BS EN 14511-3:2022

BSI Standards Publication

Air conditioners, liquid chilling packages and heat pumps for space heating and cooling and process chillers, with electrically driven compressors

Part 3: Test methods

National foreword

This British Standard is the UK implementation of EN 14511-3:2022. It supersedes BS EN 14511-3:2018, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee RHE/17, Testing of air conditioning units.

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

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

Climatiseurs, groupes refroidisseurs de liquide et pompes à chaleur pour le chauffage et le refroidissement des locaux et refroidisseurs industriels avec compresseur entraîné par moteur électrique - Partie 3 : Méthodes d'essai

Luftkonditionierer, Flüssigkeitskühlsätze und Wärmepumpen für die Raumbeheizung und -kühlung und Prozess-Kühler mit elektrisch angetriebenen Verdichtern - Teil 3: Prüfverfahren

This European Standard was approved by CEN on 10 July 2022.

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Contents

European foreword

This document (EN 14511-3:2022) has been prepared by Technical Committee CEN/TC 113 “Heat pumps and air conditioning units”, the secretariat of which is held by UNE.

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of an identical text or by endorsement, at the latest by March 2023, and conflicting national standards shall be withdrawn at the latest by March 2023.

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 supersedes EN 14511-3:2018.

The main changes compared with EN 14511-3:2018 are as follows:

— update of the flowchart with steps procedure;

— addition of new annexes for the liquid enthalpy test method;

— addition of a new Annex ZC on the relationship with Commission Regulation (EU) No 2016/2281.

This document has been prepared in the frame of:

— Commission Regulation (EU) No 206/2012 of 6 March 2012 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for air conditioners and comfort fans;

— Commission Delegated Regulation (EU) No 626/2011 of 4 May 2011 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of air conditioners;

— 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;

— Commission Delegated Regulation (EU) No 811/2013 of 18 February 2013 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to the energy labelling of space heaters, combination heaters, packages of space heater, temperature control and solar device and packages of combination heater, temperature control and solar device;

— Commission Regulation (EU) 2015/1095 of 5 May 2015 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for professional refrigerated storage cabinets, blast cabinets, condensing units and process chillers;

— Commission Regulation (EU) 2016/2281 of 30 November 2016 implementing Directive 2009/125/EC of the European Parliament and of the Council establishing a framework for the setting of ecodesign requirements for energy-related products, with regard to ecodesign requirements for air heating products, cooling products, high temperature process chillers and fan coil units.

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

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

EN 14511, *Air conditioners, liquid chilling packages and heat pumps for space heating and cooling and process chillers, with electrically driven compressors*, currently comprises the following parts:

— *Part 1: Terms and definitions*;

— *Part 2: Test conditions*;

— *Part 3: Test methods*;

— *Part 4: Requirements*.

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

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1 Scope

1.1 The scope of EN 14511-1:2022 is applicable.

1.2 This document specifies the test methods for the rating and performance of air conditioners, liquid chilling packages and heat pumps using either air, water or brine as heat transfer media, with electrically driven compressors when used for space heating and cooling. These test methods also apply for the rating and performance of process chillers.

It also specifies the method of testing and reporting for heat recovery capacities, system reduced capacities and the capacity of individual indoor units of multisplit systems, where applicable.

This document also makes possible to rate multisplit and modular heat recovery multisplit systems by rating separately the indoor and outdoor units.

2 Normative references

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

EN 14511-1:2022, *Air conditioners, liquid chilling packages and heat pumps for space heating and cooling and process chillers, with electrically driven compressors — Part 1: Terms and definitions*

EN 14825:2018, *Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling — Testing and rating at part load conditions and calculation of seasonal performance*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14511-1:2022 apply.

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

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

— IEC Electropedia: available at https://www.electropedia.org/

4 Tests for determination of capacities

4.1 Basic principles and methods

4.1.1 Air-to-air and water(brine)-to-air units

Heating and/or cooling capacity of air-to-air or water(brine)-to-air units shall be determined from measurements in a calorimeter room (see Annex A) or by the air enthalpy method (see Annex B).

NOTE 1 Annex C (informative) provides additional information to Annex B for reducing uncertainties of measurement of capacities.

The measured heating capacity Φ_{thi} shall be corrected for the heat from the indoor fan as specified in 4.1.3.2 or 4.1.3.3 to obtain the heating capacity P_H.

The measured cooling capacity Φ_{tci} shall be corrected for the heat from the indoor fan as specified in 4.1.3.2 or 4.1.3.3 to obtain the cooling capacity P_C.

NOTE 2 For rating indoor units and/or outdoor units separately, Annex G can be used.

4.1.2 Air-to-water(brine) and water(brine)-to-water(brine) units

The heating and/or cooling capacity of air-to-water(brine) and water(brine)-to-water(brine) units shall be determined in accordance with the liquid enthalpy test method at the liquid indoor heat exchanger (see Annex D).

The heat recovery capacity of air-to-water(brine) and water(brine)-to-water(brine) units shall be determined in accordance with the liquid enthalpy test method at the liquid heat recovery heat exchanger (see Annex D).

NOTE Annex E (informative) provides additional information to Annex D regarding the test installation and measurements.

The measured heating capacity Φ_{thi} shall be corrected for the heat from the indoor liquid pump as specified in 4.1.3.4 to obtain the heating capacity P_H.

The measured cooling capacity Φ_{tci} shall be corrected for the heat from the indoor liquid pump as specified in 4.1.3.4 to obtain the cooling capacity P_C.

The measured heat recovery capacity Φ_{hr} shall be corrected for the heat from the heat recovery liquid pump as specified in 4.1.3.4 to obtain the heating recovery capacity P_{HR}.

4.1.3 Capacity correction

4.1.3.1 General

The capacity shall include the correction due to the heat output of the indoor fan or pump, integrated into the unit or not as follows.

4.1.3.2 Capacity correction due to indoor fan for non-ducted units

In the case of units which are not designed for duct connection, i.e. which do not permit any external pressure difference, and which are equipped with an integral fan, no capacity correction due to heat provided by the fan shall apply.

4.1.3.3 Capacity correction due to indoor fan for ducted units

4.1.3.3.1 Units with integrated indoor fan

If the fan at the indoor heat exchanger is an integral part of the unit, the power input correction of the fan, as calculated with Formula (5) (see 4.1.4.3.1) shall be:

— subtracted from the measured heating capacity;

— added to the measured cooling capacity.

4.1.3.3.2 Units with non-integrated indoor fan

If the fan at the indoor heat exchanger is not an integral part of the unit, the power input correction as calculated with Formula (6) (see 4.1.4.3.2) shall be:

— added to the measured heating capacity;

— subtracted from the measured cooling capacity.

4.1.3.4 Capacity correction due to indoor liquid pump

4.1.3.4.1 Units with integrated liquid pump

If the liquid pump is an integrated part of the unit, the capacity correction as specified in 4.1.3.4.3 or 4.1.3.4.4 shall be:

— subtracted from the measured heating capacity;

— added to the measured cooling capacity;

— subtracted from the measured heat recovery capacity.

In case, the integrated liquid pump does not provide any available external static pressure difference, no capacity correction applies.

4.1.3.4.2 Units with non-integrated liquid pump

If the liquid pump is not an integral part of the unit, the capacity correction as specified in 4.1.3.4.5 shall be:

— added to the measured heating capacity;

— subtracted from the measured cooling capacity;

— added to the measured heat recovery capacity.

4.1.3.4.3 Capacity correction for integrated glandless circulator

If the unit is equipped with a glandless circulator, the capacity correction, expressed in W, is calculated using Formula (1).

$$\left(q \times \Delta_{pe}\right) \times \frac{1-\eta}{\eta} \quad (1)$$

where

q	is the measured liquid flow rate, expressed in m^3/s.
Δp_e	is the measured available external static pressure difference, expressed in Pa, as defined in EN 14511-1:2022, 3.3;
η	is the global efficiency of the pump calculated according to Annex F.

