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Gas-fired endothermic engine driven heat pumps

Part 4: Test methods

bsi.

National foreword

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European foreword

This document (EN 16905-4:2017) 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 European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2017, and conflicting national standards shall be withdrawn at the latest by September 2017.

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

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

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

This standard comprises the following parts under the general title, *Gas-fired endothermic engine driven heat pumps:*

— *Part 1: Terms and definitions*;

— *Part 2: Safety* (WI 00299025; currently in preparation);

— *Part 3: Test conditions*;

— *Part 4: Test methods*;

— *Part 5: Calculation of seasonal performances in heating and cooling mode*.

EN 16905-1, prEN 16905-2, EN 16905-3, EN 16905-4 and EN 16905-5 have been prepared to address the essential requirements of the European Directive 2009/142/EC relating to appliances burning gaseous fuels (see prEN 16905-2:201X, Annex ZA for safety aspects and EN 16905-5:2017, Annex ZA for rational use of energy aspects).

These documents 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, EN 16905-4:2017, Annex ZA, EN 16905-5:2017, Annex ZA and prEN 16905-2:201X, Annex ZB).

These documents will be reviewed whenever new mandates could apply.

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

1 Scope

1.1 Scope of EN 16905 series

This European Standard specifies the requirements, test methods and test conditions 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”.

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

This European Standard 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.

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

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

Packaged units, single split and multisplit systems are covered by this European Standard. Single duct and double duct units are covered by this European Standard.

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

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

In the case of packaged units (consisting of several parts), this European Standard applies only to those designed and supplied as a complete package.

NOTE All the symbols given in this text are used regardless of the language used.

1.2 Scope of EN 16905-4

This part of the EN 16905 series specifies the test methods for gas-fired endothermic engine driven heat pumps for heating and/or cooling mode including the engine heat recovery.

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

EN 12102, *Air conditioners, liquid chilling packages, heat pumps and dehumidifiers with electrically driven compressors for space heating and cooling - Measurement of airborne noise - Determination of the sound power level*

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

prEN 16905-2[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*

3 Terms and definitions

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

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 with the corresponding test methods according to EN 12102 considering that this standard, dedicated to determination of the sound power level could be used with appliances covered in the scope of the EN 16905 series.

4.2 Basic principles method of calculation for the determination of capacities

4.2.1 Capacity

4.2.1.1 Measured capacity

The measured heating or cooling 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 heating or cooling 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).

1) Currently in preparation.

4.2.1.2 Effective capacity

4.2.1.2.1 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_{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:

$$Q_{Eh} = Q_h - Abs\left(C_{device\_indoor}\right) \tag{1}$$

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_{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:

$$Q_{Eh} = Q_h + Abs\left(C_{device\_indoor}\right) \tag{2}$$

where

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

4.2.1.2.2 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, $C_{device-indoor}$, 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:

$$Q_{Ec} = Q_c + Abs\left(C_{device\_indoor}\right) \tag{3}$$

b) if the fan(s) or pump(s) is (are) not an integral part of the appliance, the capacity correction due to the device, $C_{device-indoor}$, 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:

$$Q_{Ec} = Q_c - Abs\left(C_{device\_indoor}\right) \tag{4}$$

where:

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

Q_c is the measured cooling capacity, 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.

4.2.1.3 Rating capacity

4.2.1.3.1 Rating heating capacity

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

$$Q_{Rh} = Q_h \times \frac{Q_{grh}}{Q_{gmh}} \pm Abs\left(C_{device\_indoor}\right) \tag{5}$$

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 4.2.1.2.1.

4.2.1.3.2 Rating cooling capacity

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

$$Q_{Rc} = Q_c \times \frac{Q_{grc}}{Q_{gmc}} \pm Abs\left(C_{device\_indoor}\right) \tag{6}$$

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_{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:

$$Q_{Ehr} = Q_{hr} \pm Abs\left(C_{device\_hr}\right) \tag{7}$$

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 heating mode

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

$$Q_{Rhrh} = Q_{hr} \times \frac{Q_{grhrh}}{Q_{gmhr}} \pm Abs\left(C_{device\_hr}\right) \tag{8}$$

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.

4.2.2.3 Rating engine heat recovery capacity in cooling mode

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

$$Q_{Rhrc} = Q_{hr} \times \frac{Q_{grhrc}}{Q_{gmhr}} \pm Abs\left(C_{device\_hr}\right) \tag{9}$$

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.

4.2.3 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), supplied at the corresponding normal pressure indicated in EN 437.

4.2.3.2 Measurement of heat inputs under test conditions

The appliance is installed as described in prEN 16905-2 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, 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:

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

or

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

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:

$$P_E = \frac{\sum_{j=1}^{n}\left(P_{Tj}\right)}{n} \pm Abs\left(C_{device\_indoor}\right) \pm Abs\left(C_{device\_outdoor}\right) \pm Abs\left(C_{device\_hr}\right) \quad (13)$$

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):

$$C_{device\_indoor} \; or \; C_{device\_outdoor} = \frac{q \times (-\Delta pi)}{\eta * 1\,000} \quad (14)$$

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);

Δpi 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):

$$C_{device_{indoor}} \; or \; C_{device\_outdoor} \; or \; C_{device\_hr} = \frac{q \times \Delta p_e}{\eta * 1\,000} \tag{15}$$

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):

$$C_{device\_indoor} \; or C_{device\_outdoor} = \frac{q \times \left(-\Delta p_i\right)}{\eta * 1\,000} \tag{16}$$

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);
Δpi	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):

$$C_{device\_indoor}\ or\ C_{device\_outdoor}\ or\ C_{device\_hr} = \frac{q \times \Delta p_e}{\eta * 1\,000} \tag{17}$$

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):

$$C_{device_{indoor}}\ or\ C_{device_{outdoor}}\ or\ C_{device\_hr} = \frac{q \times (-\Delta p_i)}{\eta * 1\,000} \tag{18}$$

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 Heating mode

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

$$GUE_h = \frac{Q_{Eh}}{Q_{gmh}} \tag{19}$$

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.

4.2.5.2 Cooling mode

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

$$GUE_c = \frac{Q_{Ec}}{Q_{gmc}} \tag{20}$$

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.

4.2.5.3 Simultaneous heating and cooling mode

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

$$GUE_{shc} = \frac{Q_{Eh} + Q_{Ec}}{Q_{gmhc}} \tag{21}$$

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 Auxiliary energy factor (AEF)

4.2.6.1 Heating mode

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

$$AEF_h = \frac{Q_{Eh}}{P_{Eh}} \tag{22}$$

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.

4.2.6.2 Cooling mode

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

$$AEF_c = \frac{Q_{Ec}}{P_{Ec}} \tag{23}$$

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.

4.2.6.3 Simultaneous heating and cooling mode

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

$$AEF_{shc} = \frac{Q_{Eh} + Q_{Ec}}{P_{Eshc}} \tag{24}$$

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.

4.2.7 Engine heat recovery efficiency (EHRE)

4.2.7.1 Heating mode

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

$$EHREgas_h = \frac{Q_{EHRh}}{Q_{gmh}} \qquad (25)$$

where

$EHREgas_h$ 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:

$$EHREelec_h = \frac{Q_{EHREh}}{P_{Eh}} \qquad (26)$$

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.

4.2.7.2 Cooling mode

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

$$EHREgas_c = \frac{Q_{EHRc}}{Q_{gmc}} \qquad (27)$$

where

$EHREgas_c$ 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:

$$EHREelec_c = \frac{Q_{EHRc}}{P_{Ec}} \quad (28)$$

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.

4.2.8 Primary energy factor (PER)

4.2.8.1 Heating mode

$$PER_h = \frac{1}{\frac{Prim_{gas}}{GUE_h} + \frac{Prim_{elec}}{AEF_h}} + \frac{1}{\frac{Prim_{gas}}{EHRE_{gash}} + \frac{Prim_{elec}}{EHRE_{elech}}} \quad (29)$$

4.2.8.2 Cooling mode

$$PER_c = \frac{1}{\frac{Prim_{gas}}{GUE_C} + \frac{Prim_{elec}}{AEF_C}} + \frac{1}{\frac{Prim_{gas}}{EHRE_{gasC}} + \frac{Prim_{elec}}{EHRE_{elecC}}} \quad (30)$$

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 m^2.

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 ≤ 20KPa) or ± 5 % (P > 20 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 ≤ 100 Pa) or ± 5 % (P > 100 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*ΔT − 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 as 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. 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.

$$q_{vi} = \frac{q_{vi(measured)}\rho^2(measured)}{1,204} \quad (31)$$

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:

$$\Delta p_e = \frac{\Delta p_{e(measured)}\Delta\rho^2{}_{(measured)}}{1,204^2} \quad (32)$$

— 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 ≤ Q < 12	37
12 ≤ Q < 20	50
20 ≤ Q < 30	62
30 ≤ Q < 45	75
45 ≤ Q < 82	100
82 ≤ Q < 117	125
117 ≤ Q < 147	150
Q ≥ 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	±0,2 K	±0,5 K
- outlet temperature	±0,3 K	±0,6 K
- volume flow	±1 %	±2,5 %
- static pressure difference	-	±10 %
Air		
- inlet temperature	±0,3 K	±1 K
- outlet temperature	±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	±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.

4.5.2.1.1.2 For water (brine)-to-water (brine) appliances

Table 5 — Permissible deviations on the set values during steady-state operation tests for fixed delta T protocol (reference protocol)

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
Outdoor water or brine				
- inlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,2 K ±0,2 K ±0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,5 K ±0,7 K ±0,9 K
- outlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,3 K ±0,3 K ±0,4 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,6 K ±0,8 K ±1,0 K
- flow rate	rating capacity others capacities	±2 % /	rating capacity others capacities	±5 % /
Indoor water or brine				
- inlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,2 K ±0,2 K ±0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,5 K ±0,7 K ±0,9 K
- outlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,3 K ±0,3 K ±0,4 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,6 K ±0,8 K ±1,0 K
- flow rate	rating capacity others capacities	±2 % /	rating capacity others capacities	±5 % /
Electrical input				
- voltage	±4 %		±4 %	
NOTE Permissible deviation includes the regulating capability of the test apparatus.				

Table 6 — Permissible deviations on the set values during steady-state operation tests for outlet temperature protocol and mean temperature protocol

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
Outdoor water or brine				
- inlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,2 K ±0,2 K ±0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,5 K ±0,7 K ±0,9 K
- outlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,3 K ±0,3 K ±0,4 K	/	/
- flow rate	rating capacity others capacities	±2 % /	rating capacity others capacities	±5 % /
Indoor water or brine				
- inlet temperature leading to the target outlet or to the mean temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,2 K ±0,2 K ±0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,5 K ±0,7 K ±0,9 K
- outlet temperature or mean temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,3 K ±0,3 K ±0,4 K	/	/
- flow rate	rating capacity others capacities	±2 % /	rating capacity others capacities	±5 % /
Electrical input				
- voltage	±4 %		±4 %	
NOTE Permissible deviation includes the regulating capability of the test apparatus.				

Table 7 — Permissible deviations on the set values during steady-state operation tests for inlet temperature protocol

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
Outdoor water or brine				
- inlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,2 K ±0,2 K ±0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,5 K ±0,7 K ±0,9 K
- outlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,3 K ±0,3 K ±0,4 K	/	/
- flow rate	rating capacity others capacities	±2 % /	rating capacity others capacities	±5 % /
Indoor water or brine				
- inlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,2 K ±0,2 K ±0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,5 K ±0,7 K ±0,9 K
- flow rate	rating capacity others capacities	±2 % /	rating capacity others capacities	±5 % /
Electrical input				
- voltage	±4 %		±4 %	
NOTE Permissible deviation includes the regulating capability of the test apparatus.				

4.5.2.1.1.3 For water (brine)-to-air appliances

Table 8 — Permissible deviations on the set values during steady-state operation tests for fixed delta T protocol (reference protocol)

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
Outdoor air				
- inlet temperature (dry bulb/wet bulb)	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,3 K ±0,5 K ±0,6 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±1,0 K ±1,2 K ±1,4 K
- flow rate	rating capacity others capacities	±5 % /	rating capacity others capacities	±10 % /
- static pressure drop	rating capacity	/	rating capacity	±10 %

Measured quantity	**Permissible deviations of the time average measured values from set values**		**Permissible deviations of individual measured values from time average measured values**	
	others capacities	/	others capacities	/
Indoor water or brine				
- inlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,2 K ±0,2 K ±0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,5 K ±0,7 K ±0,9 K
- outlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,3 K ±0,3 K ±0,4 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,6 K ±0,8 K ±1,0 K
- flow rate	rating capacity others capacities	±2 % /	rating capacity others capacities	±5 % /
Electrical input				
- voltage	±4 %		±4 %	
NOTE Permissible deviation includes the regulating capability of the test apparatus.				

Table 9 — Permissible deviations on the set values during steady-state operation tests for outlet temperature protocol and mean temperature protocol

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
Outdoor air				
- inlet temperature (dry bulb/wet bulb)	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,3 K ±0,5 K ±0,6 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,5 K ±0,7 K ±0,9 K
- flow rate	rating capacity others capacities	±5 % /	rating capacity others capacities	±10 % /
- static pressure drop	rating capacity others capacities	/ /	rating capacity others capacities	±10 % /
Indoor water or brine				
- inlet temperature leading to the target outlet or to the mean temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,2 K ±0,2 K ±0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,5 K ±0,7 K ±0,9 K
- outlet temperature or mean temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,3 K ±0,3 K ±0,4 K	/	/
- flow rate	rating capacity others capacities	±2 % /	rating capacity others capacities	±5 % /
Electrical input				
- voltage	±4 %		±4 %	
NOTE Permissible deviation includes the regulating capability of the test apparatus.				

Table 10 — Permissible deviations on the set values during steady-state operation tests for inlet temperature protocol

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
Outdoor air				
- inlet temperature (dry bulb/wet bulb)	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,3 K ±0,5 K ±0,6 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±1,0 K ±1,2 K ±1,4 K
- flow rate	rating capacity others capacities	±5 % /	rating capacity others capacities	±10 % /
- static pressure drop	rating capacity others capacities	/ /	rating capacity others capacities	±10 % /
Indoor water or brine				
- inlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,2 K ±0,2 K ±0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,5 K ±0,7 K ±0,9 K
- flow rate	rating capacity others capacities	±2 % /	rating capacity others capacities	±5 % /
Electrical input				
- voltage	±4 %		±4 %	
NOTE Permissible deviation includes the regulating capability of the test apparatus.				

4.5.2.1.1.4 For air-to-air and air-to-water (brine) appliances

Table 11 — Permissible deviations on the set values for steady-state operation tests (Supplement table reference protocol for air-to-air and air-to-water (brine) appliances)

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
Outdoor water (brine)				
- inlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,2 K ±0,2 K ±0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,5 K ±0,7 K ±0,9 K
- outlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,3 K ±0,3 K ±0,4 K	/	/

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
- flow rate	rating capacity others capacities	±2 % /	rating capacity others capacities	±5 % /
Outdoor and indoor air				
- inlet temperature (dry bulb/wet bulb) [a] - flow rate (volume) - static pressure drop	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 % rating capacity others capacities rating capacity others capacities	±0,3 K ±0,5 K ±0,6 K ±5 % / / /	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 % rating capacity others capacities rating capacity others capacities	±1,0 K ±1,2 K ±1,4 K ±10 % / ±10 % /
NOTE Permissible deviation includes the regulating capability of the test apparatus.				
[a] For appliances with outdoor heat exchanger surfaces greater than 5 m2, the deviation on the air inlet dry bulb is doubled.				

4.5.2.1.2 Measurement of heating capacity, cooling capacity, engine heat recovery capacity, gas input and electrical power input

The heating capacity, cooling capacity, heat recovery capacity and inputs shall be measured in the steady-state operation conditions. The duration of the data collection is 35 min. All data to be collected during the same period at the same frequency.

4.5.2.1.3 Measurement of GUE

The duration of the data collection is divided in four 10 min duration parts. A GUE is calculated for each part. The fluctuations of the GUE of the different four parts are permissible on condition the standard deviation of them does not exceed 1,5 % and the deviations of individual GUE from mean value does not exceed 3,0 %.

4.5.2.2 Measurement in cooling mode for air-to-water (brine) and air-to-air appliances

4.5.2.2.1 Steady-state operation conditions

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 11. Periodic fluctuations of measured quantities caused by the operation of regulation and control devices are permissible, on condition the value of such fluctuations does not exceed the permissible deviations listed in Table 11. The data collection period follows this period of 1 h. All the requirements apply at reduced load too when the gas fired engine operates at least at its minimal rotation speed.

4.5.2.2.2 Measurement of cooling capacity, heat recovery capacity, gas input and electrical power input

The cooling capacity, heat recovery capacity and inputs shall be measured in the steady-state operation conditions. The duration of the data collection is 35 min. All data to be collected during the same period at the same frequency.

4.5.2.2.3 Measurement of GUE

The duration of the data collection is divided in four 10 min duration parts. A GUE is calculated for each part. The fluctuations of the GUE of the different four parts are permissible on condition the standard deviation of them does not exceed 1,5 % and the deviations of individual GUE from mean value does not exceed 3,0 %.

4.5.2.3 Measurement in heating mode for air-to-air when using the air enthalpy method and air-to-water appliances

4.5.2.3.1 General

The test procedure consists of three periods: a preconditioning period, an equilibrium period, and a data collection period. The duration of the data collection differs depending upon whether the heat pump's operation is in steady-state operation or transient operation.

Annex J gives a flow chart of the procedure and pictorially represents most of the different test sequences that are possible when conducting a heating capacity test.

4.5.2.3.2 Preconditioning period

The test room preconditioning apparatus and the appliance under test shall be operated until the appropriate test tolerances specified in Table 11 are attained for at least 10 min.

A defrost cycle may end a preconditioning period. If a defrost cycle does end a preconditioning period, the appliance shall operate in the heating mode for at least 10 min after defrost termination prior to beginning the equilibrium period. It is recommended that the preconditioning period ends with an automatic or manually-induced defrost cycle.

4.5.2.3.3 Equilibrium period

The equilibrium period immediately follows either the preconditioning period or a "recovery" period of 10 min after the defrost cycle that ends the preconditioning period.

