovery factor, in kilowatt per kilowatt;
- Q_{EHRh} is the effective engine heat recovery capacity in heating mode, in kilowatt;
- P_{Eh} is the effective electrical power input in heating mode, in kilowatt.

4.2.9.3 Simultaneous heating and cooling mode

The auxiliary energy engine heat recovery factor in simultaneous heating and cooling mode is determined using the following formula:

$$AEHRF_{shc} = \frac{Q_{ERHshc}}{P_{Eshc}} \quad (36)$$

where

- $AEHRF_{shc}$ is the simultaneous heating and cooling auxiliary energy engine heat recovery factor, in kilowatt per kilowatt;

Q_{ERHshc} is the effective engine heat recovery capacity in simultaneous heating and cooling mode, in kilowatt;

P_{Eshc} is the effective electrical power input in simultaneous heating and cooling mode, in kilowatt.

4.2.10 Total auxiliary energy factor (AEF_T)

4.2.10.1 Cooling mode

The total auxiliary energy factor in cooling mode is determined using the following formula:

$$AEF_{Tc} = AEF_c + AEHRF_c \quad (37)$$

where

AEF_{Tc} is the total cooling auxiliary energy factor, in kilowatt per kilowatt;

AEF_c is the cooling auxiliary energy factor, in kilowatt per kilowatt;

$AEHRF_c$ is the cooling auxiliary energy engine heat recovery factor, in kilowatt per kilowatt.

4.2.10.2 Heating mode

The total auxiliary energy factor in heating mode is determined using the following formula:

$$AEF_{Th} = AEF_h + AEHRF_h \quad (38)$$

where

AEF_{Th} is the total heating auxiliary energy factor, in kilowatt per kilowatt;

AEF_h is the heating auxiliary energy factor, in kilowatt per kilowatt;

$AEHRF_h$ is the heating auxiliary energy engine heat recovery factor, in kilowatt per kilowatt.

4.2.10.3 Simultaneous heating and cooling mode

The total auxiliary energy factor in simultaneous heating and cooling mode is determined using the following formula:

$$AEF_{Tshc} = AEF_{shc} + AEHRF_{shc} \quad (39)$$

where

AEF_{Tshc} is the total simultaneous heating and cooling auxiliary energy factor, in kilowatt per kilowatt;

AEF_{shc} is the simultaneous heating and cooling auxiliary energy factor, in kilowatt per kilowatt;

$AEHRF_{shc}$ is the simultaneous heating and cooling auxiliary energy engine heat recovery factor, in kilowatt per kilowatt

4.2.11 Primary energy factor (PER)

4.2.11.1 Cooling mode

$$PER_c = \frac{1}{\frac{Prim_{gas}}{GUE_{Tc}} + \frac{Prim_{elec}}{AEF_{Tc}}} \quad (40)$$

4.2.11.2 Heating mode

$$PER_h = \frac{1}{\frac{Prim_{gas}}{GUE_{Th}} + \frac{Prim_{elec}}{AEF_{Th}}} \quad (41)$$

4.2.11.3 Simultaneous heating and cooling mode

$$PER_{shc} = \frac{1}{\frac{Prim_{gas}}{GUE_{Tshc}} + \frac{Prim_{elec}}{AEF_{Tshc}}} \quad (42)$$

4.3 Test apparatus

4.3.1 Arrangement of the test apparatus

4.3.1.1 General requirements

The test apparatus shall be designed in such a way that all requirements on adjustment of set values, stability criteria and uncertainties of measurement according to this standard can be fulfilled.

Permissible deviations are given for four test protocols:

- the fixed delta T protocol, where the inlet and the outlet water (brine) temperatures shall match the target values, this protocol is the reference protocol for air-to-water (brine) or water (brine)-to-water (brine) appliances;
- the outlet temperature protocol, where the outlet water (brine) temperature shall match the target value;
- the inlet temperature protocol, where the inlet water (brine) or air temperature shall match the target value, this protocol is the reference protocol for air-to-air or water (brine)-to-air appliances;
- the mean temperature protocol where the mean of outlet and inlet water (brine) temperatures shall match the target value.

4.3.1.2 Test room for the air side

The size of the test room shall be selected such that any resistance to air flow at the air inlet and air outlet orifices of the appliance is avoided. The air flow through the room shall not be capable of initiating any short circuit between these two orifices, and therefore the velocity of the air flow through the room at these two locations shall not exceed 1,5 m/s when the appliance is switched off. Unless otherwise stated by the manufacturer, the air inlet or air outlet orifices shall be not less than 1 m distant from the surfaces of the test room.