4.1.3.4.4 Capacity correction for integrated dry motor pump

If the unit is equipped with a dry-motor pump, the capacity correction, expressed in W, shall be calculated using Formula (2).

$$\left(q \times \Delta_{pe}\right) \times \frac{IE - \eta}{\eta} \quad (2)$$

where

- q is the measured liquid volume flow rate, expressed in m^3/s;
- Δp_e is the measured available external static pressure difference, expressed in Pa, as defined in EN 14511-1:2022, 3.3;
- IE is the motor efficiency as specified in the EC 2019/1781 regulation;
- η is the global efficiency of the pump calculated according to Annex F.

4.1.3.4.5 Capacity correction for non-integrated liquid pump

If the measured hydraulic power according to Annex F is ≤ 300 W, the liquid pump is considered as a glandless circulator. The capacity correction, expressed in W, is calculated using Formula (3).

$$\left(q \times -\Delta_{pi}\right) \times \frac{1 - \eta}{\eta} \quad (3)$$

where

- q is the measured liquid flow rate, expressed in m^3/s;
- Δp_i is the measured internal static pressure difference, expressed in Pa, as defined in EN 14511-1:2022, 3.30;
- η is the global efficiency of the pump calculated according to Annex F.

If the measured hydraulic power according to Annex F is > 300 W, the liquid pump is considered as a dry-motor pump. The capacity correction, expressed in W, is calculated using Formula (4).

$$\left(q \times -\Delta_{pi}\right) \times \frac{IE - \eta}{\eta} \quad (4)$$

where

- q is the liquid volume flow rate, expressed in m^3/s;
- Δp_i is the measured internal static pressure difference, expressed in Pa, as defined in EN 14511-1:2022, 3.30;
- IE is equal to 0,88 (average motor nominal efficiency specified in the EC 2019/1781 regulation for IE3 efficiency level);
- η is the global efficiency of the pump calculated according to Annex F.

4.1.4 Effective power input

4.1.4.1 General

The effective power input shall include the correction due to power input of indoor and/or outdoor fans and/or pumps, integrated into the unit or not as follows.

4.1.4.2 Power input correction due to fans for non-ducted units

In the case of units which are not designed for duct connection, i.e. which do not permit any external pressure difference, and which are equipped with an integral fan, the power absorbed by the fan shall be included in the effective power absorbed by the unit.

4.1.4.3 Power input correction due to fans for ducted units

4.1.4.3.1 Power input correction of integrated fans

If a fan is an integral part of the unit, only a fraction of the power input of the fan motor shall be included in the effective power absorbed by the unit. The fraction that is to be excluded from the total power absorbed by the unit, expressed in W, shall be calculated using Formula (5):

$$\frac{q \times \Delta p_{e(corr)}}{\eta} \quad (5)$$

where

q is the air volume flow rate, expressed in m^3/s and set according to 4.4.1.3 ($q_{v,lab}$) or 4.4.1.4 ($q_{v,outdoor,lab}$);

$\Delta p_{e\,(corr)}$ is the available external static pressure difference, expressed in Pa, as defined in EN 14511-1:2022, 3.3 and set according to 4.4.1.3 ($\Delta p_{e,lab}$) or 4.4.1.4 ($\Delta p_{e,outdoor,lab}$);

η is equal to η_{target} as declared by the fan manufacturer according to the ecodesign regulation (EU) No 327/2011 for fans driven by motors between 125 W and 500 kW; otherwise is equal to 0,3 by convention.

4.1.4.3.2 Power input correction of non-integrated fans

If no fan is provided with the unit, the proportional power input which is to be included in the effective power absorbed by the unit, expressed in W, shall be calculated using the Formula (6):

$$\frac{q \times \left(-\Delta p_i\right)}{\eta} \quad (6)$$

where

q is the air volume flow rate, expressed in m^3/s and set according to 4.4.1.3 or 4.4.1.4;

Δp_i is the measured internal static pressure difference, expressed in Pa, as defined in EN 14511-1:2022, 3.30;

η is 0,3 by convention.

4.1.4.4 Power input correction due to liquid pumps

4.1.4.4.1 Power input correction of integrated liquid pumps

When the liquid pump is integrated into the unit, it shall be connected for operation. When the liquid pump is delivered by the manufacturer apart from the unit, it shall be connected for operation according to the manufacturer's instructions and be then considered as an integral part of the unit.

For an integrated liquid pump, only a fraction of the input to the pump motor shall be included in the effective power absorbed by the unit. The fraction which is to be excluded from the total power absorbed by the unit, expressed in W, shall be calculated using Formula (7):

$$\frac{q \times \Delta p_e}{\eta} \tag{7}$$

where

q	is the measured liquid flow rate, expressed in m^3/s;
Δp_e	is the measured available external static pressure difference, expressed in Pa, as defined in EN 14511-1:2022, 3.3;
η	is the efficiency of the pump calculated according to Annex F.

In case the liquid pump is not able to provide any external static pressure difference, then this correction does not apply but the correction shall be made according to 4.1.4.4.2.

4.1.4.4.2 Power input correction of non-integrated liquid pumps

If no liquid pump is provided with the unit, the proportional power input which is to be included in the effective power absorbed by the unit, expressed in W, shall be calculated using Formula (8):

$$\frac{q \times \left(-\Delta p_i\right)}{\eta} \tag{8}$$

where

q	is the measured liquid flow rate, expressed in m^3/s;
Δp_i	is the measured internal static pressure difference, expressed in Pa, as defined in EN 14511-1:2022, 3.30;
η	is the efficiency of the pump calculated according to Annex F.

4.1.5 Units on a distribution network of pressured water

In the case of appliances designed specially to operate on a distributing network of pressurized water without water-pump, no correction shall be applied to the power input.

4.1.6 Units for use with remote condenser

The power from the auxiliary liquid pump of the remote condenser shall not be taken into account in the effective power input.

4.2 Test apparatus

4.2.1 Arrangement of the test apparatus

4.2.1.1 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 document can be fulfilled.

4.2.1.2 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 test object 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 flows through the room at these two locations shall not exceed 1,5 m/s when the test object is switched off.

The air velocity in the room shall also not be greater than the mean velocity through the unit inlet. 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 units in the test room onto the unit or onto the temperature measuring points shall be avoided.

4.2.1.3 Appliances with duct connection

The connections of a ducted air unit 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.

If defrost controls on the heat pump provide means 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.

4.2.1.4 Appliances with integrated pumps

For appliances with integrated and adjustable water or brine pumps, the pump speed shall be set at the same time as the temperature difference.

In case of a liquid pump with several fixed speeds or with variable speed, the manufacturer shall provide information on the settings of pump (speed or external static pressure to achieve).

If defrost controls on the heat pump provide means for stopping the indoor water flow rate, provision shall be made to stop the test apparatus water flow rate to the equipment during such a defrost period.

4.2.1.5 Liquid chilling package for use with remote condenser

Units for use with remote condenser are tested by using a water (brine)-cooled condenser, the characteristics of which shall enable the intended operating conditions to be achieved.

4.2.2 Installation and connection of the test object

4.2.2.1 General

The test object shall be installed and connected for the test as recommended by the manufacturer in the installation and operation manual. The accessories provided by option are not included in the test. If a back-up heater is provided in option or not, it shall be switched off or disconnected to be excluded from the testing.

For single ducts, regardless of the manufacturer's instructions, the discharge duct shall be as short and straight as possible compatibly with minimum distance between the unit and the wall for correct air inlet but not less than 0,5 m. No accessory shall be connected to the discharge end of the duct.

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

For multisplit systems, the test shall be performed with a system capacity ratio of 1, or as close as possible.

As an option, Annex K provides recommendations to determine the capacity of an individual indoor unit, either operating on its own with the other indoor units disconnected, or with all indoor units operating.