A complete equilibrium period is one hour in duration.

The appliance shall operate while meeting the appropriate test tolerances specified in Table 11, except as specified in 4.5.2.3.7 (Test procedure for transient operation).

4.5.2.3.4 Data collection period

The data collection period immediately follows the equilibrium period.

The difference between the outlet and inlet temperatures of the heat transfer medium at the indoor heat exchanger shall be measured. For each interval of 5 min during the data collection period, an average temperature difference shall be calculated, ΔTi (τ). The average temperature difference for the first 5 min of the data collection period, ΔTi ($\tau = 0$), shall be saved for the purpose of calculating the following parameter.

$$\%\Delta T = \frac{\left(\Delta Ti\left(\tau = 0\right) - \Delta Ti\left(\tau\right)\right)}{\Delta Ti\left(\tau = 0\right)} * 100 \quad (33)$$

where

$\%\Delta T$	is the coefficient of change, in Kelvin per Kelvin;
$\Delta Ti(\tau = 0)$	is the average difference between the outlet and inlet temperatures for the first 5 min period; in Kelvin;
$\Delta Ti(\tau)$	is the average difference between the outlet and inlet temperatures for other 5 min period than the first 5 min, in Kelvin.

If the coefficient of change (%ΔT) remains within 2,5 % during the first 70 min of the data collection period, and the appropriate test tolerances specified in Table 5, Table 6 or Table 7 and Table 8 are satisfied during both the equilibrium period and the first 70 min of the data collection period, then the test shall be designated a steady-state operation test. Steady-state operation tests shall be terminated after 70 min of data collection.

4.5.2.3.5 Test procedure when a defrost ends the preconditioning period

When a defrost ends the preconditioning period, if the appliance initiates a defrost cycle during the equilibrium period or during the first 70 min of the data collection period, the test shall be designated a transient operation test (see 4.5.2.3.7).

4.5.2.3.6 Test procedure when a defrost does not end the preconditioning period

4.5.2.3.6.1 General

When a defrost does not end the preconditioning period, either 4.5.2.3.6.2 or 4.5.2.3.6.3 or 4.5.2.3.6.4 applies.

4.5.2.3.6.2 Case 1

If the appliance initiates a defrost cycle during the equilibrium period or during the first 70 min of the data collection period, the test shall be restarted as 4.5.2.3.6.4.

4.5.2.3.6.3 Case 2

If the coefficient of change (%ΔT) exceeds 2,5 % any time during the first 70 min of the data collection period, then the test procedure shall be restarted as specified in 4.5.2.3.6.4. Prior to the restart, defrost cycle shall occur. This defrost cycle may be manually initiated or delayed until the appliance initiates an automatic defrost.

4.5.2.3.6.4 Case 3

If either 4.5.2.3.6.2 or 4.5.2.3.6.3 apply, then the restart shall begin 10 min after the defrost cycle terminates with a new equilibrium period of one hour. This second attempt shall follow the requirements of 4.5.2.3.3 and 4.5.2.3.4 and the test procedure of 4.5.2.3.5.

4.5.2.3.7 Test procedure for transient operation tests

When, in accordance with 4.5.2.3.5, the test is designated a transient operation test, the following adjustments shall apply.

To constitute a valid transient operation test, the test tolerances specified in Table 12 shall be achieved during both the equilibrium period and the data collection period. As noted in Table 12, the test tolerances are specified for two sub-intervals. Interval H consists of data collected during each heating interval, with the exception of the first 10 min after defrost termination. Interval D consists of data collected during each defrost cycle plus the first 10 min of the subsequent heating interval.

The test tolerance parameters in Table 12 shall be determined throughout the equilibrium and data collection periods. All data collected during each interval, H or D, shall be used to evaluate compliance with the Table 12 test tolerances. Data from two or more H intervals or two or more D intervals shall not be combined and then used in evaluating Table 12 compliance. Compliance is based on evaluating data from each interval separately.

The data collection period shall be extended until 3 h have elapsed or until the heat pump completes three complete cycles during the period, whichever occurs first. If at an elapsed time of 3 h, the appliance is conducting a defrost cycle, the cycle shall be completed before terminating the collection of data. A complete cycle consists of a heating period and a defrost period, from defrost termination to defrost termination.

Table 12 — Permissible deviations on the set values in heating mode when using the transient test procedure

Readings	Variations of arithmetical mean values from specified test conditions		Variation of individual readings from specified test conditions	
	Interval H [a]	Interval D [b]	Interval H [a]	Interval D [b]
Temperature of air entering indoor-side: - dry-bulb [c] - wet-bulb	 ±0,6 K –	 ±1,5 K –	 ±1,0 K –	 ±2,5 K –
Temperature of air entering outdoor-side: - dry-bulb [c] - wet-bulb	 ±0,6 K ±0,4 K	 ±1,5 K ±1,0 K	 ±1,0 K ±0,6 K	 ±5,0 K /
Inlet water temperature	±0,2 K	/	±0,5 K	/
Outlet or mean temperature	±0,5 K	/	±1,0 K	/
Water flow rate	±2 %	/	5 %	/
Electrical input - voltage	±4 %		±4 %	

NOTE Permissible deviation includes the regulating capability of the test apparatus during transient occurrences.

[a] Applies when the appliance is in the heating mode, except for the first 10 min after termination of a defrost cycle.

[b] Applies during the defrost cycle and during the first 10 min after the termination of a defrost cycle when the appliance is operating in the heating mode.

[c] For appliances with outdoor heat exchanger surfaces greater than 5 m2, the deviation on the air inlet dry bulb temperature is doubled.

4.5.2.3.8 Measurement of heating capacity, gas and electrical power inputs

During defrost cycles plus the first 10 min following defrost termination, data used in evaluating the heating capacity, the gas input and the electrical power input of the appliance could be sampled more frequently than during the rest of the data collection period. All data to be collected during the same period at the same frequency(ies).

4.5.2.3.9 Measurement of GUE

A GUE is calculated using heating capacity and gas input during the same data collection period.

4.5.2.3.10 Reduced load tests

The heating and cooling capacities measured on the liquid side shall be determined within a maximum uncertainty of (2+3/part load ratio) %.

The steady-state heating and cooling capacities determined using the calorimeter method shall be determined with a maximum uncertainty of:

— 5 % when the capacity measured is greater than 2,0 kW;

— 10 % when the capacity measured is between 1,0 kW and 2,0 kW;

— 15 % if it is lower than 1,0 kW.

The heating capacities determined during transient operation (defrost cycles) using the calorimeter method shall be determined with a maximum uncertainty of 10 %.

The heating and cooling capacities measured on the air side using the air enthalpy method shall be determined with a maximum uncertainty of (4+6/part load ratio) %.

All uncertainties of measurement are independent of the individual uncertainties of measurement including the uncertainties on the properties of fluids.

4.5.2.4 Measurement in heating mode for air-to-air appliances when using the calorimeter method

4.5.2.4.1 General

The test procedure consists of two periods: an equilibrium period, and a data collection period. The duration of the data collection differs depending upon whether the heat pump's operation is steady-state or transient.

4.5.2.4.2 Equilibrium period

The test room reconditioning apparatus and the heat pump under test shall be operated until the test tolerances specified in Table 10 are attained for at least 1 h, except if a defrost occurs during this period in which case the test tolerances specified in Table 12 apply.

If a defrost occurs during the equilibrium period, then the test procedure described in 4.5.2.4.5 applies.

4.5.2.4.3 Data collection period

Data shall be sampled at equal intervals that span every 10 s or less, except during defrost cycles as specified below.

The duration of measurement shall be not less than 70 min.

The difference between the leaving and entering temperatures of the heat transfer medium at the indoor heat exchanger shall be measured. For each interval of 5 min during the data collection period, an average temperature difference shall be calculated, ΔTi (τ). The average temperature difference for the first 5 min of the data collection period, ΔTi ($\tau = 0$), shall be saved for the purpose of calculating the following percent change:

$$\%\Delta T = \frac{\left(\Delta Ti\left(\tau = 0\right) - \Delta Ti\left(\tau\right)\right)}{\Delta Ti\left(\tau = 0\right)} * 100 \quad (34)$$

where

$\%\Delta T$	is the coefficient of change, in Kelvin per Kelvin;
$\Delta Ti(\tau = 0)$	is the average difference between the outlet and inlet temperatures for the first 5 min period; in Kelvin;
$\Delta Ti(\tau)$	is the average difference between the outlet and inlet temperatures for other 5 min period than the first 5 min, in Kelvin.

4.5.2.4.4 General test procedure

If a defrost occurs before the start of the data collection period, or if the quantity (%ΔT) exceeds 2,5 % during the data collection period, the heating capacity test shall be designated a transient test (see 4.5.2.4.5). Likewise, if the heat pump initiates a defrost cycle during the equilibrium period or during the data collection period, the heating capacity test shall be designated a transient test.

If the above conditions do not occur and the test tolerances specified in Table 11 are satisfied during both the equilibrium period and the data collection period, then the heat capacity test shall be designated a steady-state test. Steady-state tests shall be terminated after at least 70 min of data collection.

4.5.2.4.5 Test procedure for transient tests

When, in accordance with 4.5.2.4.4, a heating capacity test is designated a transient test, the following adjustments shall apply. To constitute a valid transient heating capacity tests, the test tolerances specified in Table 12 shall be achieved during both the equilibrium period and the data collection period. As noted in Table 12, the test tolerances are specified for two sub-intervals. Interval H consists of data collected during each heating interval, with the exception of the first 10 min after defrost termination. Interval D consists of data collected during each defrost cycle plus the first 10 min of the subsequent heating interval.

All data collected during each interval, H or D, shall be used to evaluate compliance with Table 12. Data from two or more H intervals or two or more D intervals shall not be combined and then used in evaluating Table 12 compliance. Compliance is based on evaluating data from each interval separately.

The data collection period shall be extended until 3 h at least have elapsed and until a full number of complete cycles have elapsed, except if the medium time interval for a full cycle is greater than 2 h, in which case the data collection period shall be of one full cycle only or 4 h, whichever is the shortest. A complete cycle consists of a heating period and a defrost period, from defrost termination to defrost termination. With this procedure, the maximum duration of the data collection period is 4 h.

During defrost cycles, plus the first 10 min following defrost termination, data used in evaluating the integrated heating capacity and the integrated power input of the heat pump shall be sampled more frequently, at equal intervals that span every 10 s or less. When using the calorimeter room method, these more frequently sampled data include all measurements required to determine the indoor-side capacity.

For heat pumps that automatically turn off the indoor fan during a defrost cycle, the integration of capacity shall continue while the indoor fan is off.

4.5.3 Cyclical operation

4.5.3.1 Basic principles

4.5.3.1.1 General

Capacities, gas and electrical power inputs are obtained from a number of complete stabilized “calculation cycles” of the energy “released” and of the energy consumption, respectively.

A “calculation cycle” may consist of more than one “gas engine cycle”.

A “gas engine cycle” consists of a period from an ignition of the start of gas engine to the following restart of gas engine.

The data collection period shall be extended until the appliance completes four complete “calculation cycles”.

The effectives capacities shall be obtained from the measured capacities and the corrections from the heat of the pump(s) or the fan(s) responsible for circulating the heat transfer medium through the indoor heat exchanger. The effective electrical power input shall be obtained from the measured electrical power input and the corrections from the heat of the pump(s) or fan(s) responsible for circulating the heat transfer medium through the indoor heat exchanger and the pump(s) or the fan(s) responsible for circulating the heat transfer medium through the outdoor heat exchanger, if relevant.

At least, once every 10 s sampling is required in order to have real-time measurement of the duties (heating, cooling and recovery capacities and gas and electrical power inputs).

Periodic fluctuations of measured quantities caused by the operation of regulation and control devices of the appliance are permissible on condition the value of such fluctuations does not exceed the permissible deviations listed in Table 13, Table 14 or Table 15 for air-to-water (brine) and in Table 16 for air-to-air appliances.

4.5.3.1.2 For air-to-water (brine) appliances

Table 13 — Permissible deviations on the set values for cyclical operation tests for fixed delta T protocol (reference protocol)

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
Outdoor air				
Inlet temperature: - dry-bulb (wet-bulb) [a]	±1,5 K (/)		±2,5 K (/)	
Air flow rate (volume)	/		/	
Air static pressure	/		/	
Indoor water or brine				
Inlet temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,2 K ±0,2 K ±0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,5 K ±0,7 K ±0,9 K
Flow rate	all reduced capacities	/	all reduced capacities	/
Electrical input				
- voltage	±4 %		±4 %	
NOTE Permissible deviation includes the regulating capability of the test apparatus.				
[a] For appliances with outdoor heat exchanger surfaces greater than 5 m2, the deviation on the air inlet dry bulb is doubled.				

Table 14 — Permissible deviations on the set values for cyclical operation tests for outlet temperature protocol and mean temperature protocol

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
Outdoor air				
Inlet temperature: - dry-bulb (wet-bulb) a	±1,5 K (/)		±2,5 K (/)	
Air flow rate (volume)	/		/	
Air static pressure	/		/	
Indoor water or brine				
Inlet temperature leading to the target outlet or mean temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,2 K ±0,2 K ±0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,5 K ±0,7 K ±0,9 K
Outlet temperature or mean temperature	maximum > load ≥ 15 %	±0,5 K	maximum > load ≥ 15 %	/
Flow rate	all reduced capacities	/	all reduced capacities	/
Electrical input				
- voltage	±4 %		±4 %	
NOTE Permissible deviation includes the regulating capability of the test apparatus.				
a For appliances with outdoor heat exchanger surfaces greater than 5 m2, the deviation on the air inlet dry bulb is doubled.				

Table 15 — Permissible deviations on the set values for cyclical operation tests for inlet temperature protocol

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
Outdoor air				
Inlet temperature: - dry-bulb (wet-bulb) [a]	±1,5 K (/)		±2,5 K (/)	
Air flow rate (volume)	/		/	
Air static pressure	/		/	
Indoor water or brine				
Inlet temperature leading to the target outlet or mean temperature	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,2 K ±0,2 K ±0,3 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,5 K ±0,7 K ±0,9 K
Flow rate	all reduced capacities	/	all reduced capacities	/
Electrical input				
- voltage	±4 %		±4 %	
NOTE Permissible deviation includes the regulating capability of the test apparatus.				
[a] For appliances with outdoor heat exchanger surfaces greater than 5 m^2, the deviation on the air inlet dry bulb is doubled.				

4.5.3.1.3 For air-to-air appliances

Table 16 — Permissible deviations on the set values for cyclical operation tests

Measured quantity	Permissible deviations of the time average measured values from set values		Permissible deviations of individual measured values from time average measured values	
Indoor air				
Inlet temperature: - dry-bulb (wet-bulb)	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±0,3 K ±0,5 K ±0,6 K	maximum > load ≥ 70 % 70 % > load ≥ 40 % 40 % > load ≥ 15 %	±1,0 K ±1,2 K ±1,4 K
Air flow rate (volume)	all reduced capacities	/	all reduced capacities	/
NOTE Permissible deviation includes the regulating capability of the test apparatus.				

Furthermore, the fluctuations of the GUE (calculation quantity) of the different four calculation cycles are permissible on condition the standard deviation of them does not exceed 2,5 % and the deviations of individual GUE from mean value does not exceed 5,0 %.

4.5.3.2 Reduced load tests

The heating and cooling capacities measured on the liquid side shall be determined within a maximum uncertainty of (2+3/part load ratio) %.

The steady-state heating and cooling capacities determined using the calorimeter method shall be determined with a maximum uncertainty of:

— 5 % when the capacity measured is greater than 2,0 kW;

— 10 % when the capacity measured is between 1,0 kW and 2,0 kW;

— 15 % if it is lower than 1,0 kW.

The heating capacities determined during transient operation (defrost cycles) using the calorimeter method shall be determined with a maximum uncertainty of 10 %.

The heating and cooling capacities measured on the air side using the air enthalpy method shall be determined with a maximum uncertainty of (4+6/part load ratio) %.

All uncertainties of measurement are independent of the individual uncertainties of measurement including the uncertainties on the properties of fluids.

4.6 Test methods for electric power consumption during thermostat off mode, standby mode and off mode

4.6.1 Measurement of electrical power consumption during thermostat off mode

In cooling mode (for cooling only or reversible appliances), the thermostat set point is increased until the engine stops. The electrical power consumption is measured over a time period not less than one hour to determine the thermostat off power. For heating mode, the same principle applies but the thermostat set point should be decreased until the engine stops.

4.6.2 Measurement of the electrical power consumption during standby mode

The appliance is stopped with the control device. After 10 min, the electrical power consumption is measured for a time period not less than one hour and assumed to be the standby mode electrical power consumption.

4.6.3 Measurement of the electric power consumption during crankcase heater mode

If the crankcase heater is on during standby measurements, then the power consumption due to the crankcase heater mode shall be considered equal to the standby power consumption.

If the crankcase heater is not operating during standby measurement then a test shall be performed as follows:

The unit is stopped (in heating mode) with the control device. The energy consumption of the unit shall be measured for 8 h. Average of 8 h power input shall be calculated.

The standby power consumption is deducted from this measured energy consumption to determine the crankcase heater operation consumption.

NOTE It is assumed that the crankcase heater operates when the compressor is off and the outdoor temperature is lower than a given value. This value is the temperature under which the crankcase heater starts up and depends on the crankcase heater control type.

4.6.4 Measurement of the electric power consumption during off mode

Following the standby mode electrical power consumption test, the appliance should be switched in off mode while remaining plugged. After 10 min, the electrical power consumption is measured for a time period not less than one hour and assumed to be the off mode electrical power consumption. In case no off mode switch is available on the appliance, the standby mode electrical power is supposed equal to the off mode electrical power.

4.7 Test results — Data to be recorded

The data to be recorded for capacities, inputs and rational use of energy measurements is given in Table 17. The table identifies the general information required but is not intended to limit the data to be obtained.

NOTE In this clause, the result of a calculation based on various data are considered as data.

The data will be the integrated values taken over the data collection period except time measurement during transient and cyclical operation tests, gas density, Wobbe index and gas calorific value (when the gas comes from a tank and this tank as not been changed during the tests).