Any direct heat radiation by heating device (appliance, equipment...) in the test room onto the appliance or onto the temperature measuring points shall be avoided.

4.3.1.3 Appliances with duct connection

The connections of a ducted air appliance to the test facility shall be sufficiently air tight to ensure that the measured results are not significantly influenced by exchange of air with the surroundings.

4.3.1.4 Appliances with integral pumps

For appliances with integral and adjustable water or brine pumps, the external static pressure shall be set at the same time as the temperature difference.

When the liquid pump has one or several fixed speeds, the speed of the pump shall be set in order to provide the minimum external static pressure.

In case of variable speed liquid pump, the manufacturer shall provide information to set the pump in order to reach a maximal external static pressure of 10 kPa.

4.3.2 Installation and connection of the appliance

4.3.2.1 General

The appliance shall be installed and connected for the test as recommended in installation and operation manual. It shall be connected to a test installation that allows setting of the required 100 % or reduced load. Examples of such test installation in heating and cooling mode are given:

- in Annex A and Annex B for appliances using air as heat source;
- in Annex D and Annex E for appliances using water (brine) as heat source.

For single duct appliances, in case the installation instructions do not specify how to install the discharge duct, the discharge duct shall be as short and straight as possible compatibly with minimum distance between the appliance and the wall for correct air inlet but not less than 50 cm. No accessory shall be connected to the discharge end of the duct.

For double duct appliances, the same requirements apply to both suction and discharge ducts, unless the appliance is designed to be installed directly on the wall.

NOTE If a skilled personnel with knowledge of control software is required for the start of the system, the manufacturer or the nominated agent is in attendance when the system is being installed and prepared for tests.

4.3.2.2 Installation of unit consisting of several parts

In the case of a unit consisting of several parts, the following installation conditions shall be complied for the test.

- the refrigerant lines shall be installed in accordance with the installation instructions. The length of the lines shall be 5 m except if the constraints of the test installation make 5 m not possible, in which case a greater length may be used, with a maximum of 7,5 m,
- the lines shall be installed so that the difference in elevation does not exceed 2,5 m,
- the thermal insulation of the lines shall be applied in accordance with the installation instructions,
- unless constrained by the design, at least half of the connecting lines shall be exposed to the outside conditions, with the rest of the lines exposed to the inside conditions.

4.3.2.3 Indoor units of multi-split systems

The manufacturer shall choose the number of indoor units which shall be installed.

When testing a multi-split system in a calorimeter room, the air flow rate and the external static pressure shall be adjusted separately for each one of the ducted indoor units.

When testing a multi-split system using the air enthalpy method, the air flow rate and the external static pressure shall be adjusted separately for each indoor unit, ducted or not.

In case of equipment with non-ducted indoor units tested using the air enthalpy method, the above requirement on ducted indoor units shall apply.

4.3.2.4 Measuring points

Temperature and pressure measuring points shall be arranged in order to obtain mean significant values.

For free air intake temperature measurements, it is required:

- either to have at least one sensor per square meter and not less than four measuring points and by restricting to 20 the number of sensor equally distributed on the air surface;
- or to use a sampling device. It shall be completed by four sensors for checking uniformity if the surface area is greater than 1 m².

Air temperature sensors shall be placed at a maximum distance of 0,25 m from the free air surface.

For water and brine, the density in formula of Annex D, D.2.1, D.2.2 and D.2.3, shall be determine in the temperature conditions measured near the flow measuring device.

4.4 Uncertainties of measurement

The uncertainties of individual measurement shall not exceed the values specified in Table 1.

Table 1 — Uncertainties of measurement for indicated individual values

Measured quantity	Unit	Uncertainty of measurement
Water or brine - temperature inlet/outlet - temperature difference - flow rate (volume or mass) - static pressure difference	°C K m ³ /s or kg/s Pa	±0,15 K ±0,15 K ±1 % ±5 Pa ($P \leq 20 \text{ KPa}$) or ± 5 % ($P > 20 \text{ KPa}$)
Air - dry bulb temperature - wet bulb temperature - flow rate (volume) - static pressure difference	°C °C m ³ /s Pa	±0,2 K ±0,4 K ±5 % ±5 Pa ($P \leq 100 \text{ Pa}$) or ± 5 % ($P > 100 \text{ Pa}$)
Concentration - heat transfer medium	%	±2 %
Heat input - atmospheric pressure - gas pressure - gas flow rate - gas temperature - calorific value	mbar mbar m ³ /h or kg/h °C MJ/m ³	±5 mbar ±2 % full scale without exceeding 0,5 mbar ±1 % ±0,5 K ±1 %
Gas engine - rotation speed of gas engine	rpm	±5 %
Electrical input - electrical power	kW	±1 %
Time	s	±0,2 s up to 1 h ±0,1 % beyond 1 h

The specification range of the measuring apparatus is chosen to be suitable at any capacity condition according to uncertainties in Table 1.