When performing measures in heating mode, set the highest room temperature on the unit/system control device; when performing measures in cooling mode, set the lowest room temperature on the unit/system control device. If in the instructions, the manufacturer indicates a value for the temperature set on the control device for a given rating condition, then this value shall be used.

For unit with open-type compressors the electric motor shall be supplied or specified by the manufacturer. The compressor shall be operated at the rotational speed specified by the manufacturer.

For inverter type control units, the setting of the frequency shall be done for each rating condition. The manufacturer shall provide in the documentation information about how to obtain the necessary data to set the required frequencies.

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

4.2.2.2 Installation of unit consisting of several parts

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

a) The refrigerant lines shall be installed in accordance with the manufacturer's instructions. The length of the refrigerant 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.

b) The refrigerant lines shall be installed so that the difference in elevation does not exceed 2,5 m.

c) The thermal insulation of the refrigerant lines shall be applied in accordance with the manufacturer's instructions.

d) Unless constrained by the design, at least half of the refrigerant lines shall be exposed to the outside conditions, with the rest of the refrigerant lines exposed to the inside conditions.

For single split air-to-air units above 12 kW, if a length of refrigerant lines of 7,5 m cannot be achieved, a length of 11 m ± 0,5 m shall be used and a cooling correction factor of 1,02 and a heating correction factor of 1,01 shall applied to the cooling and heating capacity respectively.

For multisplit air-to-air units above 12 kW, if a length of refrigerant lines of 7,5 m cannot be achieved, the total actual length from the outdoor unit to each indoor unit shall be as specified in Table 1. The cooling correction factor and heating correction factor as given in Table 1 shall apply to the cooling and heating capacity respectively.

The maximum height difference can be extended to 3,5 m if the installation constrains make not possible to keep it below 2,5 m.

The manufacturer shall provide a scheme of the combination to be installed, including indoor/outdoor units and all piping accessories. Piping layout shall be prepared in order to minimize pressure drop over the piping (e.g. minimize number of bends, maximize bending radius). Furthermore, refrigerant lines between the outdoor unit and all indoor units shall have the same length.

Table 1 — Length of refrigerant lines and correction factors for different capacity ranges

Capacity range	Individual refrigerant line length	Cooling correction factor	Heating correction factor
> 12 kW and < 30 kW	11 ± 0,5 m	1,02	1,01
≥ 30 kW	15 ± 0,5 m	1,03	1,02

4.2.2.3 Indoor units of multisplit systems

When testing a multisplit 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 multisplit 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.

4.2.2.4 Measuring points

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

For free air intake dry bulb temperature measurements, it is required:

— either to have at least one sensor per square metre, with not less than four measuring points and by restricting to 20 the number of sensors equally distributed on the free air surface;

— or to use a sampling device. It shall be complemented by four sensors equally distributed on the free air surface for checking uniformity if the free air surface is greater than 1 m^2.

Air dry bulb temperature sensors shall be placed at a distance between 0,15 m and 0,3 m from the free air surface, defined as the minimal enveloping surface containing the coil(s).

For units with V-shape coils, Figure 1 shows the minimum enveloping surface to be considered as the free air surface for the position of the sensors.

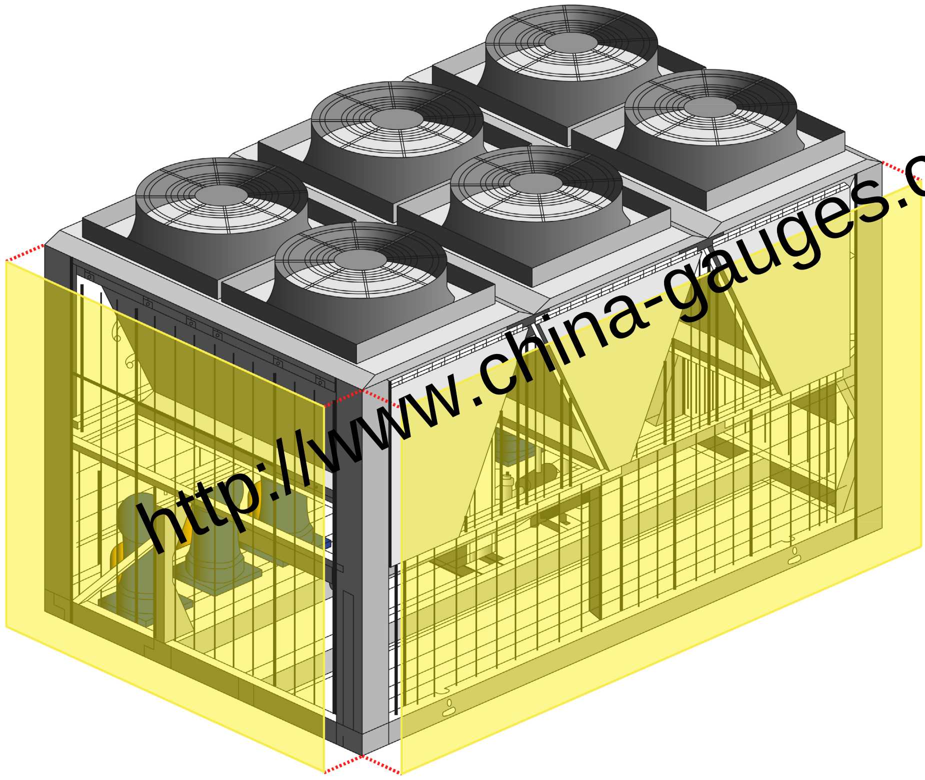


Figure 1 — Minimum enveloping surface for units with V-shaped coils (example of an outdoor unit)

For free air supply dry bulb temperature measurements, a maximum distance of 0,1 m from the indoor unit is required in order to achieve a representative mean value in the cross section.

For control cabinet air conditioners, the inlet temperature at the evaporator is measured instead of the temperature inside the control cabinet.

For units consisting of a heat pump and a storage tank as a factory made unit, water inlet and outlet temperature measurements shall be taken at the inlet and outlet of this unit.

For water and brine, the density shall be determined in the temperature conditions measured near the volume flow measuring device.

4.3 Uncertainties of measurement

The uncertainties of measurement shall not exceed the values specified in Table 2.

All uncertainties are maximum expanded uncertainties with a 95 % confidence level.

Table 2 — Uncertainties of measurement for indicated values

Measured quantity	Unit	Uncertainty of measurement
Liquid		
Temperature difference	K	±0,15 K
Temperature inlet/outlet	°C	±0,15 K
Volume (mass) flow	m^3/s (kg/s)	±1 %
Static pressure difference	kPa	±1 kPa ($\Delta p \leq 20$ kPa) or ± 5 %($\Delta p > 20$ kPa)
Air		
Dry bulb temperature	°C	±0,2 K
Wet bulb temperature	°C	±0,4 K
Air volume flow	m^3/s	±5 %
Static pressure difference	Pa	±5 Pa ($\Delta p \leq 100$ Pa) or ± 5 %($\Delta p > 100$ Pa)
Refrigerant		
Pressure at compressor outlet	kPa	±1 %
Temperature	°C	±0,5 K
Concentration (in volume)		
Heat transfer medium	%	±2
Electrical quantities		
Electric power	W	±1 %
Voltage	V	±0,5 %
Current	A	±0,5 %
Electrical energy	kWh	±1 %
Compressor rotational speed (for open type compressors)	min^{-1}	±0,5 %

The heating or cooling capacities measured on the liquid side shall be determined within a maximum uncertainty of 5 %.

The steady-state heating or cooling capacities determined using the calorimeter method shall be determined with a maximum uncertainty of 5 %; 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 %.