Table 17 — Data to be recorded

Measured quantity of result	Unit	Calorimeter	Air enthalpy	Water enthalpy
1) Ambient conditions	°C	-	X	-
- air temperature, dry bulb	mbar	X	X	X
- atmospheric pressure				
2) Gas quantities	m^3/h or kg/h	X	X	X
- gas flow rate	mbar	X	X	X
- gas pressure (absolute or relative)	°C	X	X	X
- gas temperature	MJ/m^3 or MJ/kg	X	X	X
- gas calorific value (net and gross)	kg/m^3 or $kg.m^3/kg.m^3$	X	X	X
- gas density (absolute or relative) or	MJ/m^3 or MJ/kg	X	X	X
- Wobbe index (net or gross)				
3) Electrical quantities	V	X	X	X
- voltage	A	X	X	X
- total current	W	X	X	X
- total power input, P_T	W	X	X	X
- effective power input, P_E	W	X	X	X
- power consumption thermostat off mode	W	X	X	X
- power consumption standby mode	W	X	X	X
- power consumption off mode				
4) Thermodynamic quantities	°C	X	X	-
a) Indoor heat exchanger	°C	X	X	-
a-1) Air	°C	-	X	-
- inlet temperature, dry bulb	°C	-	X	-
- inlet temperature, wet bulb	Pa	X	X	-
For duct connection	m^3/s	-	X	-
- outlet temperature, dry bulb	kg/s	X	X	-
- outlet temperature, wet bulb	°C	X	-	X
- external/internal static pressure difference	°C	X	-	X
- volume flow rate	m^3/s or kg/s	X	-	X
- rate of condensate	kPa	X	-	X
a-2) Water or brine	-	-	-	X

Measured quantity of result	Unit	Calorimeter	Air enthalpy	Water enthalpy
- inlet temperature				
- outlet temperature				
- flow rate				
- pressure drop				
- pump speed setting, if applicable				
4) Thermodynamic quantities	°C	X	X	X
b) Outdoor heat exchanger	°C	X	X	X
b-1) Air	°C	-	X	-
- inlet temperature, dry bulb	°C	-	X	-
- inlet temperature, wet bulb	Pa	X	X	-
For duct connection	m^3/s	X	X	X
- outlet temperature, dry bulb	°C	X	X	X
- outlet temperature, wet bulb	°C	X	X	X
- external/internal static pressure difference	m^3/s or kg/s	X	X	X
- volume flow rate	kPa	X	X	X
b-2) Water or brine	-	-	-	X
- inlet temperature				
- outlet temperature				
- flow rate				
- pressure drop				
- pump speed setting, if applicable				
c) Engine heat recovery heat exchanger	°C	-	-	X
- inlet temperature	°C	-	-	X
- outlet temperature	m^3/s	-	-	X
- volume flow rate	kPa	-	-	X
- pressure drop	-	-	-	X
- pump speed setting, if applicable				
d) Heat transfer medium (other than water)	-	-	-	-
- concentration	%	X	X	X
- density	kg/m^3	X	X	X
- specific heat	J/kg.K	X	X	X
e) Gas engine and compressor	rpm	X	X	X
- rotation speed of gas engine	-	X	X	X
- number of compressor(s) working				
f) Calorimeter	W	X	-	-
- heat input to calorimeter	W	X	-	-
- heat extracted from calorimeter	°C	X	-	-
- ambient temperature around the calorimeter	°C	X	-	-
- temperature of the water entering the humidifier	°C	X	-	-
- condensate temperature				
g) Defrost	s	X	X	X
- defrost period	min	X	X	X
- operating cycle with defrost				
5) Data collection period	min	X	X	X
- data collection period	-	X	X	X
- number of ON/OFF gas engine cycles during the calculation cycle				

Measured quantity of result	Unit	Calorimeter	Air enthalpy	Water enthalpy
6) Capacities	W	X	X	X
- measured heating capacity (*P*H)	W	X	X	X
- measured total cooling capacity (*P*C)	W	X	X	X
- measured latent cooling capacity (*P*L)	W	X	X	X
- measured sensible cooling capacity (*P*S)	W	-	-	X
- measured heat recovery capacity				
7) Ratios	W/W	X	X	X
- GUEh	W/W	X	X	X
- GUEc	W/W	X	X	X
- GUEshc	W/W	X	X	X
- GUEhT	W/W	X	X	X
- GUEcT	W/W	X	X	X
- GUEshcT	W/W	X	X	X
- AEFh	W/W	X	X	X
- AEFc	W/W	X	X	X
- AEFshc	W/W	X	X	X
- AEFhT	W/W	X	X	X
- AEFcT	W/W	X	X	X
- AEFshcT				

5 Heat recovery test for air-cooled multisplit systems

5.1 Test installation

5.1.1 General

The heat recovery capacity of the system is determined by measurements in a three-room calorimeter or by the air enthalpy method using two or three rooms. The three rooms shall consist of one outdoor room and two indoor rooms, one at the heating condition and the other at the cooling condition. The two-room air enthalpy method shall have one room at the outdoor condition and the other at the common indoor side condition given in EN 16905-3:2017, Table 5.

The calorimeter room and air enthalpy methods are described in Annex A and Annex B respectively. Each calorimeter room should satisfy the requirements of Annex A and the test facilities for the air enthalpy method should satisfy the requirements of Annex B.

5.1.2 Three-room calorimeter method

If measurements are made by the calorimeter method, then the testing of a heat recovery system shall need a three-room calorimeter test facility. The indoor units in the cooling mode shall be assembled in one room and the indoor units in the heating mode in the other. The outdoor unit shall be installed in the third room.

5.1.3 Three-room air-enthalpy method

The indoor units in the cooling mode shall be assembled in one room and the indoor units in the heating mode in another room; the outdoor unit shall be installed in the third room.

5.1.4 Two-room air-enthalpy method

All indoor units, either operating in cooling or heating mode, are assembled in one indoor room. The outdoor unit shall be installed in the other room.

All units operating in the heating mode should be connected to a common plenum; all units operating in the cooling mode should be connected to another common plenum, both in accordance with the requirements established in Annex B.

5.2 Test procedure

The heat recovery test shall be carried out with all operating indoor units.

For ducted indoor units, the individual external static pressure of each indoor unit is set by adjusting a damper located in the duct length connecting the discharge area of the unit to the common plenum.

5.3 Test results

For the results to be valid, the sum of the cooling capacity of the indoor units (see A.6.2) and the electrical power input plus the gas power input to the engine and any fans should differ by not more than 10 % from the sum of the heating capacity of the indoor units (see A.7.2) plus the heat from the outdoor unit plus the enthalpy of exhaust gases plus engine heat recovery. The heat from the outdoor unit may be negative if the unit is absorbing heat, or positive if the unit is rejecting heat.

Test results are recorded and expressed as specified in 4.5. The references of the indoor units operating in cooling mode and of the indoor units operating in heating mode shall be specified.

6 Test report

6.1 General information

The test report shall at least contain:

a) date;

b) test institute;

c) test location;

d) test method;

e) test supervisor;

f) appliance designation:

   1) type;

   2) serial / sample number;

   3) name of the manufacturer;

   4) flue type;

   5) gas family;

   6) gas engine type (number of cylinder(s));

   7) number and type of compressor(s);

g) type of refrigerant;

h) mass of refrigerant;

i) properties of heat transfer medium if different from water or air;

j) reference to this European Standard.

6.2 Additional information

Additional information given on the rating plate shall be noted and any other information relevant for the test. Particularly, it shall be stated whether the test is performed on an appliance new or not. In the case of a test performed on an appliance in use, information relative to the year of installation and of the heat exchange tubes cleaning shall be given.

6.3 Rating test results

Effective capacities, gas and electrical power inputs, GUE, AEF, internal or external static pressure shall be given together with the corresponding rating conditions.

Annex A
(normative)

Calorimeter test method

A.1 General

A.1.1 The calorimeter provides a method for determining capacity simultaneously on both the indoor-side and the outdoor-side. In the cooling mode, the indoor-side capacity determination is made by balancing the cooling and dehumidifying effects with measured heat and water inputs. The outdoor-side capacity provides a confirming test of the cooling and dehumidifying effect by balancing the heat and water rejection on the condenser side with a measured amount of cooling.

A.1.2 The size of the calorimeter shall be sufficient to avoid any restriction to the intake or discharge openings of the equipment. Perforated plates or other suitable grilles shall be provided at the discharge opening from the reconditioning equipment to avoid face velocities exceeding 1,0 m/s. Sufficient space shall be allowed in front of any inlet or discharge grilles of the equipment to avoid interference with the air flow. Minimum distance from the equipment to side walls or ceiling of the compartment(s) shall be 1 m, except for the back of console-type equipment and single duct units, which shall be in normal relation to the wall. Ceiling mounted equipment shall be installed at a minimum distance of 1,8 m from the floor. Table A.1 gives the suggested dimensions for the calorimeter. To accommodate peculiar sizes of equipment, it may be necessary to alter the suggested dimensions to comply with the space requirements.

Table A.1 — Sizes of calorimeter

Rating cooling capacity of equipment W	**Suggested minimum inside dimensions of each room of calorimeter** m		
	Width	Height	Length
3 000	2,4	2,1	1,8
6 000	2,4	2,1	2,4
9 000	2,7	2,4	3,0
12 000	3,0	2,4	3,7

For larger capacity equipment, the following dimensions are recommended:

— Width ≥ 4 times the unit width;

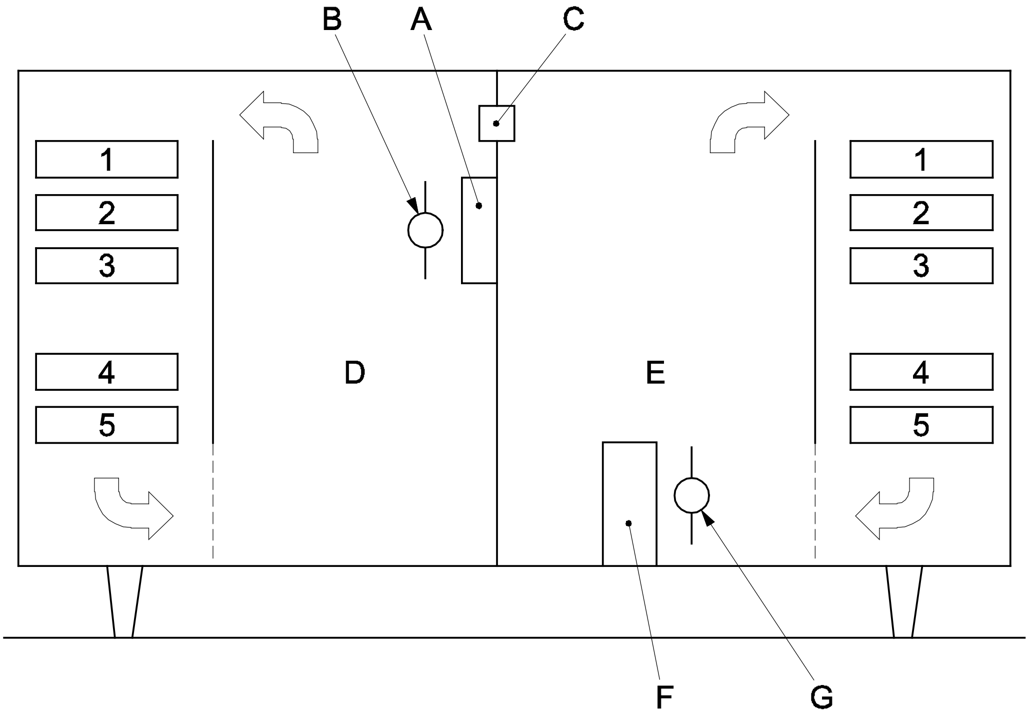
— Height ≥ 2,5 times the unit height;

— Length ≥ 1,5 times the unit length.

A.1.3 Each compartment shall be provided with reconditioning equipment to maintain specified air flow and prescribed conditions. Reconditioning apparatus for the indoor-side compartment shall consist of heaters to supply sensible heat and a humidifier to supply moisture. Reconditioning apparatus for the outdoor-side controlled and measured.

When calorimeters are used for heat pumps, they shall have heating, humidifying and cooling capabilities for both rooms (see Figures A.1 and A.2) or other means, such as rotating the equipment, may be used as long as the rating conditions are maintained. The exhaust gas evacuation pipe shall be such that it shall not affect the air of the calorimeter room.

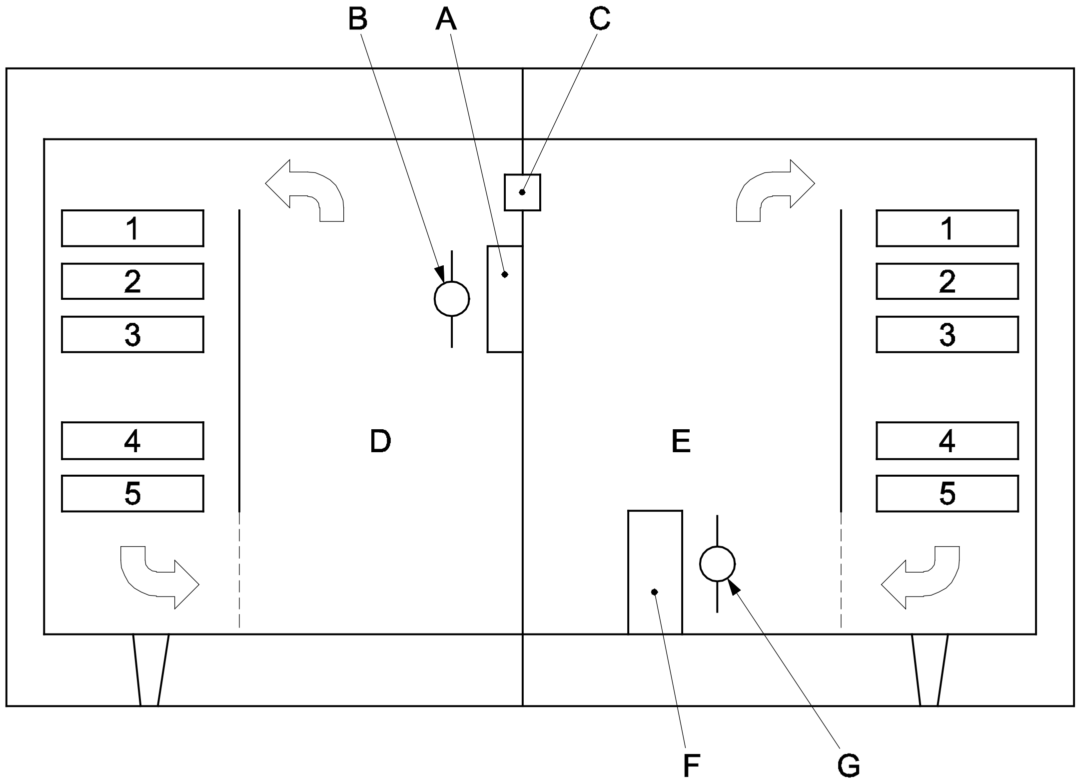
A.1.4 Reconditioning apparatus for both compartments shall be provided with fans of sufficient capacity to ensure air flows of not less than twice the quantity of air discharged by the equipment under test in the calorimeter. The calorimeter shall be equipped with means of measuring or determining specified wet- and dry-bulb temperatures in both calorimeter compartments.



Key

A	indoor unit (wall mounted)	1	cooling coil
B	air sampling tubes	2	heating coil
C	pressure equalizing system	3	humidifier
D	indoor room side	4	fan
E	outdoor room side	5	mixers
F	outdoor unit		
G	air sampling tubes		

Figure A.1 — Typical calibrated ambient room type calorimeter



Key

A	indoor unit (wall mounted)	1	cooling coil
B	air sampling tubes	2	heating coil
C	pressure equalizing system	3	humidifier
D	indoor room side	4	fan
E	outdoor room side	5	mixers
F	outdoor unit		
G	air sampling tubes		

Figure A.2 — Typical balanced ambient room type calorimeter

A.1.5 A pressure-equalizing device shall be provided in the partition wall between the indoor-side and the outdoor-side compartments to maintain a balanced pressure between these compartments. This device consists of one or more nozzles, a discharge chamber equipped with an exhaust fan and manometers for measuring compartment and air flow pressures.

Since the air flow from one compartment to the other may be in either direction, two such devices mounted in opposite directions, or a reversible device, shall be used. The manometer pressure tubes shall be so located as to be unaffected by air discharged from the equipment or by the exhaust from the pressure-equalizing device. The fan or blower, which exhausts air from the discharge chamber, shall permit variation of its air flow by any suitable means, such as variable speed drive or a damper. The exhaust from this fan or blower shall be such that it shall not affect the inlet air to the equipment.

A.1.6 It is recognized that in both the indoor-side and outdoor-side compartments, temperature gradients and air flow patterns result from the interaction of the reconditioning apparatus and test equipment. Therefore, the resultant conditions are peculiar to and dependent upon a given combination of compartment size, arrangement and size of reconditioning apparatus, and the air discharge characteristics of the equipment under test.

The point of measurement of the specified test temperatures, both wet bulb – or dew point - and dry-bulb, temperatures shall be such that the following conditions are fulfilled:

a) The measured temperatures shall be representative of the temperature surrounding each piece of the equipment and shall simulate the conditions encountered in an actual application for both indoor and outdoor sides, as indicated above.

b) At the point of measurement, the temperature of air shall not be affected by air discharged from any piece of the equipment. This makes it mandatory that the temperatures are measured upstream of any recirculation produced by the equipment.

Air sampling tubes shall be positioned on the intake side of the equipment.

A.1.7 Interior surfaces of the calorimeter compartments shall be of non-porous material with all joints sealed against air and moisture leakage. The access door shall be tightly sealed against air and moisture leakage by use of gaskets or other suitable means.

A.1.8 When using the calorimeter room method, the capacity determined using the outdoor-side data should agree within 5 % of the value obtained using the indoor-side data.

In the case of non-ducted air conditioners with water-cooled condensers, the heat flow rejected via the cooling water is measured instead of the measurement in the outdoor-side compartment.

A.2 Transient heating capacity test

If defrost controls on the heat pump provide for stopping the indoor air flow, provision shall be made to stop the test apparatus air flow to the equipment on both the indoor and outdoor-sides during such a defrost period. If it is desirable to maintain operation of the reconditioning apparatus during the defrost period, provision may be made to bypass the conditioned air around the equipment as long as assurance is provided that the conditioned air does not aid in the defrosting. A watt-hour meter shall be used for obtaining the integrated electrical input to the equipment under test.