The steady-state heating or cooling capacities determined using the calorimeter method shall be determined with a maximum uncertainty of 5 %, independent of the individual uncertainties of measurement including the uncertainties on the properties of fluids; this maximum uncertainty is extended to 10 % for single duct units due to the air exchange between the two compartments of the calorimeter room.

Heating capacity determined during transient operation (defrost cycles) using the calorimeter method shall be determined with a maximum uncertainty of 10 %, independent of the individual uncertainties of measurement including the uncertainties on the properties of fluids.

The heating and cooling capacities measured on the air side using the air enthalpy method shall be determined with a maximum uncertainty of 10 %, independent of the individual uncertainties of measurement including the uncertainties on the properties of fluids.

The heating, cooling and engine heat recovering capacities measured on the water enthalpy method shall be determined within a maximum overall uncertainty of $(20,5 \cdot \Delta T - 0,89)$ %, independent of the individual uncertainties of measurement including the uncertainties on the properties of fluids.

The gas input shall be determined within a maximum overall uncertainty of 2 %, independent of the individual uncertainties of measurement including the uncertainties on the properties of the gas.

If the water (brine) or air flow rate stops during, for example, a transient test or during a cyclical operation test, no maximum overall uncertainty is required for the capacity. However, the measurements tools shall fulfil the uncertainties of individual measurements required in Table 1.

4.5 Test procedure

4.5.1 General

4.5.1.1 Introduction

The test procedures describe below are valid for any condition capacity tests.

For the heating capacity, cooling capacity, heat recovery capacity and inputs measurements, it is necessary to record all the meaningful data mentioned in 4.7 continuously except for gas density, Wobbe index and gas calorific value when the gas comes from a tank and this tank has not been changed during the tests. For heat recovery and inputs measurements, the sampling (intervals and frequencies) shall be the same as for corresponding heating or cooling capacity.

For any type of operation, the sequence shall be adjusted such that a complete recording is effected at least once every 10 s.

The laboratory can carry out the test and use the test bench it wants on condition that it respects the required permissible deviations given and it let operate the control of the appliance (no use of On/Off cycles generated by the laboratory itself).

4.5.1.2 All appliances

The test conditions are given in EN 16905-3:2017. However, test conditions coming from other standards, regulations or certification procedures can be used.

If liquid heat transfer media other than water are used, the specific heat capacity and density of such heat transfer media shall be determined and taken into consideration in the evaluation (results and uncertainty).

For 100 % load tests, when performing measures in heating mode, set the highest room temperature on the appliance/system control device. When performing measures in cooling mode, set the lowest room temperature on the appliance/system control device. If in the instructions, the manufacturer indicates a value for the temperature set on the control device for a given standard rating conditions, then this value shall be used.

The manufacturer shall provide laboratories necessary information on the setting of the appliance for operating at the required reduced load conditions upon request. Contact information to obtain such information shall be provided in both user manual and website of the manufacturer or importer.

4.5.1.3 Non ducted appliances

For non ducted appliances, the adjustable settings such as louvers and fan speed shall be set for maximum steady-state operation air flow.

After that setting, the air flow rate is left under control of the appliance.

When appliance is modulating, no perturbation of air flow should be perceived by appliance as consequence of operation of test room apparatus.

4.5.1.4 Units ducted on the indoor heat exchanger

The air flow rate and the pressure difference shall be related to standard air and with dry heat exchanger.

If the air flow rate is given by the manufacturer with no atmospheric pressure, temperature and humidity conditions, it shall be considered as given for standard rating conditions. The air flow rate given by the manufacturer shall be converted into standard air conditions. The air flow rate setting shall be made when the fan only is operating.

$$q_{vi} = \frac{q_{vi(measured)} \rho^2(measured)}{1,204} \quad (43)$$

The setting of this airflow rate shall be made when the fan only is operating.