For air conditioners and heat pumps tested according to the air enthalpy method and having a capacity below or equal to 12 kW in cooling mode, or heating mode if the unit has no cooling function, under the standard rating conditions of EN 14511-2:2022, the following applies:

— The steady-state heating and cooling capacity shall be determined with a maximum uncertainty of 5 %.

— The transient heating capacity shall be determined with a maximum uncertainty of 10 %.

For air conditioners and heat pumps tested according to the air enthalpy method and having a capacity above 12 kW in cooling mode, or heating mode if the unit has no cooling function, under the standard rating conditions of EN 14511-2:2022, the heating and cooling capacity shall be determined with a maximum uncertainty of 10 %.

Maximum uncertainties on heating and cooling capacities shall be fulfilled, independently of the individual uncertainties of measurements including the uncertainties on the properties of fluids.

NOTE CEN ISO/TS 16491 provides guidelines for the evaluation of uncertainty of measurement in air conditioner and heat pump cooling and heating capacity tests.

4.4 Test procedure

4.4.1 Settings

4.4.1.1 All units

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 for rating the unit.

Table 5 and Table 6 state permissible deviations of the measured values from the test conditions.

4.4.1.2 Non-ducted units

Adjustable settings such as louvers and fan speed shall be set for maximum steady-state air flow.

If the manufacturer indicates a fan speed different from the maximum one to set on the control device for a given rating condition, then this fan speed shall be used.

4.4.1.3 Units ducted on the indoor heat exchanger

Supply air flow rate shall be set with dry heat exchanger. Whenever possible only the fan shall be operating to guarantee dry coil conditions.

The air volume flow rate declared by the manufacturer for the cooling mode (or heating mode if no cooling mode of the unit) shall be related to standard air.

This air flow rate, $q_{\mathrm{v,declared}}$, shall be corrected for the actual atmospheric conditions at the laboratory location so that the air volume flow rate to be set by the test facility, $q_{\mathrm{v,lab}}$, is as given in Formula (9).

$$q_{v,lab} = \frac{p_{std}}{p_{lab}} \times q_{v,declared} \tag{9}$$

where

$q_{\mathrm{v,declared}}$	is the air flow rate in standard air conditions as declared by the manufacturer, expressed in m^3/h;
p_{std}	is the density of standard air (20° C, 101 325 Pa), equal to 1,204 kg/m^3;
p_{lab}	is the density of air at the actual atmospheric conditions, expressed in kg/m^3.

Once the air volume flow rate $q_{\mathrm{v,lab}}$ is set, the resulting external static pressure difference is measured as $\Delta p_{\mathrm{e,lab}}$.

This resulting $\Delta p_{\mathrm{e,lab}}$ shall be converted to standard air using Formula (10) to obtain the external static pressure difference to be set as $\Delta p_{\mathrm{e,std}}$.

$$\Delta p_{e,std} = \frac{p_{std}}{p_{lab}} \times \Delta p_{e,lab} \quad (10)$$

where

$\Delta p_{e,lab}$ is the available external static pressure at the actual atmospheric conditions, expressed in Pa, as defined in EN 14511-1:2022, 3.58;

p_{std} is the density of standard air (20° C, 101 325 Pa), equal to 1,204 kg/m^3;

p_{lab} is the density of air at the actual atmospheric conditions, expressed in kg/m^3.

If $\Delta p_{e,std}$ is lower than the minimum value given in Table 3 (or Table 4), the fan speed shall be adjusted to reach at least this minimum value, using the closest speed step of the fan that meets the minimum pressure requirement. If no fan speed is available, the air flow rate shall be decreased until reaching the minimum required $\Delta p_{e,std}$.

If $\Delta p_{e,std}$ is greater than twice the minimum value given in Table 3 (or Table 4), the fan speed shall be adjusted so the external static pressure is twice this minimum value or below, if the closest speed step of the fan doesn't allow to match exactly twice the minimum external static pressure value. If no lowest fan speed is available, the air flow rate shall be increased until reaching twice the minimum external static pressure value ($\Delta p_{e,std}$).

The apparatus used for setting the external static pressure difference shall be maintained with the same running settings for all tests on the same unit, once the standard airflow and standard external static pressure have been determined.

This usually involves to fix a damper position and to control the fan speed inside the airflow measurement device to achieve 0 Pa pressure difference between the air loop section after the damper and the ambient.

Figure 2 provides an example of a layout for setting the ESP with a damper.

For ducted units to be tested using the air enthalpy method, the ESP shall be set at point 3 and the pressure at point 8 shall be equal to 0.

For ducted units to be tested in a calorimeter room, the ESP shall be set at point 3 while the pressure at point 8 shall be equal to 0. The air flow measurement device can be disconnected after the damper once the air flowrate/ESP are set.

Table 3 — Pressure requirement for comfort air conditioners and heat pumps

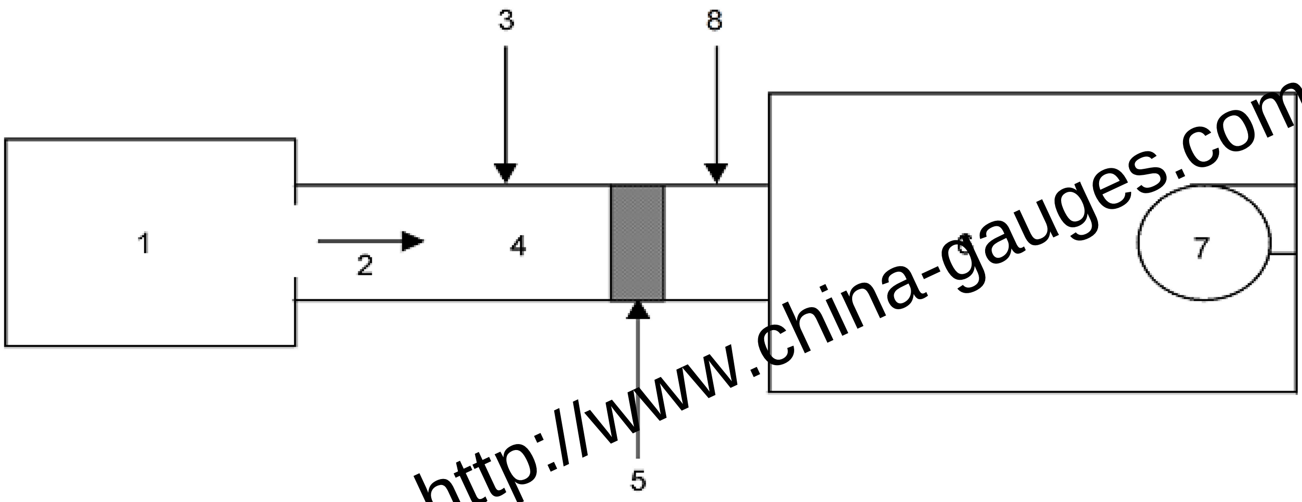
Standard capacity ratings kW	**Minimum external static pressure difference (*ESP*$_{min}$) [a, b]** Pa
0 < *Q* < 8	25
8 ≤ *Q* < 12	37
12 ≤ *Q* < 20	50
20 ≤ *Q* < 30	62
30 ≤ *Q* < 45	75
45 ≤ *Q* < 82	100
82 ≤ *Q* < 117	125
117 ≤ *Q* < 147	150
Q ≥ 147	175

[a] For equipment tested without an air filter installed, the minimum external static pressure shall be increased by 10 Pa.

[b] If the manufacturer’s 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 4 — Pressure requirement for close control air conditioners

Capacity kW	**Minimum external static pressure difference (ESP$_{min}$)** Pa	
	For down-flow discharge into double floor	For up-flow discharge into duct all units
< 30	50	—
≥ 30	75	—
All	—	50



Key

1 object under test
2 airflow
3 external static pressure measurement
4 duct
5 damper
6 airflow measuring apparatus
7 fan
8 external static pressure measurement

Figure 2 — Example of layout for setting the ESP with a damper

4.4.1.4 Units ducted on the outdoor heat exchanger

The air flow rate shall be set with dry heat exchanger. Whenever possible only the fan shall be operating to guarantee dry coil conditions.