A.3 Calibrated room-type calorimeter

A.3.1 The calibrated room-type calorimeter is shown in Figure A.1. Each calorimeter, including the separating partition, shall be insulated to prevent heat leakage (including radiation) in excess of 5 % of the equipment's capacity. An air space permitting free circulation shall be provided under the calorimeter floor.

A.3.2 Heat leakage may be determined in either the indoor-side or outdoor-side compartment by the following method: all openings shall be closed. Either compartment may be heated by electric heaters to a temperature of at least 11 K above the surrounding ambient temperature. The ambient temperature shall be maintained constant within ± 1 K outside all six enveloping surfaces of the compartment, including the separating partition. If the construction of the partition is identical with that of the other walls, the heat leakage through the partition may be determined on a proportional area basis.

A.3.3 For calibrating the heat leakage through the separating partition alone, the following procedure may be used: a test is carried out as described above. Then the temperature of the adjoining area on the other side of the separating partition is raised to equal the temperature in the heated compartment, thus eliminating heat leakage through the partition, while the 11 K differential is maintained between the heated compartment and the ambient surrounding the other five enveloping surfaces.

The difference in heat input between the first test and second test shall permit the determination of the leakage through the partition alone.

A.3.4 For the outdoor-side compartment equipped with means for cooling, an alternative means of calibration may be to cool the compartment to a temperature at least 11 K below the ambient temperature (on six sides) and carry out a similar analysis.

A.3.5 As an alternative to the two-room simultaneous method of determining capacities, the performance of the indoor room-side compartment may be verified at least every six months using an industry standard cooling capacity calibrating device. A calibrating device may also be another piece of equipment whose performance has been measured by the simultaneous indoor and outdoor measurement method at an accredited national test laboratory as part of an industry-wide cooling capacity verification program.

A.4 Balanced ambient room-type calorimeter

A.4.1 The balanced ambient room-type calorimeter is shown in Figure A.2 and is based on the principle of maintaining the dry-bulb temperatures surrounding the particular compartment equal to the dry-bulb temperatures maintained within that compartment. If the ambient wet-bulb temperature is also maintained equal to that within the compartment, the vapour-proofing provisions of A.1.6 are not required.

A.4.2 The floor, ceiling, and walls of the calorimeter compartments shall be spaced a sufficient distance away from the floor, ceiling, and walls of the controlled areas in which the compartments are located in order to provide a uniform air temperature in the intervening space. It is recommended that this distance be at least 0,3 m. Means shall be provided to circulate the air within the surrounding space to prevent stratification.

A.4.3 Heat leakage through the separating partition shall be introduced into the heat balance calculation and may be calibrated in accordance with A.3.3, or may be calculated.

A.4.4 It is recommended that the floor, ceiling, and walls of the calorimeter compartments be insulated so as to limit heat leakage (including radiation) to no more than 10 % of the test equipment's capacity, with an 11 K temperature difference, or 300 W for the same temperature difference, whichever is greater, as tested using the procedure given in A.3.2.

A.5 Calorimeter and auxiliary equipment for water-cooled condenser tests

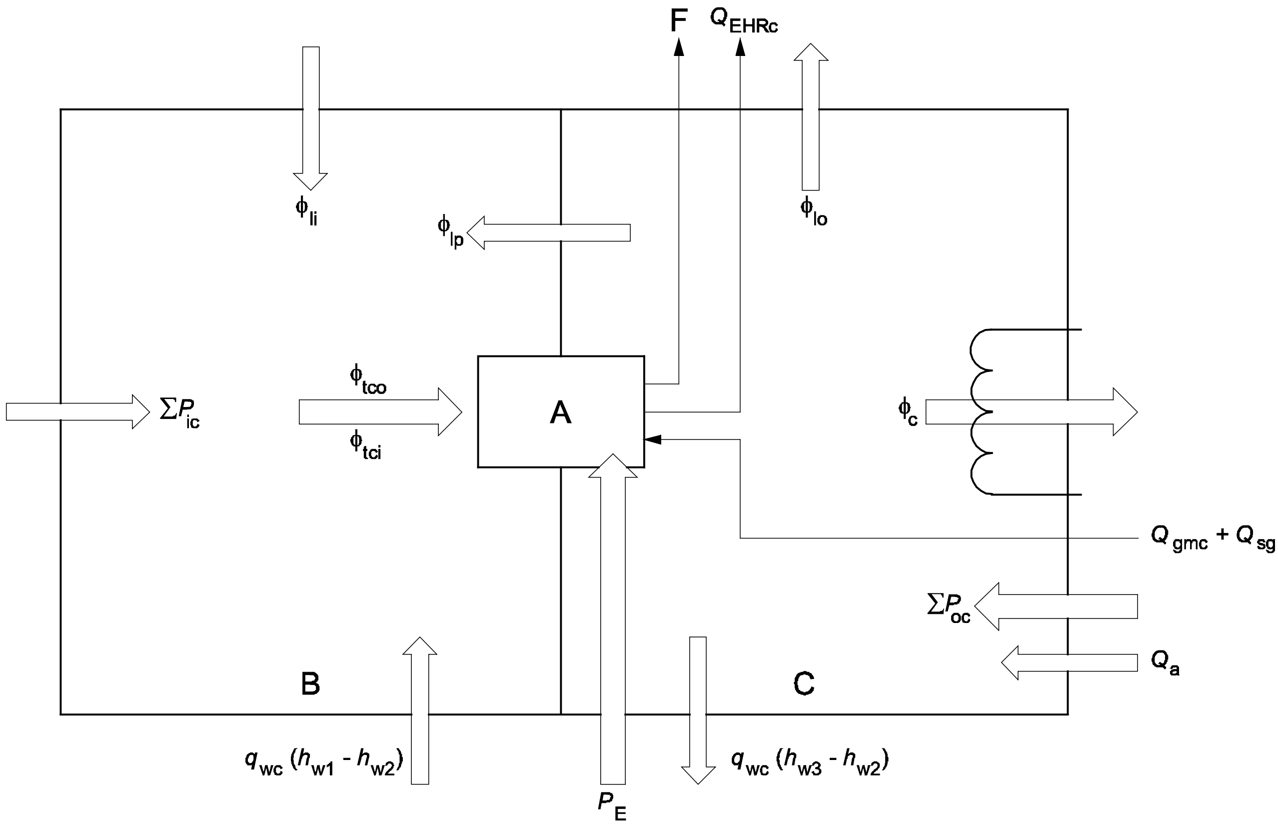
A.5.1 The indoor-side compartment of a room calorimeter of either the calibrated or the balanced ambient type shall be used.

A.5.2 Measurements shall be made for determining flow and temperature rise of condenser cooling water. Water lines shall be insulated between the condenser and points of temperature measurement.

A.6 Calculations-cooling capacities

A.6.1 General:

The energy flow quantities used to calculate the total cooling capacity based on indoor and outdoor-side measurements are shown below in Figure A.3.



Key

A equipment under test

B indoor chamber

C outdoor chamber

F Flueloss

All symbols with their units are defined in Annex C.

Figure A.3 — Calorimeter energy flows during cooling capacity tests

A.6.2 The total cooling capacity on the indoor-side, as tested in either the calibrated or balanced-ambient, room-type calorimeter (see Figures A.1 and A.2), is calculated as follows:

$$\phi_{tci} = \frac{\sum_{j=1}^{n}\left(P_{ic} + q_{wc}\left(h_{w1} - h_{w2}\right) + \phi_{lp} + \phi_{li}\right)}{n} \tag{A.1}$$

NOTE 1 If no water is introduced during the test, h_{w1} is taken at the temperature of the water in the humidifier tank of the conditioning apparatus.

When it is not practical to measure the temperature of the water leaving the indoor-side compartment to the outdoor-side compartment, the temperature of the condensate may be assumed to be at the measured or estimated wet-bulb temperature of the air leaving the test equipment.

The water vapour (q_{wc}) condensed by the equipment under test may be determined by the amount of water evaporated into the indoor-side compartment by the reconditioning equipment to maintain the required humidity.

The heat leakage ϕ_{lp} into the indoor-side compartment through the separating partition between the indoor side and outdoor side compartments may be determined from the calibrating test or, in the case of the balanced-ambient room-type compartment, may be based on calculations.

$$\varphi_{tco} = \frac{\sum_{j=1}^{n}\left(\varphi_c - P_{oc} - P_E - Q_{gmc} - Q_{sg} - Q_a + Flueloss + Q_{EHRc} + q_{wc}\left(h_{w3} - h_{w2}\right) + \varphi_{lp} + \varphi_{lo}\right)}{n} \tag{A.2}$$

NOTE 2 The hw3 enthalpy is taken at the temperature at which the condensate leaves the outdoor-side compartment.

The heat leakage rate (ϕ_{lp}) into the indoor side compartment through the separating partition between the indoor side and outdoor side compartments may be determined from the calibrating test or, in the case of the balanced-ambient room-type compartment, may be based on calculations.

NOTE 3 This quantity can be numerically equal to that used in Formula (A.1) if, and only if, the area of the separating partition exposed to the outdoor-side is equal to the area exposed to the indoor-side compartment.

A.6.3 The total cooling capacity of liquid (water)-cooled equipment deducted from the condenser side is calculated as follows:

$$\varphi_{tco} = \frac{\sum_{j=1}^{n}\left(\varphi_{co} - P_{Eff} - Q_a - Q_{gmh} - Q_{sg} + Flueloss + Q_{EHRh}\right)}{n} \tag{A.3}$$

A.6.4 The latent cooling capacity (room dehumidifying capacity) is calculated as follows:

$$\varphi_d = \frac{K_1 \sum_{j=1}^{n} q_{wc}}{n} \tag{A.4}$$

A.6.5 The sensible cooling capacity is calculated as follows:

$$\varphi_s = \varphi_{tci} - \varphi_d \tag{A.5}$$

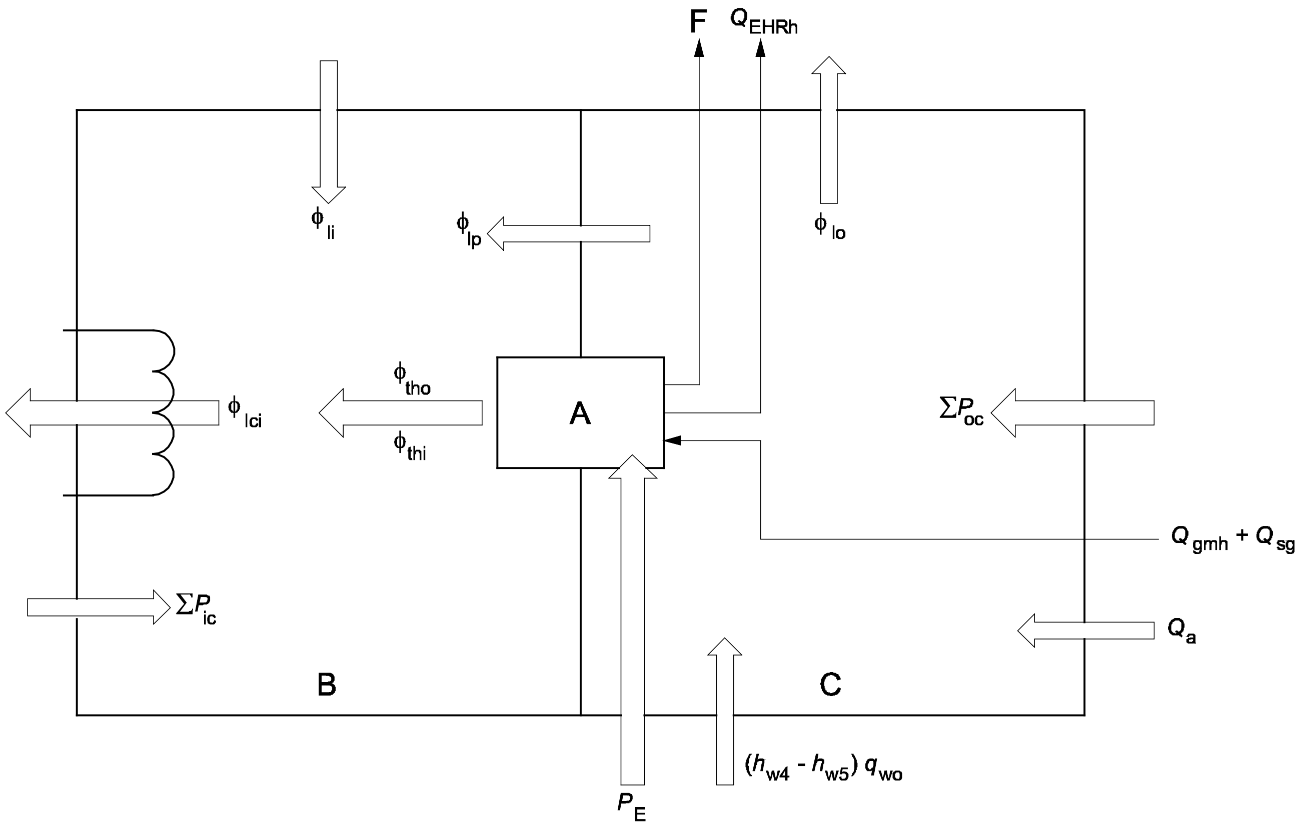
A.6.6 Sensible heat ratio is calculated as follows:

$$SHR = \frac{\varphi_s}{\varphi_{tci}} \tag{A.6}$$

A.7 Calculations- heating capacities

A.7.1 General

The energy flow quantities used to calculate the total heating capacity based on indoor and outdoor-side measurements are shown below in Figure A.4.



Key

A equipment under test

B indoor chamber

C outdoor chamber

F Flueloss

All symbols with their units are defined in Annex C.

Figure A.4 — Calorimeter energy flows during heating capacity tests

A.7.2 Determination of the heating capacity by measurement in the indoor-side compartment of the calorimeter is calculated as follows:

$$\phi_{thi} = \frac{\sum_{j=1}^{n} \left(\phi_{lci} - \phi_{lp} - \phi_{li} - P_{ic} \right)}{n} \tag{A.7}$$

A.7.3 Determination of the heating capacity by measurement of the heat absorbing side is calculated for equipment where the evaporator takes the heat from an air-flow as follows:

$$\varphi_{tho} = \frac{\sum_{j=1}^{n} \left(P_{oc} + P_E + Q_{gmh} + Q_{sg} + Q_a + q_{wo} \left(h_{w4} - h_{w5} \right) - Flueloss - \varphi_{lp} - Q_{EHRh} - \varphi_{lo} \right)}{n} \tag{A.8}$$

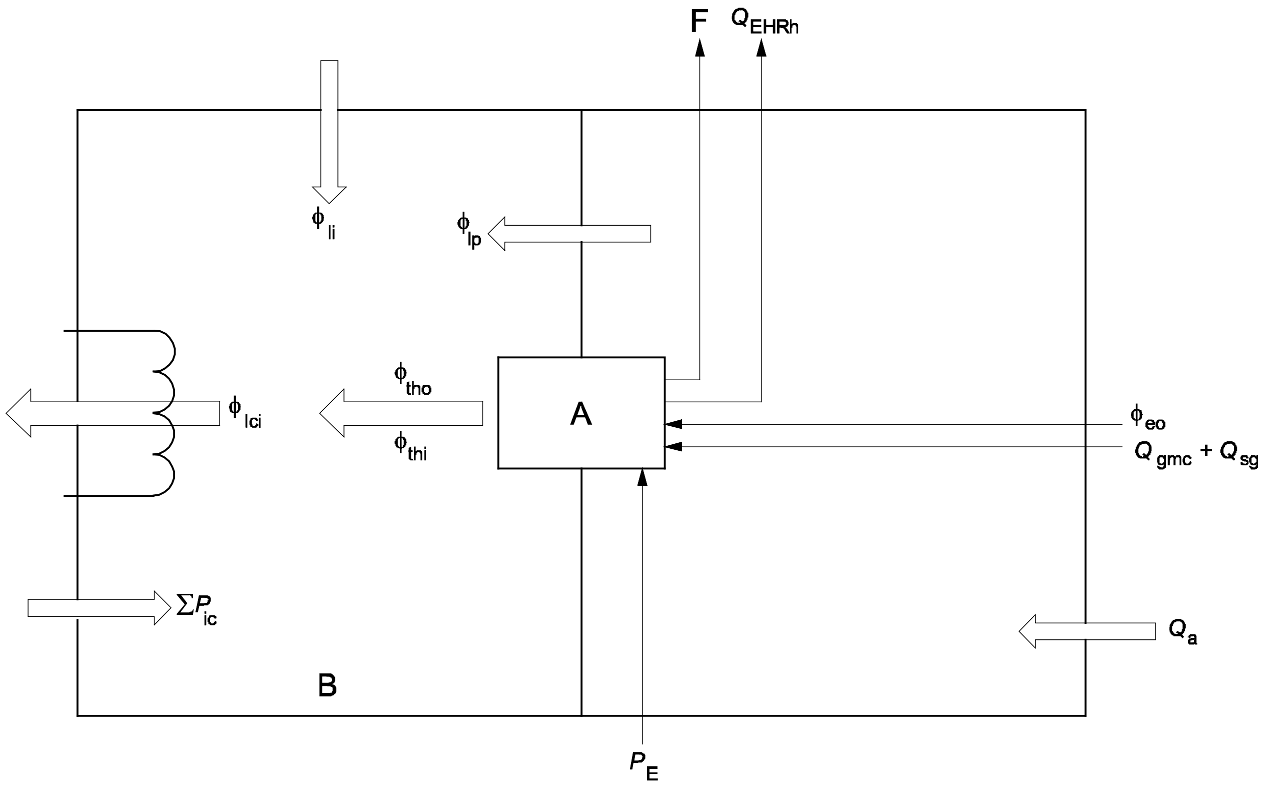
A.7.4 The total heating capacity of liquid (water)-cooled equipment deducted from the evaporator side is calculated as follows:

$$\varphi_{tho} = \frac{\sum_{j=1}^{n}\left(\varphi_{eo} + P_{Eff} + Q_a + Q_{gmh} + Q_{sg} - Flueloss - Q_{EHRh}\right)}{n} \quad \text{(A.9)}$$

where:

ϕ is the heat supplied to the evaporator coil of the equipment.