The rating air flow rate given by the manufacturer converted into standard air conditions if necessary shall be set and the resulting ESP measured. This ESP shall also be converted into standard air conditions as follows:

$$\Delta p_e = \frac{\Delta p_{e(measured)} \Delta \rho^2(measured)}{1,204^2} \quad (44)$$

- If the ESP is lower than the minimum value given in Table 2 or Table 3, the air flow rate is decreased to reach this minimum value.
- If the ESP is greater than twice the minimum value given in Table 2 or Table 3, the air low rate is increased to reach twice this minimum value.
- If the ESP is greater than the minimum value given in Table 2 or Table 3 but not greater than twice this minimum value, then keep this ESP.

After that setting, the air flow rate is left under control of the appliance.

Table 2 — Pressure requirement for comfort air conditioners

Standard capacity ratings kW	Minimum external static pressure ^{a b} Pa
$0 < Q < 8$	25
$8 \leq Q < 12$	37
$12 \leq Q < 20$	50
$20 \leq Q < 30$	62
$30 \leq Q < 45$	75
$45 \leq Q < 82$	100
$82 \leq Q < 117$	125
$117 \leq Q < 147$	150
$Q \geq 147$	175
^a For equipment tested without an air filter installed, the minimum external static pressure shall be increased by 10 Pa. ^b If the installation instructions state that the maximum allowable discharge duct length is less than 1m, then the unit can be considered as a free delivery unit and be tested as a non ducted indoor unit with an ESP of 0 Pa.	

Table 3 — Pressure requirement for close control air conditioners

Capacity kW	Pressure Pa	
	For down-flow discharge into double floor	For up-flow discharge into duct all units
< 30	50	--
≥ 30	75	--
All	--	50

4.5.1.5 Units ducted on the outdoor heat exchanger

The volume flow and the pressure difference shall be related to standard air and with dry heat exchanger.

If the air flow rate is given by the manufacturer with no atmospheric pressure, temperature and humidity conditions, it shall be considered as given for standard rating conditions.

The air flow rate given by the manufacturer shall be converted into standard air conditions. The air flow rate setting shall be made when the fan only is operating.

The rated air flow rate given by the manufacturer shall be set and the resulting external static pressure (ESP) measured.

If the ESP is lower than 30 Pa, this minimum value shall be set by the way of the apparatus used for the setting of the ESP.

This apparatus shall be maintained in the same setting during all the tests.

If the installation instructions state that the maximum allowable discharge duct length is less than 1 m, then the unit can be considered as a free delivery unit and be tested as a non ducted outdoor unit with an ESP of 0 Pa.

Table 4 — Permissible deviations from set values

Measured quantity	Permissible deviations of the arithmetic mean values from set values	Permissible deviations of each of the individual measured values from set values
Liquid		
- inlet temperature	$\pm 0,2$ K	$\pm 0,5$ K
- outlet temperature	$\pm 0,3$ K	$\pm 0,6$ K
- volume flow	± 1 %	$\pm 2,5$ %
- static pressure difference	-	± 10 %
Air		
- inlet temperature	$\pm 0,3$ K	± 1 K
- outlet temperature	$\pm 0,4$ K	± 1 K
- volume flow	± 5 %	± 10 %
- static pressure difference	-	± 10 %
Refrigerant		
- liquid temperature	± 1 K	± 2 K
- saturated vapour/bubble point temperature	$\pm 0,5$ K	± 1 K
Voltage	± 4 %	± 4 %

4.5.1.6 Water (brine)-to-water (brine) and air-to-water (brine) appliances

The nominal water (brine) flow rate given by the manufacturer shall be set at corresponding standard rating conditions and the resulting pressure drops measured. After that setting, the water flow rate is left under control of the appliance.

In case of brine, if it is not mentioned in the technical instructions for installation and adjustment, the manufacturer shall give the nature and the concentration of the product to use for the tests. The minimum brine concentration shall be chosen to provide even proper operation at minimum outlet temperature allowed by the manufacturer.

4.5.2 Non-cyclical operation

4.5.2.1 Output measurement for water (brine)-to-water (brine) and water (brine)-to-air appliances

4.5.2.1.1 Steady-state operation conditions

4.5.2.1.1.1 General

The data collection is allowed when steady-state operation conditions are fulfilled. These conditions are considered obtained and maintained when all the measured quantities remain constant without having to alter the set values, for a minimum duration of 1 h, with respect to the tolerances given in Table 5, Table 6, Table 7, Table 8, Table 9 or Table 10. Periodic fluctuations of measured quantities caused by the operation of regulation and control devices are permissible on condition the mean value of such fluctuations does not exceed the permissible deviations listed in Table 5, Table 6, Table 7, Table 8, Table 9 or Table 10. The data collection period follows this period of 1 h. All these requirements apply at reduced load too when the gas fired engine operates at least at its minimal rotation speed.