The air volume flow rate declared by the manufacturer shall be related to standard air.

This air flow rate, $q_{\mathrm{v,outdoor,declared}}$, shall be corrected for the actual atmospheric conditions at the laboratory location so that the air volume flow rate to be set by the test facility, $q_{\mathrm{v,outdoor,lab}}$, is as given in Formula (11).

$$q_{v,outdoor,lab} = \frac{p_{std}}{p_{lab}} \times q_{v,outdoor,declared} \quad (11)$$

where

$q_{\mathrm{,v,outdoor,declared}}$	is the air flow rate in standard air conditions as declared by the manufacturer, expressed in m^3/h;
p_{std}	is the density of standard air (20° C, 101 325 Pa), equal to 1,204 kg/m^3;
p_{lab}	is the density of air at the actual atmospheric conditions, expressed in kg/m^3.

Once the air volume flow rate $q_{\mathrm{v,outdoor,lab}}$ is set, the resulting external static pressure difference is measured as $\Delta p_{\mathrm{e,outdoor,lab}}$.

This resulting $\Delta p_{e,outdoor,lab}$ shall be converted to standard air using Formula (12) to obtain the external static pressure difference to be set as $\Delta p_{e,outdoor,std}$.

$$\Delta p_{e,outdoor,std} = \frac{p_{std}}{p_{lab}} \times \Delta p_{e,outdoor,lab} \qquad (12)$$

where

$\Delta p_{e,outdoor,lab}$	is the available external static pressure at the actual atmospheric conditions, expressed in Pa, as defined in EN 14511-1:2022, 3.58;
p_{std}	is the density of standard air (20° C, 101 325 Pa), equal to 1,204 kg/m^3;
p_{lab}	is the density of air at the actual atmospheric conditions, expressed in kg/m^3.

If $\Delta p_{e,outdoor,std}$, is lower than 30 Pa, the fan speed shall be adjusted to reach this minimum value. If no fan speed is available, the air flow rate shall be decreased.

The apparatus used for setting the external static pressure difference shall be maintained in the same position during all the tests.

4.4.2 Output measurement for water (brine)-to-water (brine) and water (brine)-to-air units

4.4.2.1 Steady-state conditions

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 30 min, with respect to the permissible deviations given in Table 5. 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.

4.4.2.2 Measurement of heating capacity, cooling capacity and heat recovery capacity

The data collection starts after the steady-state conditions have been achieved according to 4.4.2.1.

For the output measurement, it is necessary to record all the meaningful data continuously. In the case of recording instruments which operate on a cyclic basis, the sequence shall be adjusted such that a complete recording is effected at least once every 30 s.

The output shall be measured in the steady-state conditions. The duration of measurement shall not be less than 35 min.

4.4.3 Output measurement for cooling capacity of air-to-water (brine) and air-to-air units

4.4.3.1 Steady-state conditions

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 permissible deviations given in Table 5. 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.

4.4.3.2 Measurement of cooling capacity

The data collection starts after the steady-state conditions have been achieved according to 4.4.3.1.

For the output measurement it is necessary to record all the meaningful data continuously. In the case of recording instruments which operate on a cyclic basis, the sequence shall be adjusted such that a complete recording is effected at least once every 30 s.

The output shall be measured in the steady-state conditions. The duration of measurement shall not be less than 35 min.

4.4.4 Output measurement for heating capacity of air-to-air and air-to-water units

4.4.4.1 General

The test procedure shall identify whether the data collection will occur in steady-state operation of the unit or will integrate transient operation of the unit (due to defrost cycles that may occur depending on the operating conditions).

A defrost cycle starts when the operation of the unit is modified to manage the defrost of the outdoor heat exchanger.

NOTE 1 Here below some examples of modified operation which define the start of a defrost cycle:

— The 4-way valve signal indicates a change of state;

— The water temperature difference between inlet and outlet is smaller than 0,2 K;

— One or several compressor(s) stop(s).

A defrost cycle ends when the operation of the unit comes back to heating.

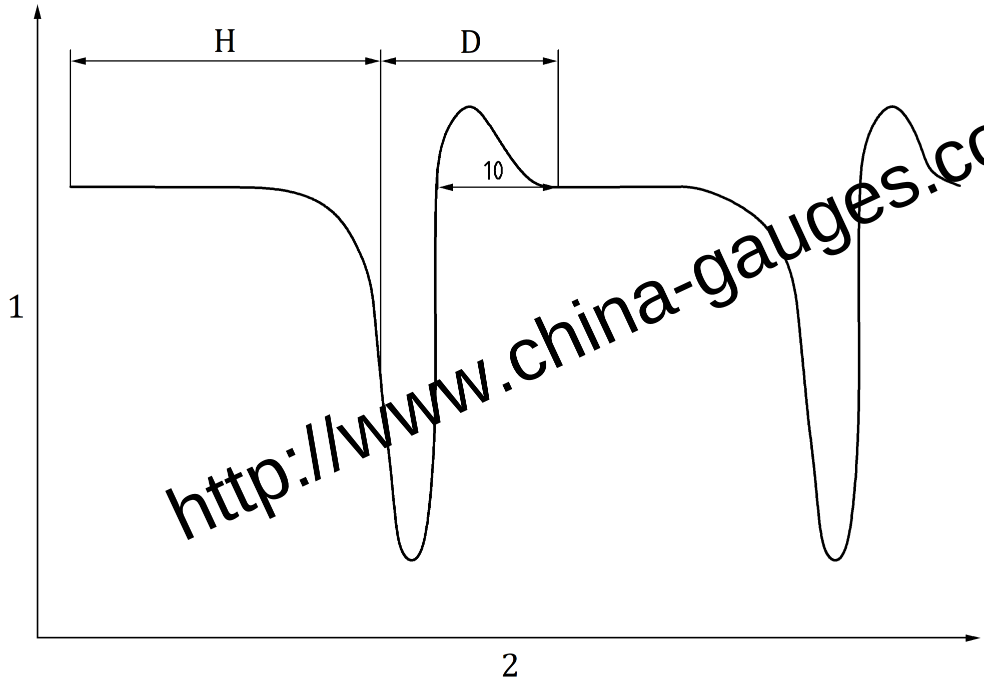
NOTE 2 Here below some examples of modified operation which define the end of a defrost cycle:

— The 4-way valve signal indicates a change of state;

— The water temperature difference between inlet and outlet is larger than 0,2 K;

— One or several compressor(s) start(s).

In transient regime, an interval H is defined as a heating period with the exception of the first 10 min after defrost termination. An interval D consists of a defrost cycle plus the first 10 min of heating operation after the termination of the defrost cycle (see Figure 3).



Key

1 Water temperature, in °C

2 Time, in min

Figure 3 — Example of defrost cycle with intervals H and D

During intervals H, data shall be sampled at equal intervals that span every 30 s or less.

During intervals D, 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 indoor air enthalpy method, these more frequently sampled data include the change in indoor-side dry bulb temperature. When using the calorimeter method, these more frequently sampled data include all measurements required to determine the indoor side capacity.

For heat pumps that automatically switch off the indoor fan during a defrost, the contribution of the net heating delivered and/or the change in indoor-side dry bulb temperature shall be assigned the value of zero when the indoor fan is off, if using the indoor air enthalpy method. If using the calorimeter test method, the integration of capacity shall continue while the indoor fan is off.

The test procedure is applicable to both the air enthalpy and the calorimeter room methods.

The test procedure is described by the following flowchart (see Figure 4). The steps of the flowchart shall immediately follow each other.