The energy flow quantities used to calculate the total heating capacity of liquid (water)-cooled equipment deducted from the evaporator side are shown below in Figure A.5.



Key

A equipment under test

B indoor chamber

F Flueloss

Figure A.5 — Energy flow quantities for total heating capacity calculation

Annex B
(normative)

Indoor air enthalpy test method

B.1 General

In the air-enthalpy method, capacities are determined from measurements of entering and leaving wet-bulb – or dew point - and dry-bulb temperatures and the associated air flow rate.

B.2 Test conditions

The air flow rate shall be related to standard air and measured with dry heat exchanger, when the fan only is operating.

For ducted units, the external static pressure ESP shall be set in accordance with 4.5.1.4 for units ducted on in the indoor heat exchanger and with 4.5.1.5 for units ducted on the outdoor heat exchanger.

For non ducted units, the ESP shall be set equal to zero (0).

B.3 Application

B.3.1 Packaged units and single split units shall have a duct section attached to the outlet area of the indoor section for connection to the air flow measuring device.

Multi-split systems shall have short plenums attached to each indoor unit. Each plenum shall discharge into a common duct section, the duct section in turn discharging into an air measuring device. Each plenum shall have an adjustable restrictor located in the plane where the plenums enter the common duct section for the purpose of adjusting the static pressures in each plenum to the installation instructions.

The length of the duct section for package and single split systems and the length of the individual plenums for multi-split systems is a minimum of $2{,}5\times\sqrt{\left(4\times\left(A\times B\right)\div\pi\right)}$ where A = width and B = height of duct or outlet. Static pressure readings are taken at a distance of $2\times\sqrt{\left(A\times B\right)}$ from the outlet.

B.3.2 Air flow measurements shall be made so that the requirement on the uncertainty of measurement given in Table 1 is fulfilled.

EN ISO 5167-1 and EN ISO 5801 may be used.

B.4 Calculations-cooling capacities

Total, sensible and latent indoor cooling capacities based on the indoor-side test data are calculated by the following formulae:

$$\varphi_{tci} = \frac{q_{vi\times\left(h_{a1}-h_{a2}\right)}}{v'_n\left(1+W_n\right)}1\,000 \qquad \text{(B.1)}$$

$$\varphi_s = \frac{q_{vi\times\left(c_{pa1}t_{a1}-c_{pa2}t_{a2}\right)}}{v'_n\left(1+W_n\right)} \tag{B.2}$$

$$\varphi_d = \frac{K_1 q_{vi} \times \left(W_{i1}-W_{i2}\right)}{v'_n\left(1+W_n\right)} 1\,000 \tag{B.3}$$

$$\varphi_d = \varphi_{tci} - \varphi_S \tag{B.4}$$

$$\varphi_d = K_1 q_{wc} \tag{B.5}$$

NOTE All symbols and their units are defined in Annex C.

B.5 Calculations-heating capacities

Total heating capacity based on indoor-side data are calculated by the following formula:

$$\varphi_{thi} = \frac{q_{vi} \times \left(h_{a2}-h_{a1}\right)}{v'_n\left(1+W_n\right)} 1\,000 \tag{B.6}$$

NOTE 1 Formulae (B.1), (B.2), (B.3) and (B.6) do not provide allowance for heat leakage in the duct section.

NOTE 2 All symbols and their units are defined in Annex C.

Annex C
(normative)

Symbols and units used in Annex A and B

Table C.1 — Symbols and units used in calorimeter and indoor enthalpy test methods

Symbol	Description	Unit
c_{pa1}	Specific heat of moist air entering indoor-side	J/kg.K
c_{pa2}	Specific heat of moist air leaving indoor-side	J/kg.K
h_{a1}	Specific enthalpy of wet air entering indoor-side compartment	kJ/kg of dry air
h_{a2}	Specific enthalpy of air leaving indoor-side compartment	kJ/kg of dry air
h_{w1}	Specific enthalpy of water or steam supplied to indoor-side compartment	kJ/kg
h_{w2}	Specific enthalpy of condenser moisture leaving indoor-side compartment	kJ/kg
h_{w3}	Specific enthalpy of condensate removed by the air-treating coil in the outdoor side compartment	kJ/kg
h_{w4}	Specific enthalpy of the water supplied to the outdoor-side compartment	kJ/kg
h_{w5}	Specific enthalpy of the condensed water or the frost generated by the equipment	kJ/kg
$K1$	Latent heat of vaporization of water (constant = 2 460)	kJ/kg
ϕ_{c}	Heat removed by cooling coil in the outdoor-side compartment	W
ϕ_{co}	Heat removed by the condenser coil of the equipment	W
ϕ_{d}	Latent cooling capacity (dehumidifying)	W
ϕ_{eo}	Heat supplied to the evaporator coil of the equipment	W
ϕ_{lci}	Heat removed from indoor-side compartment	W
ϕ_{li}	Heat leakage flow into the indoor-side compartment through all the enveloping surfaces of the indoor-side compartment, except the separating partition to the outdoor-side compartment	W
ϕ_{lo}	Heat leakage flow out of the outdoor-side compartment through all the enveloping surfaces of the outdoor-side compartment, except the separating partition to the indoor-side compartment	W
ϕ_{lp}	Heat leakage flow through the separating partition into the indoor-side compartment from the outdoor-side compartment	W
ϕ_{s}	Sensible cooling capacity	W
ϕ_{tci}	Total cooling capacity, indoor-side data	W
ϕ_{tco}	Total cooling capacity, outdoor-side data	W

Symbol	Description	Unit
ϕ_{thi}	Total heating capacity, indoor-side data	W
ϕ_{tho}	Total heating capacity, outdoor-side data	W
j	The scan number	–
n	The number of scan of the data collection period	–
P_E	Total electrical power input to equipment	W
$\sum Pic$	Sum of all power inputs to the indoor-side compartment	W
$\sum Poc$	Sum of all power inputs to any apparatus in the outdoor-side compartment (e.g. reheaters, fans, etc.)	W
P_{Eff}	Effective electrical power input to the equipment	W
Flueloss	Flue gas losses	W
$Q_{EHR(c/h)}$	Engine heat recovery power (cooling / heating)	W
Qgm(c/h)	Quantity of energy used in unit time corresponding to the combustion gas (cooling / heating)	W
Qsg	Sensible heat of gas entering the engine	W
Qa	Sensible heat of air entering the outdoor room	W
q_{vi}	Indoor air flow rate	m^3/s
q_{wo}	Mass flow rate of water supplied to the outdoor-side calorimeter compartment	g/s
SHR	Sensible heat ratio	–
t_{a1}	Temperature of air entering indoor-side compartment	°C
t_{a2}	Temperature of air leaving indoor-side compartment	°C
v'_n	Specific volume of air at air-flow measuring device	m^3/kg of air-water vapour mixture
q_{wc}	Rate at which water vapour is condensed by the equipment	g/s
W_{i1}	Specific humidity of air entering indoor-side compartment	kg/kg of dry air
W_{i2}	Specific humidity of air leaving indoor-side compartment	kg/kg of dry air
W_n	Specific humidity at the nozzle inlet	kg water vapour/kg of dry air

Annex D
(normative)

Water enthalpy test method

D.1 General

In the water (brine)-enthalpy method, capacities are determined from measurements of entering and leaving temperatures and the associated water flow rate, taking into consideration the specific heat capacity and density, or the enthalpy change, of the heat transfer medium.

D.2 Calculations

D.2.1 Measured cooling capacity

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

$$Q_c = Vm \times \delta \times c_p \times \Delta t \tag{D.1}$$

where

- Q_c is the measured cooling capacity, in kilowatt;
- Vm is the volume flow rate of the heat transfer medium, in cubic meters per second;
- δ is the density of the heat transfer medium at flow meter temperature, in kilogram per cubic meter;
- c_p is the specific heat of the heat transfer medium at constant pressure at mean temperature of the heat transfer medium, in kilojoule per kilogram and Kelvin;
- Δt is the difference between inlet and outlet temperatures of the heat transfer medium, in Kelvin.

NOTE 1 The mass flow can be determined directly instead of the term ($Vm * \delta$).

NOTE 2 The enthalpy change ΔH can be determined directly instead of the term ($c_p * \Delta t$).

D.2.2 Measured heating capacity

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

$$Q_h = Vm \times \delta \times c_p \times \Delta t \tag{D.2}$$

where

- Q_h is the measured heating capacity, in kilowatt;
- Vm is the volume flow rate of the heat transfer medium, in cubic meters per second;
- δ is the density of the heat transfer medium at flow meter temperature, in kilogram per cubic meter;
- c_p is the specific heat of the heat transfer medium at constant pressure at mean temperature of the heat transfer medium, in kilojoule per kilogram and Kelvin;

Δt is the difference between inlet and outlet temperatures of the heat transfer medium, in Kelvin.

NOTE 1 The mass flow can be determined directly instead of the term (Vm * δ).

NOTE 2 The enthalpy change ΔH can be determined directly instead of the term (c_p * Δt).

D.2.3 Measured engine heat recovery capacity

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

$$Q_{hr} = Vm \times \delta \times c_p \times \Delta t \tag{D.3}$$

where

Q_{hr} is the measured engine heat recovery capacity, in kilowatt;

Vm is the volume flow rate of the heat transfer medium, in cubic meters per second;

δ is the density of the heat transfer medium at flow meter temperature, in kilogram per cubic meter;

c_p is the specific heat of the heat transfer medium at constant pressure at mean temperature of the heat transfer medium, in kilojoule per kilogram and Kelvin;

Δt is the difference between inlet and outlet temperatures of the heat transfer medium, in Kelvin.

NOTE 1 The mass flow can be determined directly instead of the term ($Vm \cdot \delta$).

NOTE 2 The enthalpy change ΔH can be determined directly instead of the term ($cp \cdot \Delta t$).

Annex E
(normative)

Direct method for air-to-water (brine) and water (brine)-to-water (brine) appliances

E.1 General

Annex E provides examples of compensation systems that can be used for the full and reduced load tests of air-to-water (brine) (see E.2) or water (brine)-to-water (brine) (see E.3) appliance in cooling and heating mode.

E.2 Compensation system for air-to-water (brine) appliances

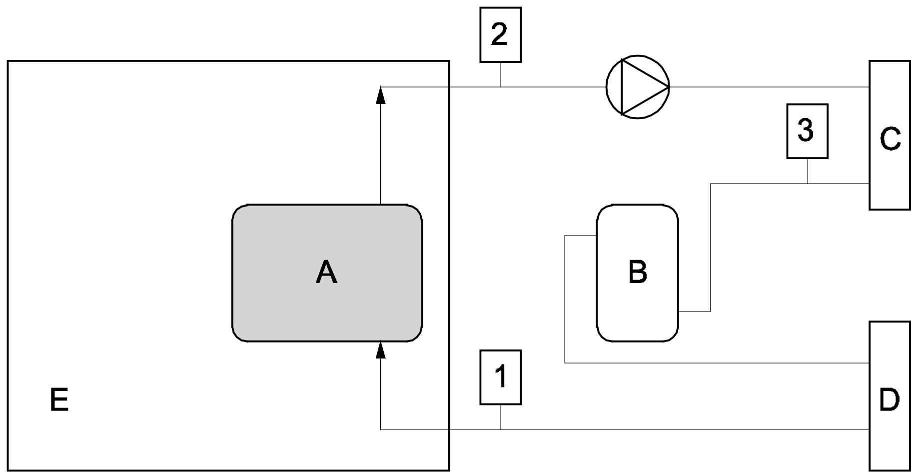
The outdoor heat exchanger of the air to water appliance recovers air energy from a closed climatic test room within the dry and wet bulb temperature are maintained within the ranges tolerated.

The indoor heat exchanger of the appliance is connected to a test rig that includes:

— primary compensation and secondary compensation heat exchangers, to compensate for the cooling and the heating capacity of the appliance,

— one or more storage tanks, to avoid large inlet temperature deviations (10 l/kW to 30 l/kW),

as described in Figure E.1.



Key

A	appliance under test	E	climatic test room
B	storage tank	1	inlet temperature of the indoor heat exchanger of the appliance
C	primary compensation heat exchanger	2	outlet temperature of the indoor heat exchanger of the appliance
D	secondary compensation heat exchanger	3	intermediate temperature for test rig control with 3 < 2 and 3 < 1

Figure E.1 — Test installation for air to water (brine) appliance at full or reduced capacity in heating mode

The outlet temperature (2) of the indoor heat exchanger is set from the system control of the appliance (A) under test. The quantity of heat flowing through the heat exchanger (C) varies depending on the desired intermediate temperature whose value is on the initiative of the test supervisor and determined by the control system of the test rig. This first control stage (supplemented by the addition of one or more storage tanks (B)) allows to attenuate the effect of the large variations in the output temperature of the heat exchanger of the appliance (2) (in particular when it operates cyclically). The second control stage of the test rig is located at the heat exchanger (D) where the quantity of heat flowing therein is adjusted according to the desired inlet temperature of the indoor heat exchanger of the appliance (A).

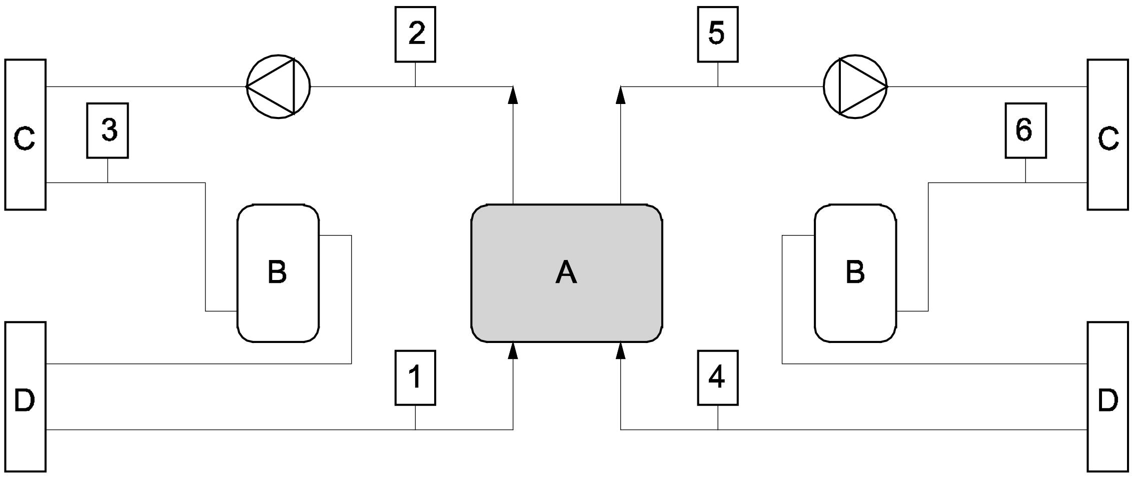
E.3 Compensation system for water(brine) to water (brine) appliances

The appliance under test is installed in a test rig that includes:

— heating and cooling heat exchangers, to compensate for the cooling and the heating capacity of the appliance;

— one or more storage tanks, to avoid large inlet temperature deviations (10 l/kW to 30 l/kW),

as described in Figure E.2.



Key

A appliance under test

B storage tank

C Primary compensation heat exchanger

D Secondary compensation heat exchanger

1 inlet temperature of the outdoor heat exchanger of the appliance

2 outlet temperature of the outdoor heat exchanger of the appliance

3 intermediate temperature for test rig control with 3 < 1 and 3 < 2

4 inlet temperature of the indoor heat exchanger of the appliance

5 outlet temperature of the indoor heat exchanger of the appliance

6 intermediate temperature for test rig control with 6 < 5 and 6 < 4

Figure E.2 — Test installation for water (brine) to water (brine) appliance at full or reduced capacity

Annex F
(informative)

Measurement control criteria for water (brine) to water (brine) appliances

F.1 General

This annex is a "quality" tool which can be used to detect a possible measurement error due to a bad operation of a measuring device, especially when the test result is not consistent with the expected result.

F.2 Water (brine)-to-water (brine) heat pump in heating mode

For water (brine) to water(brine) heat pump for which an energy balance may be calculated (see Formula (F.2)), the energy balance coefficient calculated according to Formula (F.3) may not exceed $0,37 \times \Delta T^{-0,53}$ (where ΔT is the difference between the outlet and inlet temperatures of the heat transfer medium at the indoor heat exchanger).

The calculation of the energy balance coefficient requires the measurement and calculation of additional parameters which are not strictly required in this standard. These parameters are the capacity of the outdoor heat exchanger, the flue gas losses and the jacket losses.

For jacket losses, a default value of 4 % of nominal gas input can be used. For other parameters, the characteristics of the devices necessary to determine them were reasonably chosen according to their relative importance in meeting the criterion.

For flue gas losses, the following formula could be used:

$$Flueloss = \frac{Q_{gmh(Hi)}}{100} \times q_c \tag{F.1}$$

where

Flueloss	is the flue gas losses, in kilowatts;
$Q_{\mathrm{gmh(Hi)}}$	is the measured heating net heat input, in kilowatts;
q_c	is the flue gas losses as defined in EN 15502–2–2:2014, 8.101.2.2, in percent of the heat input.

The energy balance is calculated by the following formula:

$$Ebalance_h = \frac{Q_{gmh(Hs)} + P_{th} + Q_{outside} - Q_h - Flueloss - Jloss}{Q_{gmh(Hi)}} \tag{F.2}$$

where

$Ebalance_{\mathrm{h}}$	is the energy balance in heating mode, in kilowatts per kilowatt;
$Q_{\mathrm{gmh(Hs)}}$	is the measured heating gross heat input, in kilowatts;
$Q_{\mathrm{gmh(Hi)}}$	is the measured heating net heat input, in kilowatts;
P_{th}	is the measured electrical power input in heating mode, in kilowatts;

Q_{outside} is the measured capacity across the outdoor heat exchanger(s), in kilowatts;

Q_{h} is the measured heating capacity, in kilowatts;

Flueloss is the flue gas losses, in kilowatts;

Jloss is the jacket losses, in kilowatts.

The energy balance coefficient is calculated by the following formula:

$$CoefEbalance_h = \left|Ebalance_h\right| + \left|UcEbalance_h\right| \tag{F.3}$$

where

$CoefEbalance_{\text{h}}$ is the energy balance coefficient in heating mode, in kilowatts per kilowatt;

E_{balanceh} is the energy balance in heating mode, in kilowatts per kilowatt;

$UcEbalance_{\text{h}}$ is the overall uncertainty of the energy balance in heating mode, in kilowatts per kilowatt.

F.3Water (brine)-to-water (brine) chiller or chiller/heater in cooling mode

For water (brine) to water(brine) chiller or chiller/heater in cooling mode for which an energy balance may be calculated (see Formula (F.5)), the energy balance coefficient calculated according to Formula (F.6) may not exceed $0,37 \times \Delta T^{-0,53}$ (where ΔT is the difference between the outlet and inlet temperatures of the heat transfer medium at the indoor heat exchanger).

The calculation of the energy balance coefficient requires the measurement and calculation of additional parameters which are not strictly required in this standard. These parameters are capacity of the outdoor heat exchanger, the flue gas losses and the jacket losses.

For jacket losses, a default value of 4 % of nominal gas input can be used. For other parameters, the characteristics of the devices necessary to determine them were reasonably chosen according to their relative importance in meeting the criterion.

For flue gas losses, the following formula could be used:

$$Flueloss = \frac{Q_{gmh(Hs)}}{100} \times q_c \tag{F.4}$$

where

Flueloss is the flue gas losses, in kilowatts;

$Q_{\text{gmh(Hs)}}$ is the measured heating gross heat input, in kilowatts;

q_c is the flue gas losses as defined in EN 15502–2–2:2014, 8.101.2.2, in percent of the heat input.

The energy balance is calculated by the following formula:

$$Ebalance_c = \frac{Q_{gmc(Hs)} + P_{tc} + Q_c - Q_{outside} - Q_{hr} - Flueloss - Jloss}{Q_{gmc(Hi)}} \tag{F.5}$$

where

$Ebalance_c$	is the energy balance in cooling mode, in kilowatts per kilowatt;
$Q_{gmc(Hs)}$	is the measured cooling gross heat input, in kilowatts;
$Q_{gmc(Hi)}$	is the measured cooling net heat input, in kilowatts;
P_{tc}	is the measured electrical power input in cooling mode, in kilowatts;
$Q_{outside}$	is the measured capacity across the outdoor heat exchanger(s), in kilowatts;
Q_c	is the measured cooling capacity, in kilowatts;
Q_{hr}	is the measured heat recovery capacity in cooling mode, in kilowatts;
Flueloss	is the flue gas losses, in kilowatts;
Jloss	is the jacket losses, in kilowatts.

The energy balance coefficient is calculated by the following formula:

$$CoefEbalance_c = \left|Ebalance_c\right| + \left|UcEbalance_c\right| \tag{F.6}$$

where

$CoefEbalance_c$	is the energy balance coefficient in cooling mode, in kilowatts per kilowatt;
$Ebalance_c$	is the energy balance in cooling mode, in kilowatts per kilowatt;
$UcEbalance_c$	is the overall uncertainty of the energy balance in cooling mode, in kilowatts per kilowatt.

Annex G
(normative)

Determination of the pump efficiency

G.1 General

The method for calculating the efficiency of the pump, whether the pump is an integral part of the appliance or not, is based on the relationship between the efficiency of the pump and its hydraulic power.

If the pump is an integral part of the appliance and if the pump present a negative external supply pressure (ESP) due to mismatch with the appliance, the total power input of the pump is the sum of its electric power and the complementary required power calculated from Formula (G.1). The external static pressure to use is the absolute value of the different between the measured value and zero.

G.2 Hydraulic power of the pump

G.2.1 The pump is an integral part of the appliance

When the pump is an integral part of the appliance, the hydraulic power of the pump is defined as:

$$P_{hydrau} = q * \Delta p_e \qquad \text{(G.1)}$$

where

P_{hydrau} is the hydraulic power of the pump, in watt;

q is the water volume flow rate, in cubic meters per second;

Δp_e is the measured available external static pressure difference, in pascal.

G.2.2 The pump is not an integral part of the appliance

When the pump is not an integral part of the appliance, the hydraulic power of the pump is defined as:

$$P_{hydrau} = q * \left(-\Delta p_i\right) \qquad \text{(G.2)}$$

where

P_{hydrau} is the hydraulic power of the pump, in watt;

q is the water volume flow rate, in cubic meters per second;

Δp_i is the measured internal static pressure difference, in pascal

G.3 Efficiency of the pump

The efficiency of the pump given in a report edited by an accredited laboratory is used. Otherwise, the efficiency of the pump required to deliver the hydraulic power is determined by using the following formula:

a) when the measured hydraulic power of the pump is lower than 500 W, then the efficiency of the pump is determined from the following formula:

$$\eta = 0,0721 P_{hydrau}^{0,3183} \quad \text{(G.3)}$$

b) when the measured hydraulic power of the pump is greater than 500 W, then the efficiency of the pump is determined from the following formula:

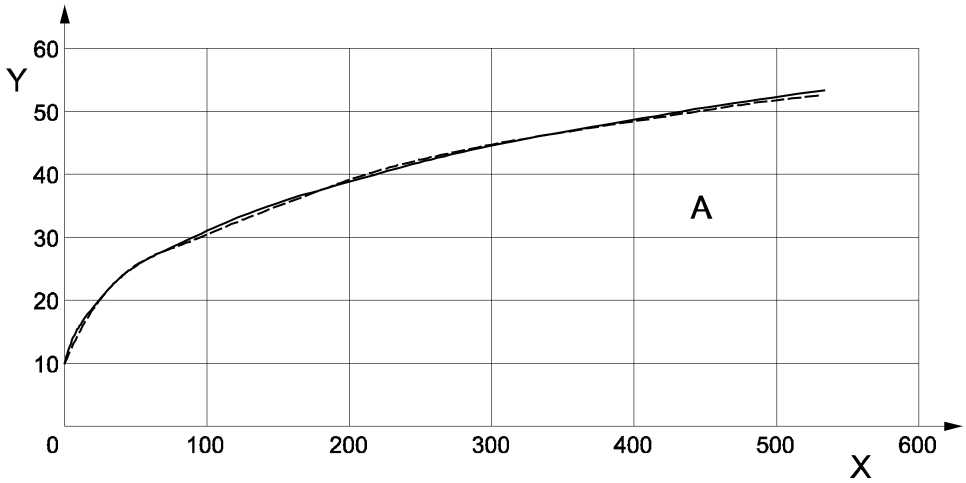
$$\eta = 0,092\, ln\left(P_{hydrau}\right) - 0,0403 \quad \text{(G.4)}$$

where

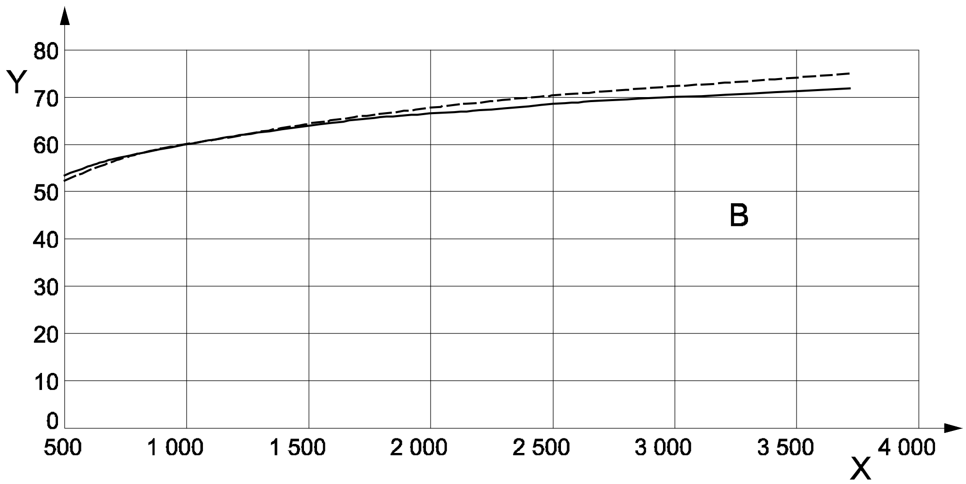
η is the efficiency of the pump, watt per watt;

P_{hydrau} is the hydraulic power of the pump, in watt.

For information, the graphs of the efficiency of the pump versus its hydraulic power are given below.



a) Efficiency of circulating pumps (source: COSTIC)



b) Efficiency of circulating pumps (extrapolation of COSTIC curve above 1 kW)

Key

X efficiency (%)

Y P_{hydrau} (W)

A $y = 0{,}0721\ x^{0{,}3183}$ $R^2 = 1$

B $y = 0{,}092 \ln(x) - 0{,}0403$ $R^2 = 0{,}9875$

Figure G.1 — Efficiency of the pump versus its hydraulic power graphs

Annex H
(informative)

Calculation procedure for determination of GUE, AEF and Cd values

H.1 Calculation procedure for determination of GUE values at part load (GUEPL)

H.1.1 General

In part load conditions there can be two possibilities:

— if the declared partial load capacity values of a unit match with the required loads, the corresponding GUE_{DC} value of the unit shall be used. This may occur with variable capacity units;

— if any of the declared partial load capacity values of a unit are higher than the required loads, the unit shall cycle on/off. This may occur with fixed capacity or variable capacity units. In such cases, a degradation factor shall be used to calculate the corresponding GUE_{PL} value. Such calculation is explained below.

H.1.2 For air-to-air, brine-to-air and water-to-air units

H.1.2.1 Calculation procedure for fixed capacity units cycling

For each part load condition the GUE is calculated as follows:

$$GUE_{PL(B,C,D)} = GUE_{DC} \times \left(1 - Cd \times \left(1 - CR\right)\right) \tag{H.1}$$

where

GUE_{DC} is the GUE corresponding to the declared capacity (DC) of the unit at the same temperature conditions as for part load A B C D;

Cd is the degradation coefficient;

CR is the capacity ratio.

The capacity ratio is the ratio of the cooling / heating demand (Pc / Ph) over the declared partial load capacity (DC) of the unit at the same temperature conditions. *CR* at DC point equals 1.

For determination of the Cd value, see H.3.

If Cd is not determined by test then, the default degradation coefficient *Cd* shall be 0,25.

H.1.2.2 Calculation procedure for variable capacity units

Determine the declared capacity and GUE_{PL} at the closest step or increment of the capacity control of the unit to reach the required cooling load. If this step does not allow to reach the required cooling load within ± 10 % (e.g. between 9,9 kW and 8,1 kW for a required cooling load of 9 kW), determine the capacity and GUE_{PL} at the defined part load temperatures for the steps on either side of the required cooling load. The part load capacity and the GUE_{PL} at the required cooling load are then determined by linear interpolation between the results obtained from these two steps.

If the smallest control step of the unit is higher than the required cooling load, the GUE_{PL} at the required part load ratio is calculated using Formula (H.1) as for fixed capacity units. GUE_{DC} is referred to a minimum controlled step of the units.

H.1.3 For air-to-water, water-to-water and brine-to-water units

H.1.3.1 Calculation procedure for fixed capacity units cycling

For each part load condition the GUE is calculated as follows:

$$GUE_{PL(B,C,D)} = GUE_{DC} \times \frac{CR}{Cc \times CR + (1 - Cc)} \tag{H.2}$$

where

- GUE_{DC} is the GUE corresponding to the declared capacity (DC) of the unit at the same temperature conditions as for part load A B C D;
- Cc is the degradation coefficient;
- CR is the capacity ratio.

The capacity ratio is the ratio of the cooling / heating demand (Pc / Ph) over the declared capacity (DC) of the unit at the same temperature conditions. *CR* at DC point equals 1.

For determination of the Cc value, see H.4.

If Cc is not determined by test then, the default degradation coefficient *Cc* shall be 0,9.

H.1.3.2 Calculation procedure for variable capacity units

Determine the declared capacity and GUE_{PL} at the closest step or increment of the capacity control of the unit to reach the required cooling load. If this step does not allow to reach the required cooling load within ± 10 % (e.g. between 9,9 kW and 8,1 kW for a required cooling load of 9 kW), determine the capacity and GUE_{PL} at the defined part load temperatures for the steps on either side of the required cooling load. The part load capacity and the GUE_{PL} at the required cooling load are then determined by linear interpolation between the results obtained from these two steps.

If the smallest control step of the unit is higher than the required cooling load, the GUE_{PL} at the required part load ratio is calculated using Formula (H.2) as for fixed capacity units. GUE_{DC} is referred to a minimum controlled step of the units.

H.2 Calculation procedure for determination of AEF values at part load (AEFPL)

H.2.1 General

In part, load conditions there can be two possibilities:

— if the declared partial load capacity values of a unit match with the required loads, the corresponding AEF_{DC} value of the unit shall be used. This may occur with variable capacity units;

— if any of the declared partial load capacity values of a unit are higher than the required loads, the unit shall cycle on/off. This may occur with fixed capacity or variable capacity units. In such cases, a degradation factor shall be used to calculate the corresponding AEFPL value. Such calculation is explained below.

H.2.2 For air-to-air, brine-to-air and water-to-air units

H.2.2.1 Calculation procedure for fixed capacity units

For each part load conditions the AEF is calculated as follows:

$$AEF_{PL(B,C,D)} = AEF_{DC} \times \left(1 - Cd \times \left(1 - CR\right)\right) \tag{H.3}$$

where

AEF_{DC}	is the AEF corresponding to the declared capacity (DC) of the unit at the same temperature conditions as for part load A B C D
Cd	is the degradation coefficient;
CR	is the capacity ratio.

The capacity ratio is the ratio of the cooling / heating demand (Pc / Ph) over the declared partial load capacity (DC) of the unit at the same temperature conditions. *CR* at DC point equals 1.

For determination of the Cd value, see H.3.

If Cd is not determined by test then, the default degradation coefficient *Cd* shall be 0,25.

H.2.2.2 Calculation procedure for variable capacity units

Determine the declared capacity and AEF_{PL} at the closest step or increment of the capacity control of the unit to reach the required cooling load. If this step does not allow to reach the required cooling load within ± 10 % (e.g. between 9,9 kW and 8,1 kW for a required cooling load of 9 kW), determine the capacity and AEF_{PL} at the defined part load temperatures for the steps on either side of the required cooling load. The part load capacity and the AEF_{PL} at the required cooling load are then determined by linear interpolation between the results obtained from these two steps.

If the smallest control step of the unit is higher than the required cooling load, the AEF_{PL} at the required part load ratio is calculated using Formula (H.3) as for fixed capacity units. AEF_{DC} is referred to a minimum controlled step of the units.

H.2.3 For air-to-water, water-to-water and brine-to-water units

H.2.3.1 Calculation procedure for fixed capacity units

For each part load condition the AEF is calculated as follows:

$$AEF_{PL(B,C,D)} = AEF_{DC} \times \frac{CR}{Cc \times CR + \left(1 - Cc\right)} \tag{H.4}$$

where

AEF_{DC}	is the AEF corresponding to the declared capacity (DC) of the unit at the same temperature conditions as for part load A B C D;
Cc	is the degradation coefficient;
CR	is the capacity ratio.

The capacity ratio is the ratio of the cooling / heating demand (Pc / Ph) over the declared partial load capacity (DC) of the unit at the same temperature conditions. *CR* at DC point equals 1.

For determination of the Cc value, see H.4.

If Cc is not determined by test then, the default degradation coefficient *Cc* shall be 0,9.

H.2.3.2 Calculation procedure for variable capacity units

Determine the declared capacity and AEF_{PL} at the closest step or increment of the capacity control of the unit to reach the required cooling load. If this step does not allow to reach the required cooling load within ± 10 % (e.g. between 9,9 kW and 8,1 kW for a required cooling load of 9 kW), determine the capacity and AEF_{PL} at the defined part load temperatures for the steps on either side of the required cooling load. The part load capacity and the AEF_{PL} at the required cooling load are then determined by linear interpolation between the results obtained from these two steps.

If the smallest control step of the unit is higher than the required cooling load, the AEF_{PL} at the required part load ratio is calculated using Formula (H.4) as for fixed capacity units. AEF_{DC} is referred to a minimum controlled step of the units.

H.3 Air-to-air and water-to-air units - Determination of the degradation coefficient Cd

H.3.1 General

When there is a cooling/heating demand, the compressor is on and the total power consumption includes all electrical auxiliary devices.

Once the set point is reached, the cooling/heating demand is satisfied. The compressor is then off but there is still a remaining power consumption due to the other auxiliary devices (electronics, fans…). The degradation coefficient is due to two effects:

1) the power consumption of the unit when the compressor is off;

2) the pressure equalization that reduces the cooling/heating capacity when the unit is restarted.

For determining the degradation factor Cd, the unit is cycled on for 6 min and then off for 24 min for an approximately 20 % part load (of the declared partial load capacity DC) by switching on and off the compressor.

If it is not possible to make the measurements with the required uncertainty of measurement when using a cycling interval of 6/24 min, then another cycling interval shall be chosen but not presenting a greater part load ratio than 50 % (of the declared partial load capacity DC) (i.e. 10/10 min).

During this cyclic test, the delivered cooling (heating) capacity is integrated over the on/off interval. Then the cyclic GUE and AEF are obtained by dividing the integrated cooling (heating) capacity and heat recovery (kWh) by the energy used by the unit over the same on/off interval.

The energy ratio (ER) is calculated by dividing the time integrated cooling (heating) capacity (kWh) by the cooling (heating) energy (kWh) that would have been delivered by the unit running continuously for the same time interval (i.e. 30 min).

The degradation coefficient Cd is calculated as the ratio of the cyclic GUE and AEF to the continuous (steady-state) GUE and AEF(for the same test conditions) according to following formula.

$$Cd_{GUE} = \frac{\left(1 - \frac{GUE_{cyclic}}{GUE_{continuous}}\right)}{(1 - ER)} \; or \; Cd_{AEF} = \frac{\left(1 - \frac{AEF_{cyclic}}{AEF_{continuous}}\right)}{(1 - ER)} \tag{H.5}$$

If the degradation coefficient Cd has been determined for cooling (function) mode, it can be applied for heating (function) mode and vice versa.