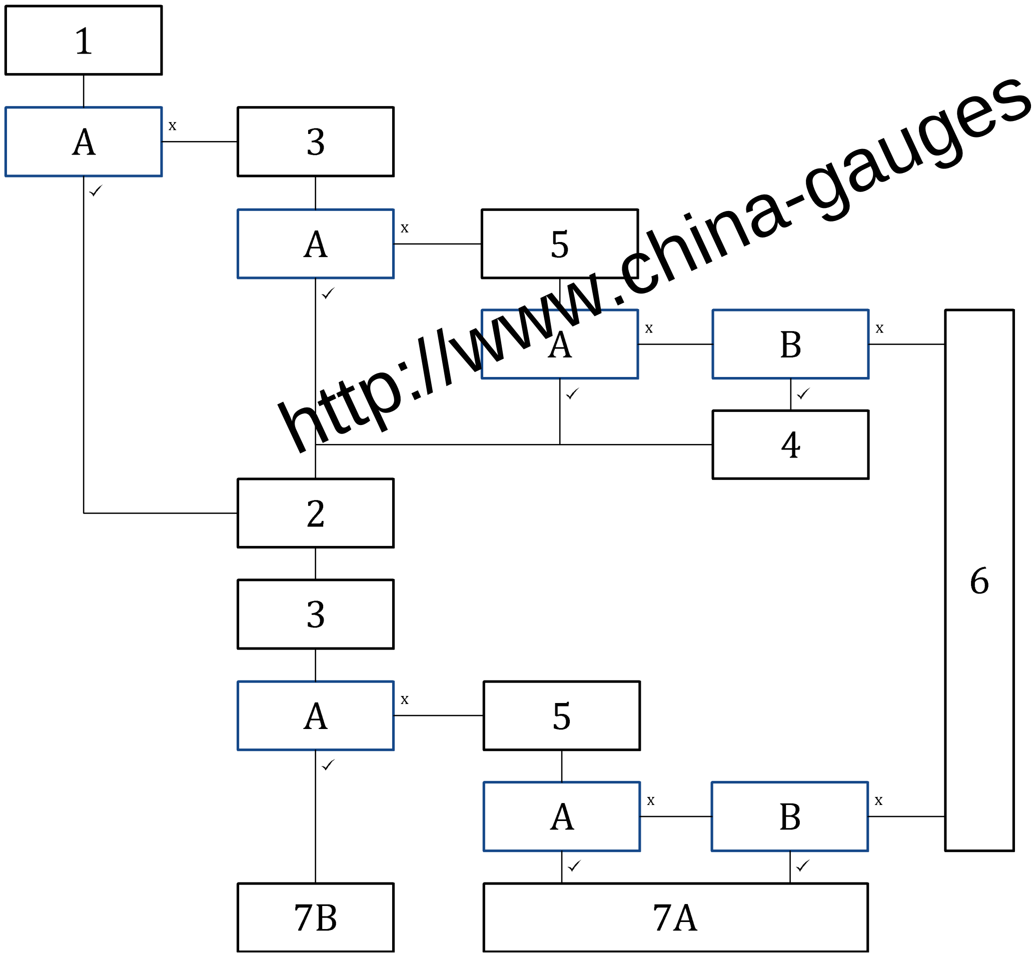
The different steps of the procedure are explained in the following subclauses.

For air-to-water units which are tested with a fixed temperature difference between inlet and outlet temperatures, the setting of the water flowrate shall be done as follows:

— The water flow rate is set during the preconditioning period (Step 1).

— When and if the unit undergoes the first defrost cycle at any step of the procedure, it shall be checked if the permissible deviations specified in Table 5 are fulfilled on a 5-min period starting 20 min after the end of this defrost cycle.

— If the above requirement is not fulfilled, the water flowrate shall be adapted and the whole procedure shall be restarted from Step 1 with this new water flowrate.



Key

✓	yes	3	Step 3: Equilibrium period
✗	no	4	Step 4: Defrost cycle
A	Did a defrost cycle occur?	5	Step 5: Data collection
B	Did the quantity %ΔT exceed 2,5 %?	6	Step 6: Steady-state operation
1	Step 1: Preconditioning	7A	Step 7A: Transient operation
2	Step 2: End of defrost cycle	7B	Step 7B: Transient operation

Figure 4 — Flowchart of steps procedure

4.4.4.2 Step 1: Preconditioning

The test room reconditioning apparatus and the heat pump under test shall start and operate until the permissible deviations specified in Table 5 are attained for at least 10 min.

It is recommended that the preconditioning ends with an automatic or manually induced defrost cycle.

Question A: Did a defrost cycle occur?

— If Step 1 ends with a defrost cycle, then go to Step 2.

— If Step 1 does not end with a defrost cycle, go to Step 3.

4.4.4.3 Step 2: End of defrost cycle

As the previous Step terminates with a defrost cycle, wait 10 min after this defrost cycle before continuing with Step 3.

Defrost cycle of the previous step and these 10 min constitute an interval D for which permissible deviations specified in Table 6 apply.

4.4.4.4 Step 3: Equilibrium period

During an equilibrium period of 60 min, the heat pump shall operate while meeting the permissible deviations specified in Table 5. If a defrost occurs during this period, the permissible deviations specified in Table 6 apply.

Question A: Did a defrost cycle occur?

— If Step 3 ends with a defrost cycle, then go to next Step, either Step 2 or Step 7B.

— If Step 3 does not end with a defrost cycle, go to Step 5.

NOTE If a defrost occurs before the end of Step 3, it is not necessary to wait for the complete duration of this step. The test can continue directly with the next step of the flowchart.

4.4.4.5 Step 4: Defrost cycle

As the previous Step does not terminate with a defrost cycle, wait for a defrost cycle before continuing with Step 2.

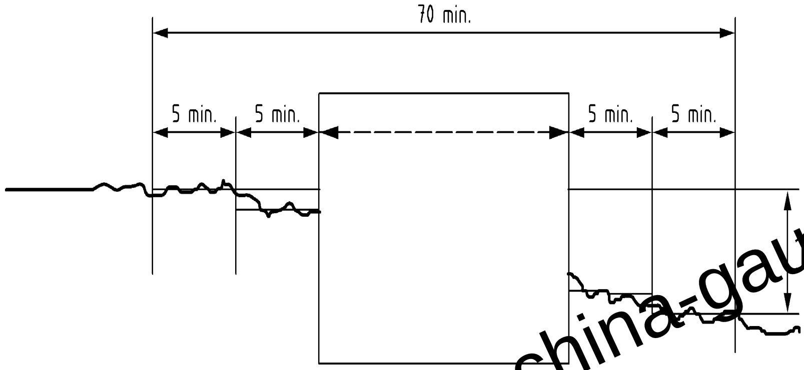
4.4.4.6 Step 5: Data collection

Data shall be collected for a duration of 70 min.

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

$$\%\Delta T = \left[\frac{\Delta T_i\left(\tau = 0\right) - \Delta T_i\left(\tau\right)}{\Delta T_i\left(\tau = 0\right)}\right] \quad (13)$$

The following Figure 5 illustrates the temperature decrease during Step 5 and the calculation of %ΔT.



Key

1 %ΔT

Figure 5 — Data collection

Question A: Did a defrost cycle occur?

— If Step 5 does not terminate with a defrost cycle, check Question B.

— If Step 5 does terminate with a defrost cycle, go to next Step, either Step 2 or Step 7A.

NOTE If a defrost occurs before the end of Step 5, it is not necessary to wait for the complete duration of this step. The test can continue directly with the next step of the flowchart.

Question B: Did the quantity %ΔT exceed 2,5 %?

— If the quantity %ΔT did not exceed 2,5 %, then go to Step 6.

— If the quantity %ΔT did exceed 2,5 %, then go to next step, either Step 4 or Step 7A.

4.4.4.7 Step 6: Steady-state operation

The test is considered to be steady-state and shall be terminated after the data collection (Step 5) during which permissible deviations specified in Table 5 were fulfilled.

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.

Data from the 70 min of the data collection is used for calculating the heating capacity of the unit (see 4.5.3).

4.4.4.8 Step 7: Transient operation

4.4.4.8.1 General

The test is considered to be a transient test and defrost cycles might occur.

As noted in Table 6, the test tolerances are specified for the two sub-intervals H and D.

All data collected during each interval, H or D, shall be used to evaluate compliance with the Table 6 permissible deviations. Data from two or more H intervals or two or more D intervals shall not be combined and then used in evaluating Table 6 compliance. Compliance is based on evaluating data from each interval separately.

4.4.4.8.2 Step 7A

The data collection, including the duration of previous Step 5, is extended until 3 h have elapsed or until the heat pump completes three complete cycles during the period, whichever occurs first. In Step 7A, the permissible deviations specified in Table 6 shall be achieved during the total duration.

Only the data from the completed cycles that occurred during the 3 h, are used for performance calculation. If no complete cycle occurs during 3 h, then the performance is calculated from the average data over the 3 h.

If at an elapsed time of 3 h, the heat pump is conducting a defrost cycle, the cycle shall be completed before ending the data recording. A complete cycle consists of a heating period and a defrost period; from defrost termination to defrost termination.

For a multiple refrigerant circuit unit, the data are recorded and calculated over a 3-h duration whatever the state of cycling of the different refrigerant circuits.

4.4.4.8.3 Step 7B

In Step 7B, the data shall be recorded until 3 h have elapsed or until the heat pump completes three complete cycles during the period, whichever occurs first, as no data collection (Step 5) occurred after the latest equilibrium period (Step 3). In Step 7B, the permissible deviations specified in Table 6 shall be achieved during the total duration.

Only the data from the completed cycles that occurred during the 3 h, are used for performance calculation. If no complete cycle occurs during 3 h, then the performance is calculated from the average data over the 3 h.

If at an elapsed time of 3 h, the heat pump is conducting a defrost cycle, the cycle shall be completed before ending the data recording. A complete cycle consists of a heating period and a defrost period; from defrost termination to defrost termination.

For a multiple refrigerant circuit unit, the data are recorded and calculated over a 3-h duration whatever the state of cycling of the different refrigerant circuits.

4.4.5 Permissible deviations

When conducting tests according to 4.4.2 to 4.4.4 permissible deviations are specified in Tables 5 and 6 for steady-state operation and for transient operation respectively.

Table 5 — Permissible deviations from set values for steady-state operation

Measured quantity	Permissible deviation of the arithmetic mean values from set values	Permissible deviation 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 (mass) flow	±1 %	±2,5 %
- static pressure difference	—	±10 %
Air		
- inlet temperature (dry bulb)[a]	±0,3 K	±1 K
- inlet temperature (wet bulb) [a]	±0,4 K	±1 K
- (dry bulb - wet bulb) temperature difference[b]	±0,3 K	—
- volume flow	±5 %	±10 %
- static pressure difference	—	±10 %
Refrigerant		
- liquid temperature	±1 K	±2 K
- saturated liquid/bubble point temperature	±0,5 K	±1 K
Voltage	±4 %	±4 %

[a] For units with outdoor heat exchanger surfaces greater than 5 m^2, the permissible deviation is doubled. When testing single duct units, the arithmetic mean value of the difference between the dry bulb temperature of the indoor compartment and of the air introduced from the outdoor compartment should have a maximum permissible deviation of 0,3 K. This requirement also applies to the wet bulb temperature difference.

[b] This variation applies to the set temperature difference. If equal to 1K, the temperature difference is thus allowed to vary between 0,7 K and 1,3 K.

Table 6 — Permissible deviations from set values for transient operation

Readings	**Permissible deviation of the arithmetical mean values from set values**		**Permissible deviation of each individual measured values from set values**	
	Interval H	Interval D	Interval H	Interval D
Temperature of air entering indoor-side:				
- dry-bulb	±0,6 K	±1,5 K	±1,0 K	±2,5 K
- wet-bulb	—	—	—	—
Temperature of air entering outdoor-side:				
- dry-bulb [a]	±0,6 K	±1,5 K	±1,0 K	±5,0 K
- wet-bulb [a]	±0,4 K	±1,0 K	±1,0 K	—
- temperature difference (dry bulb – wet bulb) [d]	±0,6 K	—	—	—
Inlet water temperature	±0,2 K [c]	—	±0,5 K [c]	[b]
Outlet water temperature	±0,5 K	—	—	—

[a] For units with outdoor heat exchanger surfaces greater than 5 m^2, the allowed deviation is doubled.

[b] The variation shall not exceed – 5,0 K and +2,0 K of the arithmetic mean value measured during the previous interval H.

[c] Only applies to units tested with a fixed temperature difference between water inlet and outlet temperatures.

[d] This variation applies to the set temperature difference. If equal to 1K, the temperature difference is thus allowed to vary between 0.4K and 1.6K.

4.5 Test results

4.5.1 Data to be recorded

The data to be recorded for the capacity tests are given in Table 7. The table identifies the general information required but is not intended to limit the data to be obtained.

These data shall be the mean values taken over the data collection period, with the exception of time measurement.

Table 7 — Data to be recorded

Quantity	Unit	Calorimeter	Air enthalpy method	Liquid enthalpy method
1) Ambient conditions				
— air temperature, dry bulb	°C	—	X	X
— atmospheric pressure	kPa	X	X	—
2) Electrical quantities				
— voltage	V	X	X	X
— total current	A	X	X	X
— total power input, P_T	kW	X	X	X
— effective power input, P_E	kW	X	X	X
3) Thermodynamic quantities				
a) Indoor heat exchanger				
Air				
— inlet temperature, dry bulb	°C	X	X	—
— inlet temperature, wet bulb	°C	X	X	—
For duct connection				
— outlet temperature, dry bulb	°C	—	X	—
— outlet temperature, wet bulb	°C	—	X	—
— external/internal static pressure difference	Pa	X	X	—
— volume flow rate, *q*	m^3/s	—	X	—
— rate of condensate	kg/s	X	X	—
Water or brine				
— inlet temperature	°C	X	—	X
— outlet temperature	°C	X	—	X
— volume flow	m^3/s	X	—	X
— liquid pump speed setting, if applicable	—	X	—	X

Quantity	Unit	Calorimeter	Air enthalpy method	Liquid enthalpy method
— external/internal static pressure difference	kPa	X	—	X
b) Outdoor heat exchanger				
Air				
— inlet temperature, dry bulb	°C	X	X	X
— inlet temperature, wet bulb, if applicable	°C	X	X	X
For duct connection				
— outlet temperature, dry bulb	°C	—	X	—
— outlet temperature, wet bulb	°C	—	X	—
— external/internal static pressure difference	Pa	X	X	X
— volume flow rate, *q*	m^3/s	X	X	X
Water or brine				
— inlet temperature	°C	X	X	X
— outlet temperature	°C	X	X	X
— volume flow	m^3/s	X	X	X
— liquid pump speed setting, if applicable	-	X	X	X
— external/internal static pressure difference	kPa	X	X	X
c) Heat recovery heat exchanger				
— inlet temperature	°C	—	—	X
— outlet temperature	°C	—	—	X
— volume flow	m^3/s	—	—	X
— external/internal static pressure difference	kPa	—	—	X
d) Heat transfer medium (other than water)				
— concentration (volume)	%	X	X	X
— density (if needed for calculation)	kg/m^3	X	X	X
— specific heat (if needed for calculation)	kJ/kg.K	X	X	X
e) Refrigerant [a]				
— discharge pressure	bar abs.	—	—	X

Quantity	Unit	Calorimeter	Air enthalpy method	Liquid enthalpy method
— saturated vapour/bubble point temperature	°C	—	—	X
— liquid temperature	°C	—	—	X
f) Compressor				
— rotational speed (only for open compressor type)	min^{-1}	—	—	X
— power input of motor (only for open compressor type)	kW	—	—	X
— compressor frequency for inverter type	Hz	X	X	X
g) Calorimeter				
— heat input to calorimeter	kW	X	—	—
— heat extracted from calorimeter	kW	X	—	—
— ambient temperature around the calorimeter	°C	X	—	—
— temperature of the water entering the humidifier	°C	X	—	—
— condensate temperature	°C	X	—	—
h) Defrost				
— defrost period(s)	s	X/X/X	X/X/X	X/X/X
— operating cycle(s) with defrost	min	X/X/X	X/X/X	X/X/X
4) Data collection period	min	X	X	X
5) Capacities				
— heating capacity (P_H)	kW	X	X	X
— total cooling capacity (P_C)	kW	X	X	X
— latent cooling capacity (P_L)	kW	X	X	X
— sensible cooling capacity (P_S)	kW	X	X	X
— heat recovery capacity	kW	—	—	X
6) Ratios				
— COP	kW/kW	X	X	X
— EER	kW/kW	X	X	X
— SHR [b]	kW/kW	X	X	—

[a] Only for unit with remote condenser.