The temperature conditions at which the full load (continuous) and cyclic tests shall be performed are given below for each type of unit and mode.

H.3.2 Air-to-air units – Cooling mode

— One test at an outdoor dry bulb temperature of 20 °C with dry indoor coil.

— One cyclic test at the same dry bulb temperature conditions, with dry indoor coil.

H.3.3 Air-to-air units – Heating mode

— One test at an outdoor dry bulb temperature of 12 °C with dry outdoor coil.

— One cyclic test at the same dry bulb temperature conditions, with dry outdoor coil.

H.3.4 Water-to-air units – Cooling mode

— One test at the temperature condition of the “A” test given in EN 16905-5:2017, Table 2.

— One cyclic test at the same “A” test temperature conditions.

H.3.5 Water-to-air units – Heating mode

— One test at the temperature condition given in EN 16905-5:2017, Table 8.

— One cyclic test at the same test temperature conditions.

H.4 Air-to-water units and water-to-water units - Determination of the degradation coefficient Cc

For air-to-water units and water-to-water units, the degradation coefficient Cc due to the pressure equalization effect when the unit restarts can be considered as negligible.

The only effect that will impact the cyclic GUE and AEF at cycling is the remaining power input when the compressor is switching off.

The electrical power input during the compressor off state of the unit is measured when the compressor is switched off for at least 10 min.

The degradation coefficient Cc is determined for each part load ratio as follows:

$$Cc = 1 - \frac{measured\ power\ of\ compressor\ off\ state}{total\ power\ input\left(full\ capacity\ at\ the\ part\ load\ conditions\right)} \qquad (H.6)$$

Annex I
(informative)

"Individual" correction to include in the "global" electrical power input correction depending on the GEHP appliance

Table I.1 — Corrections depending on GEHP appliances

Appliance	Electrical auxiliary device responsible for circulating the heat transfer medium through the outdoor heat exchanger	*Cdevice_ outdoor*	Electrical auxiliary device responsible for circulating the heat transfer medium through the indoor or heat recovery heat exchanger	*Cdevice_ indoor*	Electrical auxiliary device responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger	*Cdevice_hr*
Air-to-air without duct connection at indoor and outdoor sides	The fan is an integral part of the appliance	See 4.2.4.3.2.1 (no correction)	The fan is an integral part of the appliance	See 4.2.4.3.2.1 (no correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The fan is an external part of the appliance	See 4.2.4.3.2.2 (positive correction)	The fan is an integral part of the appliance	See 4.2.4.3.2.1 (no correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The fan is an integral part of the appliance	See 4.2.4.3.2.1 (no correction)	The fan is an external part of the appliance	See 4.2.4.3.2.2 (positive correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The fan is an external part of the appliance	See 4.2.4.3.2.2 (positive correction)	The fan is an external part of the appliance	See 4.2.4.3.2.2 (positive correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
Air-to-air without duct connection at indoor and with duct connection	The fan is an integral part of the appliance	See 4.2.4.3.3.1 (negative correction)	The fan is an integral part of the appliance	See 4.2.4.3.2.1 (no correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)

Appliance	**Electrical auxiliary device responsible for circulating the heat transfer medium through the outdoor heat exchanger**	***Cdevice_ outdoor***	**Electrical auxiliary device responsible for circulating the heat transfer medium through the indoor or heat recovery heat exchanger**	***Cdevice_ indoor***	**Electrical auxiliary device responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger**	***Cdevice_hr***
at outdoor side	The fan is an external part of the appliance	See 4.2.4.3.3.2 (positive correction)	The fan is an integral part of the appliance	See 4.2.4.3.2.1 (no correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The fan is an integral part of the appliance	See 4.2.4.3.3.1 (negative correction)	The fan is an external part of the appliance	See 4.2.4.3.2.2 (positive correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The fan is an external part of the appliance	See 4.2.4.3.3.2 (positive correction)	The fan is an external part of the appliance	See 4.2.4.3.2.2 (positive correction)	Internal	See 4.2.4.4.3.1
					external	See Clause 4.2. 4.4.3.2 (equal to 0)
Air-to-air with duct connection at indoor and without duct connection at outdoor side	The fan is an integral part of the appliance	See 4.2.4.3.2.1 (no correction)	The fan is an integral part of the appliance	See 4.2.4.3.3.1 (negative correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The fan is an external part of the appliance	See 4.2.4.3.2.2 (positive correction)	The fan is an integral part of the appliance	See 4.2.4.3.3.2 (positive correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The fan is an integral part of the appliance	See 4.2.4.3.2.1 (no correction)	The fan is an external part of the appliance	See 4.2.4.3.3.1 (negative correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)

Appliance	Electrical auxiliary device responsible for circulating the heat transfer medium through the outdoor heat exchanger	*Cdevice_ outdoor*	Electrical auxiliary device responsible for circulating the heat transfer medium through the indoor or heat recovery heat exchanger	*Cdevice_ indoor*	Electrical auxiliary device responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger	*Cdevice_hr*
	The fan is an external part of the appliance	See 4.2.4.3.2.2 (positive correction)	The fan is an external part of the appliance	See 4.2.4.3.3.2 (positive correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
Air-to-air with duct connection at indoor and outdoor sides	The fan is an integral part of the appliance	See 4.2.4.3.3.1 (negative correction)	The fan is an integral part of the appliance	See 4.2.4.3.3.1 (negative correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The fan is an external part of the appliance	See 4.2.4.3.3.2 (positive correction)	The fan is an integral part of the appliance	See 4.2.4.3.3.2 (positive correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The fan is an integral part of the appliance	See 4.2.4.3.3.1 (negative correction)	The fan is an external part of the appliance	See 4.2.4.3.3.1 (negative correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The fan is an external part of the appliance	See 4.2.4.3.3.2 (positive correction)	The fan is an external part of the appliance	See 4.2.4.3.3.2 (positive correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
Air-to-water (brine) without duct connection	The fan is an integral part of the appliance	See 4.2.4.3.2.1 (no correction)	The pump is an integral part of the appliance	See 4.2.4.4.2.1 (negative correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)

Appliance	Electrical auxiliary device responsible for circulating the heat transfer medium through the outdoor heat exchanger	*Cdevice_ outdoor*	Electrical auxiliary device responsible for circulating the heat transfer medium through the indoor or heat recovery heat exchanger	*Cdevice_ indoor*	Electrical auxiliary device responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger	*Cdevice_hr*
	The fan is an external part of the appliance	See 4.2.4.3.2.2 (positive correction)	The pump is an integral part of the appliance	See 4.2.4.4.2.1 (negative correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The fan is an integral part of the appliance	See 4.2.4.3.2.1 (no correction)	The pump is an external part of the appliance	See 4.2.4.4.2.2 (positive correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The fan is an external part of the appliance	See 4.2.4.3.2.2 (positive correction)	The pump is an external part of the appliance	See 4.2.4.4.2.2 (positive correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
Air-to-water (brine) with duct connection	The fan is an integral part of the appliance	See 4.2.4.3.3.1 (negative correction)	The pump is an integral part of the appliance	See 4.2.4.4.2.1 (negative correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The fan is an external part of the appliance	See 4.2.4.3.3.2 (positive correction)	The pump is an integral part of the appliance	See 4.2.4.4.2.1 (negative correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The fan is an integral part of the appliance	See 4.2.4.3.3.1 (negative correction)	The pump is an external part of the appliance	See 4.2.4.4.2.2 (positive correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)

Appliance	Electrical auxiliary device responsible for circulating the heat transfer medium through the outdoor heat exchanger	*Cdevice_ outdoor*	Electrical auxiliary device responsible for circulating the heat transfer medium through the indoor or heat recovery heat exchanger	*Cdevice_ indoor*	Electrical auxiliary device responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger	*Cdevice_hr*
	The fan is an external part of the appliance	See 4.2.4.3.3.2 (positive correction)	The pump is an external part of the appliance	See 4.2.4.4.2.2 (positive correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
Water (brine)-to-water (brine)	The pump is an integral part of the appliance	See 4.2.4.4.2.1 (negative correction)	The pump is an integral part of the appliance	See 4.2.4.4.2.1 (negative correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The pump is an external part of the appliance	See 4.2.4.4.2.2 (positive correction)	The pump is an integral part of the appliance	See 4.2.4.4.2.1 (negative correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The pump is an integral part of the appliance	See 4.2.4.4.2.1 (negative correction)	The pump is an external part of the appliance	See 4.2.4.4.2.2 (positive correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The pump is an external part of the appliance	See 4.2.4.4.2.2 (positive correction)	The pump is an external part of the appliance	See 4.2.4.4.2.2 (positive correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
Water (brine)-to-air without duct connection	The pump is an integral part of the appliance	See 4.2.4.4.2.1 (negative correction)	The fan is an integral part of the appliance	See 4.2.4.4.2.1 (negative correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)

Appliance	**Electrical auxiliary device responsible for circulating the heat transfer medium through the outdoor heat exchanger**	***Cdevice_ outdoor***	**Electrical auxiliary device responsible for circulating the heat transfer medium through the indoor or heat recovery heat exchanger**	***Cdevice_ indoor***	**Electrical auxiliary device responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger**	***Cdevice_hr***
	The pump is an external part of the appliance	See4.2.4.4.2.2 (positive correction)	The fan is an integral part of the appliance	See 4.2.4.4.2.1 (negative correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The pump is an integral part of the appliance	See 4.2.4.4.2.1 (negative correction)	The fan is an external part of the appliance	See 4.2.4.4.2.2 (positive correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The pump is an external part of the appliance	See 4.2.4.4.2.2 (positive correction)	The fan is an external part of the appliance	See 4.2.4.4.2.2 (positive correction)	Internal	See Clause 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
Water (brine)-to-air with duct connection	The pump is an integral part of the appliance	See 4.2.4.4.2.1 (negative correction)	The fan is an integral part of the appliance	See 4.2.4.4.2.1 (negative correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The pump is an external part of the appliance	See 4.2.4.4.2.2 (positive correction)	The fan is an integral part of the appliance	See 4.2.4.4.2.1 (negative correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)
	The pump is an integral part of the appliance	See 4.2.4.4.2.1 (negative correction)	The fan is an external part of the appliance	See 4.2.4.4.2.2 (positive correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)

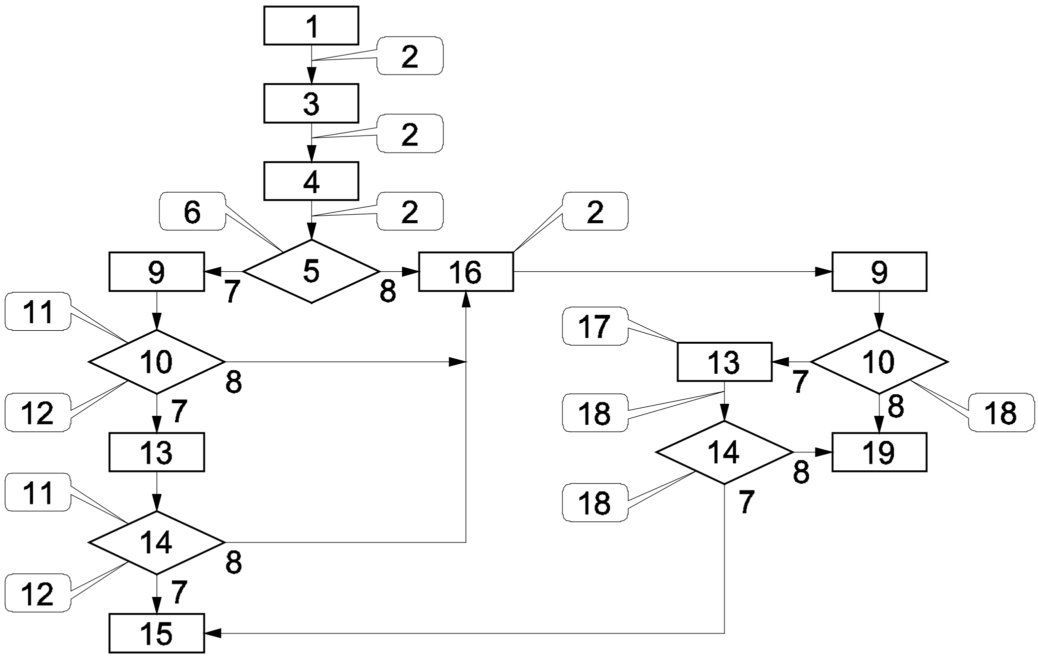
Appliance	**Electrical auxiliary device responsible for circulating the heat transfer medium through the outdoor heat exchanger**	***Cdevice_ outdoor***	**Electrical auxiliary device responsible for circulating the heat transfer medium through the indoor or heat recovery heat exchanger**	***Cdevice_ indoor***	**Electrical auxiliary device responsible for circulating the heat transfer medium through the engine heat recovery heat exchanger**	***Cdevice_hr***
	The pump is an external part of the appliance	See 4.2.4.4.2.2 (positive correction)	The fan is an external part of the appliance	See 4.2.4.4.2.2 (positive correction)	Internal	See 4.2.4.4.3.1
					external	See 4.2.4.4.3.2 (equal to 0)

Annex J
(informative)

Heating capacity tests - Flow chart and examples of different test sequences

J.1 Flow chart

Figure J.1 illustrates with a flow chart the test procedure described in 4.5.2.3.



Key

1 start of the test apparatus and start of the appliance

2 see 4.5.2.3.2

3 operation until test tolerances of Tables 4 or 5 or 6 and 7 are fulfilled

4 start of the pre-conditioning period

5 defrost at the end of pre-conditioning period

6 see 4.5.2.3.5

7 no

8 yes

9 start of the equilibrium period according to 4.5.2.3.3

10 during the equilibrium period: or %ΔT > 2,5 % or defrost operation

11 see 4.5.2.3.6.2

12 see 4.5.2.3.6.3

13 data collection period (70 min) according to 4.5.2.3.4

14 during the data collection period: or %ΔT > 2,5 % or defrost operation

15 steady-state test procedure according to 4.5.2.3.4

16 10 min operation after defrost

17 see 4.5.2.3.6.4

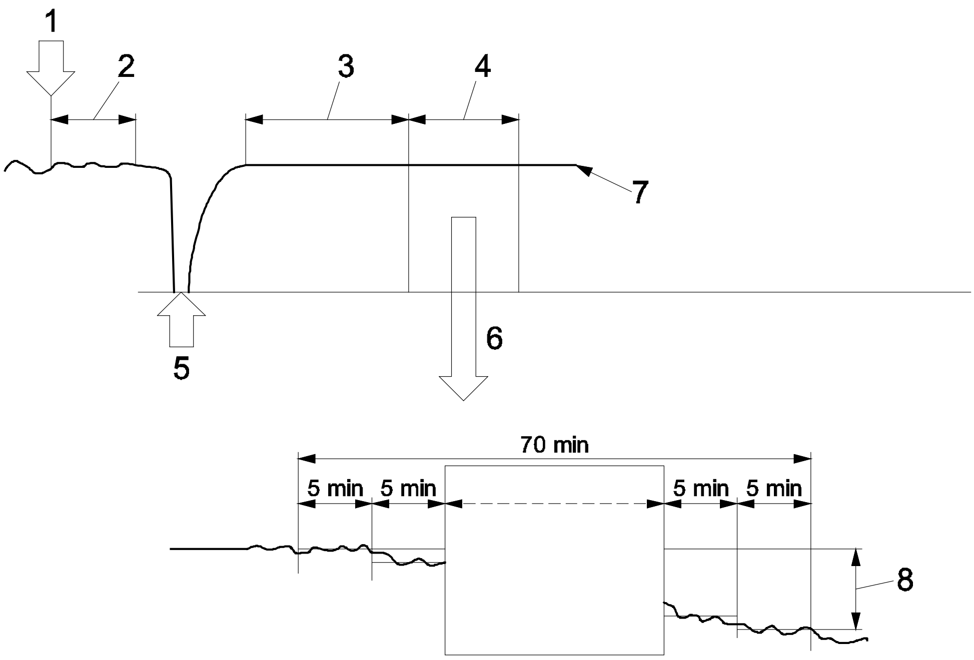
18 see 4.5.2.3.5

19 transient test procedure according to 4.5.2.3.7

Figure J.1 — Flow chart

J.2 Examples of test profiles

Figures J.2 to J.7 given below show several of the cases that could occur while conducting a heating capacity test as specified in 4.5.2.3. All examples show cases where a defrost cycle ends the preconditioning period.



Key

1 compliance with test tolerances first achieved

2 preconditioning period (10 min minimum)

3 equilibrium period 60 min

4 data for capacity calculation data collection period 70 min

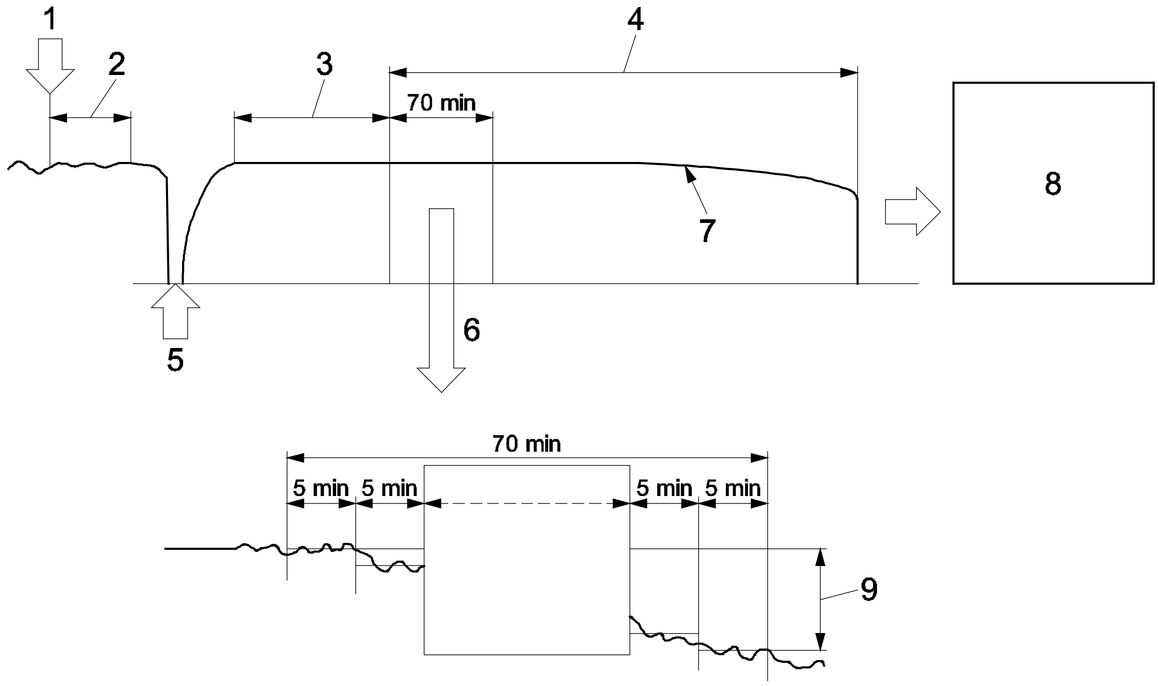
5 defrost at end of preconditioning period

6 expand

7 ΔT water (indoor side)

8 ΔT decreases by 2,5 % or less during the first 70 min of the data collection period

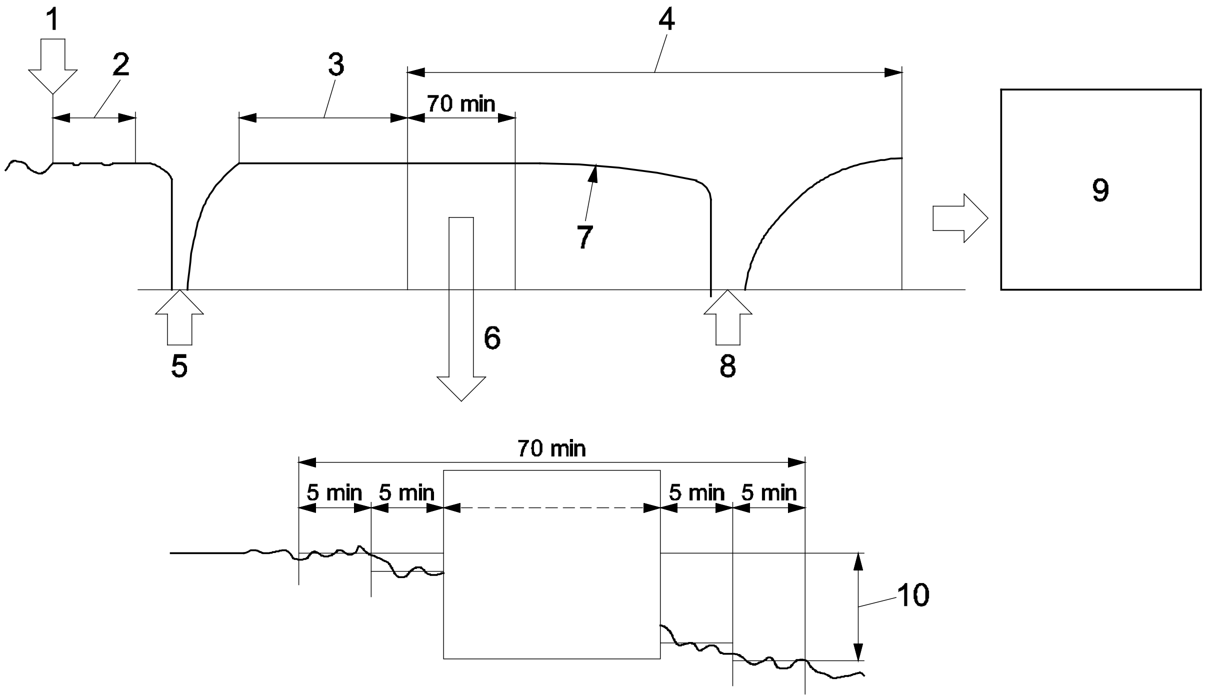
Figure J.2 — Steady-state heating capacity test



Key

1 compliance with test tolerances first achieved
2 preconditioning period (10 min minimum)
3 equilibrium period 60 min
4 data for capacity calculation data collection period 3 h
5 defrost at end of preconditioning period
6 expand
7 ΔT water (indoor side)
8 transient test. Terminate test when data collection period equals 3 h
9 ΔT decreases by more than 2,5 % during the first 70 min of the data collection period

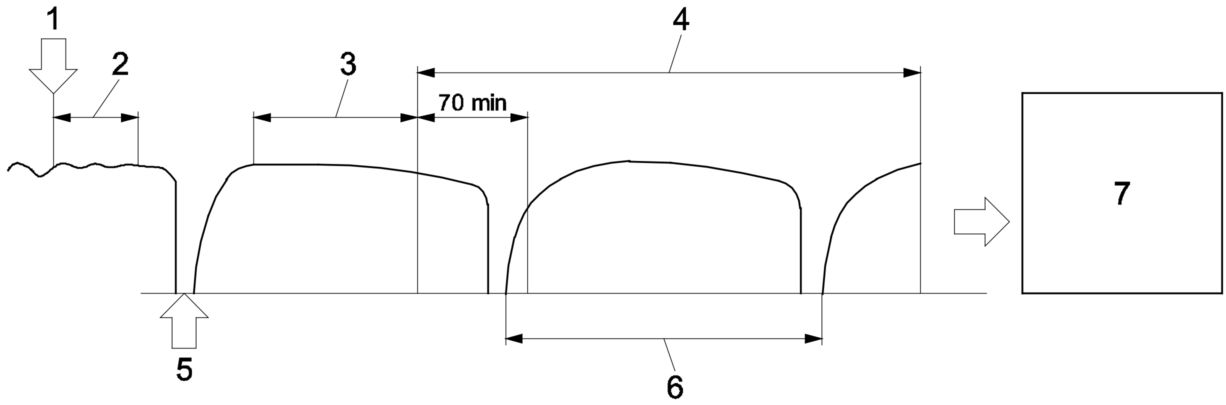
Figure J.3 — Transient heating capacity test with no defrost period



Key

1 compliance with test tolerances first achieved
2 preconditioning period (10 min minimum)
3 equilibrium period 60 min
4 data for capacity calculation data collection period 3 h
5 defrost at end of preconditioning period
6 expand
7 ΔT water (indoor side)
8 automatic defrost cycle occurs
9 transient test. Terminate test when data collection period equals 3 h
10 ΔT decreases by more than 2,5 % during the first 70 min of the data collection period

Figure J.4 — Transient heating capacity test with one defrost period during the data collection period



Key

1 compliance with test tolerances first achieved

2 preconditioning period (10 min minimum)

3 equilibrium period 60 min

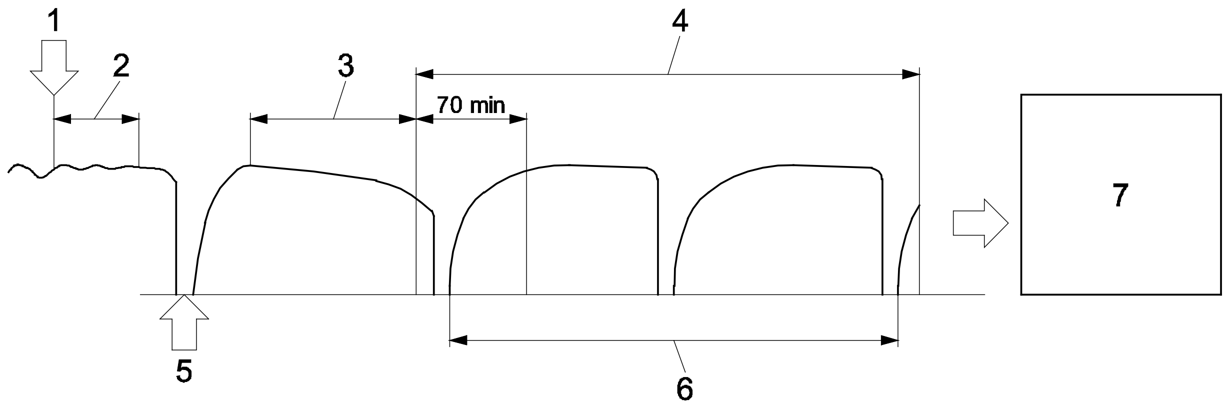
4 data collection period 3 h

5 defrost at end of preconditioning period

6 1 complete cycle data for capacity calculation

7 transient test. Terminate test when data collection period equals 3 h

Figure J.5 — Transient heating capacity test with one complete cycle with defrost during the data collection period



Key

1 compliance with test tolerances first achieved

2 preconditioning period (10 min minimum)

3 equilibrium period 60 min

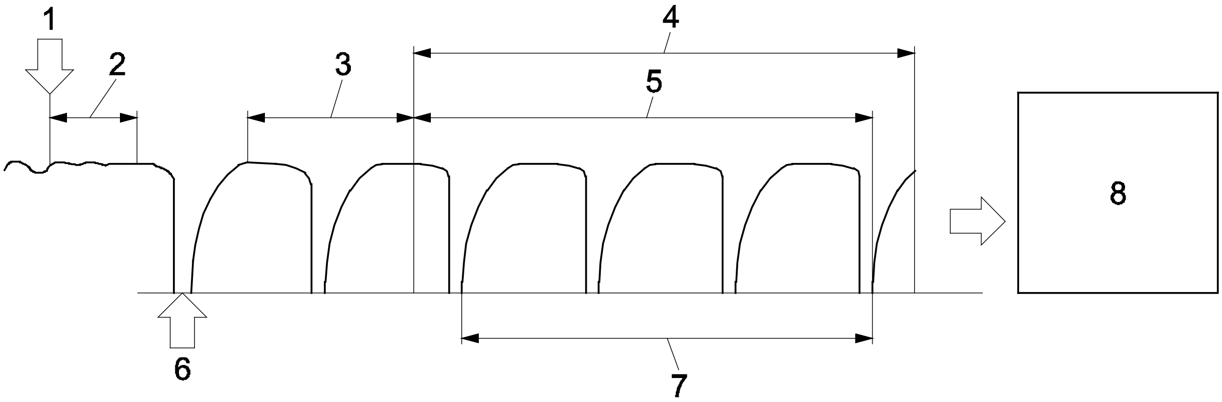
4 data collection period 3 h

5 defrost at end of preconditioning period

6 2 complete cycles data for capacity calculation

7 transient test. Terminate test when data collection period equals 3 h

Figure J.6 — Transient heating capacity tests with two complete cycles with defrost during the data collection period



Key

1 compliance with test tolerances first achieved

2 preconditioning period (10 min minimum)

3 equilibrium period 60 min

4 3 h

5 data collection period

6 defrost at end of preconditioning period

7 3 complete cycles data for capacity calculation

8 transient test. Terminate test at the end of 3 complete cycles during the data collection period

Figure J.7 — Transient heating capacity test with three complete cycles with defrost during the data collection period

Annex K
(informative)

Rating of indoor and outdoor units of multisplit and modular heat recovery multisplit system

K.1 General

This annex provides a possibility of rating multisplit and modular heat recovery multisplit systems by rating separately the indoor and outdoor units.

K.2 Terms and definitions

In addition to the terms and definitions given in EN 16905-1, the following apply.

K.2.1
outdoor cooling capacity
$\mathbf{P_{C,outdoor}}$
total cooling capacity of the outdoor unit measured as the total indoor units cooling capacity

K.2.2
outdoor heating capacity
$\mathbf{P_{H,outdoor}}$
heating capacity of the outdoor unit measured as the total indoor units heating capacity

K.2.3
outdoor power input
$\mathbf{P_{E,outdoor}}$
effective power input measured on the outdoor unit

K.2.4
indoor power input
$\mathbf{P_{E,indoor}}$
effective power input measured on the indoor unit

K.2.5
outdoor cooling energy efficiency ratio
$\mathbf{PERc\text{-}_{outdoor}}$
ratio of the outdoor cooling capacity to the outdoor power input

K.2.6
outdoor heating energy efficiency ratio
$\mathbf{PERh\text{-}_{outdoor}}$
ratio of the outdoor heating capacity to the outdoor power input

K.3 Rating in indoor units

K.3.1 General

Non ducted indoor units shall be rated on the basis of the measurement of the power input, $P_{E,indoor}$

Ducted indoor units shall be rated on the basis of the measurement of the air flow rate and on the power input $P_{E,indoor}$.

K.3.2 Air flow rate measurement

Ducted units shall have their flow rate measured according to Annex L.

K.3.3 Measurement of the power input of indoor units

The indoor unit shall be connected and shall run for a minimum of 30 min before measuring the total power input to the unit.

For ducted units, the measured power input shall be corrected from the fan power input due to external static pressure as specified in 4.2.4.3.3.

K.4 Rating of outdoor units

K.4.1 General

For rating an outdoor unit, it shall be connected to a minimum of two indoor units, for which a capacity ratio of (1 ± 5) % is obtained.

In case of ducted indoor units, the correction on the fan power due to the ESP of these units shall not be taken into account in the calculation of the effective power input, the cooling and/or heating capacities of the outdoor unit.

K.4.2 Test conditions

The test conditions shall be those as described in EN 16905-3 and as applicable to the multisplit or modular heat recovery multisplit system under test.

K.4.3 Test procedure

The cooling and/or heating capacity test(s) shall be performed according to the test procedure described in this standard.

The rating performance of outdoor units shall include the following as applicable:

— outdoor cooling/heating capacity: $P_{C,outdoor}$/ $P_{H,outdoor}$;

— outdoor power input in cooling/heating mode: $P_{E,outdoor}$;

— outdoor cooling energy efficiency ratio: $PER_{c-outdoor}$;

— outdoor heating energy efficiency ratio: $PER_{h-outdoor}$.

Annex L
(informative)

Air flow measurement

L.1 General

This annex provides information and describes the test procedure for rating the indoor and/or outdoor air flow rate of a ducted or non ducted air conditioner or heat pump.

L.2 Test installation

Packaged units and single split units shall have a duct section attached to the outlet area of the indoor section for connection to the air flow measuring device.

Multisplit systems shall have short plenums attached to each indoor unit. Each plenum shall discharge into a common duct section, the duct section in turn discharging into an air measuring device. Each plenum shall have an adjustable restrictor located in the plane where the plenums enter the common duct section for purpose of adjusting the static pressures in each plenum to the manufacturer's specifications.

The length of the duct section for package and single split systems and the length of the individual plenums for multisplit systems is a minimum of $2{,}5 \times \sqrt{\left(4 \times \left(A \times B\right) \div \pi\right)}$ where A = width and B = height of duct or outlet.

Static pressure readings are taken at a distance of $2 \times \sqrt{\left(A \times B\right)}$ from the outlet.

L.3 Test conditions

The air flow rate shall be related to standard air and measured with dry heat exchanger, when the fan only is operating.

For ducted units, the external static pressure ESP shall be set in accordance with 4.5.1.4 for units ducted on the indoor heat exchanger and with 4.5.1.5 for units ducted on the outdoor heat exchanger.

For non ducted units, the ESP shall be set equal to zero (0).

L.4 Air flow measurement

Air flow measurements shall be made so that the requirement on the uncertainty of measurement given in Table 1 is fulfilled.

EN ISO 5167-1 and EN ISO 5801 may be used.

Annex ZA
(informative)

Relationship between this European Standard and the ecodesign requirements of Commission Regulation (EU) No 813/2013 aimed to be covered

This European Standard has been prepared under a Commission's standardization request "M/535" to provide one voluntary means of conforming to the ecodesign requirements of Commission Regulation (EU) No 813/2013 of 2 August 2013 implementing Directive 2005/32/EC [2] / 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for space heaters and combination heaters.

Once this standard is cited in the Official Journal of the European Union under that Regulation, compliance with the normative clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding ecodesign requirements of that Regulation and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and 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 and Commission's standardization request M/535

Ecodesign Requirements of Regulation (EU) No 813/2013	Clause(s)/subclause(s) of this EN	Remarks/Notes
Annex II.3	4.1	-
Annex III.4	4.2; 4.3; 4.5	-
Annex III.4	Clause 4: Table 6, Table 9, Table 10 and Table 11	-

WARNING 1 — Presumption of conformity stays valid only as long as a reference to this European Standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

WARNING 2 — Other Union legislation may be applicable to the products falling within the scope of this standard.

2) The Directive was replaced by Directive 2009/125/EC.

Annex ZB
(informative)

Relationship between this European Standard and the energy labelling requirements of Commission Delegated Regulation (EU) No 811/2013 aimed to be covered

This European Standard has been prepared under a Commission's standardization request "M/535" to provide one voluntary means of conforming to the energy labelling requirements of 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 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.

Once this standard is cited in the Official Journal of the European Union under that Regulation, compliance with the normative clauses of this standard given in Table ZB.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding energy labelling requirements of that Regulation and associated EFTA regulations.

Table ZB.1 — Correspondence between this European Standard and 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 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 and Commission's standardization request M/535

Energy labelling requirements of Regulation (EU) No 811/2013	Clause(s)/subclause(s) of this EN	Remarks/Notes
Article 3, 1(a), Annex II, 1	Not applicable	Energy efficiency classes
Article 3, 1(a), Annex II, 2	Not applicable	Water heating energy classes
Article 3, 1(a), Annex III and IV	4.1	Test protocol to measure the sound power level
Article 3, 1(a), Annex III, 1.1 and Annex III, 3.	4.2.1	Tests protocols for measuring the rating heat output to be inserted in the Energy label for space heater
Article 3, 1(b), Annex IV, 1 and Annex IV, 5.	4.1 4.2 4.3 4.5	Tests protocols for measuring the data to be inserted in the product fiche for space heater
Article 3, 1(c), Annex V, 1.	4.1 4.2 4.3 4.5	Tests protocols for measuring the data to be inserted in the technical documentation for space heater
Article 3, 2(a), Annex III, 2.1 and Annex III, 4.	Not applicable	Energy label for combination heater
Article 3, 2(b), Annex IV, 2 and Annex IV, 6.	Not applicable	Product fiche for combination space heater
Article 3, 2(c), Annex V, 2	Not applicable	Technical documentation for combination heater

WARNING 1 — Presumption of conformity stays valid only as long as a reference to this European Standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

WARNING 2 — Other Union legislation may be applicable to the products falling within the scope of this standard.

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