[b] Only for air-to-air and water(brine)-to-air units.

4.5.2 Cooling capacity and heat recovery capacity calculation

Average cooling and heat recovery capacities shall be determined from the set of cooling and heat recovery capacities recorded over the data collection period, or on the basis of average values of temperature and volume flow recorded over the data collection period.

4.5.3 Heating capacity calculation

4.5.3.1 Steady-state capacity test

An average heating capacity shall be determined from the set of heating capacities recorded over the data collection period or on the basis of average values of temperature and volume flow recorded over the data collection period.

4.5.3.2 Transient capacity test

For equipment where one or more complete cycles occur during the data collection period, the following shall apply. The average heating capacity shall be determined using the integrated capacity and the elapsed time corresponding to the total number of complete cycles that occurred over the data collection period.

For equipment where no complete cycle occurs during the data collection period, the following shall apply. The average heating capacity shall be determined by using the integrated capacity and the elapsed time corresponding to the total data collection period.

When using the air enthalpy method, in case the flow rates are different during intervals H and D of the transient test, a weighted value of flow rates during H and D intervals shall be used for the calculation of the pump/fan correction(s) to be applied.

4.5.4 Effective power input calculation

4.5.4.1 Steady-state test

An average electric power input shall be determined from the integrated electrical power over the same data collection period than the one used for the heating/cooling capacity or heat recovery capacity calculation.

4.5.4.2 Transient with defrost cycle

An average electric power input shall be determined on the basis of the integrated electrical power and the time corresponding to the total number of complete cycles during the same data collection period as the one used for the heat capacity calculation.

In case the flow rates are different during intervals H and D of the transient test, a weighted value of flow rates during H and D intervals shall be used for the calculation of the pump/fan correction(s) to be applied.

4.5.4.3 Transient without defrost cycle

An average electric power input shall be determined on the basis of the integrated electrical power and the time corresponding to the same data collection period as the one used for the heat capacity calculation.

4.5.5 EER and COP calculation

The EER shall be the ratio of the cooling capacity as determined according to 4.5.2 and the effective power input as determined according to 4.5.4.

The COP shall be the ratio of the heating capacity as determined according to 4.5.3 and the effective power input as determined according to 4.5.4.

5 Electrical consumptions for single duct and double duct units

5.1 Determination of power consumption due to standby mode

After the unit (for cooling only and reverse cycle units) has been running for 30 min in cooling mode, it is switched in standby mode with the control device, if available. After 10 min, the electrical energy consumption is measured during the next 10 min and the average value during this period is assumed to be the standby mode consumption, P_{SB}.

For heating only units, the measurements are made in the same way, after the following test condition.

Table 8 — Test conditions for power consumption due to standby mode for heating only units

		Outdoor heat exchanger		**Indoor heat exchanger**	
		Inlet dry bulb temperature °C	**Inlet wet bulb temperature** °C	**Inlet dry bulb temperature** °C	**Inlet wet bulb temperature** °C
Heating mode	Double duct units	7	6	20	15 max
	Single duct units	20	12	20	12

5.2 Determination of power consumption in off-mode

Following the standby mode test, the unit shall be switched in off mode, if available, while remaining plugged. After 10 min, the residual energy power is measured during 10 min and the average value during this period is assumed to be the off mode consumption, P_{OFF}.

5.3 Electricity consumption

The electricity consumption in cooling mode, Q_{SD} for single duct units and Q_{DD} for double duct units, shall be declared as the rated power input P_{EER} multiplied by the number of "on mode" hours, equal to 1, as specified in the regulation.

It is expressed in kWh/h.

The electricity consumption in heating mode, Q_{SD} for single duct units and Q_{DD} for double duct units, shall be declared as the rated power input P_{COP} multiplied by the number of "on mode" hours, equal to 1, as specified in the regulation.

It is expressed in kWh/h.

6 Air flow rate measurement of ducted units

For ducted units, the manufacturer shall declare the nominal air flow rate, indoor and/or outdoor as applicable, measured according to Annex I.

7 Heat recovery test for air-cooled multisplit system

7.1 Test installation

7.1.1 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.

The calorimeter room and indoor 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.

NOTE Annex C (informative) provides additional information to Annex B for reducing uncertainties of measurement of capacities.

7.1.2 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 another room. The outdoor unit shall be installed in the third room.

7.1.3 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.

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

NOTE Annex C (informative) provides additional information to Annex B for reducing uncertainties of measurement of capacities.

7.2 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.

7.3 Test results

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.

8 Test report

8.1 General information

The test report shall at least contain:

a) date;

b) test institute;

c) test location;

d) test method;

e) test supervisor;

f) test object designation:

   1) type;

   2) serial number;

   3) name of the manufacturer;

g) type of refrigerant;

h) mass of refrigerant;

i) properties of fluids;

j) reference to this document.

8.2 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 a unit new or not. In the case of a test performed on a unit in use, information relative to the year of installation and heat exchanger tubes cleaning shall be given.

8.3 Rating test results

The rating capacities, power inputs, EER, COP, internal or external static pressure shall be given together with the rating conditions.

Table 9 provides a template for the test results to be reported for single duct and double duct units.

Table 9 — Test results for single duct and double duct units

Description	Symbol	Unit
Standard rating conditions, indoor air dry bulb (wet bulb) temperature in cooling mode	—	°C
Standard rating conditions, outdoor air dry bulb (wet bulb) temperature, in cooling mode	—	°C
Rated capacity for cooling	P_{rated}	kW
Rated power input for cooling	P_{EER}	kW
Rated Energy efficiency ratio	EER_{rated}	kW/kW
Electricity consumption in cooling mode — single duct unit — double duct unit	 Q_{SD} Q_{DD}	 kWh/h kWh/h
Standard rating conditions, indoor air dry bulb (wet bulb) temperature, in heating mode	—	°C
Standard rating conditions, outdoor air dry bulb (wet bulb) temperature, in heating mode	—	°C
Rated capacity for heating	P_{rated}	kW
Rated power input for heating	P_{COP}	kW
Rated Coefficient of Performance	COP_{rated}	kW/kW
Electricity consumption in heating mode — single duct unit — double duct unit	 Q_{SD} Q_{DD}	 kWh/h kWh/h
Power consumption in off-mode	P_{OFF}	W
Power consumption in standby mode	P_{SB}	W

Annex A
(normative)

Calorimeter test method

A.1 General

A.1.1 The calorimeter provides a method for determining capacity of a unit by measuring the effect of a reconditioning apparatus in order to maintain the specified test conditions in each room.

For air-to-air units, cooling and heating capacities shall be determined from measurements and calculations from either indoor or outdoor room of the calorimeter providing that the requirement on the maximum uncertainty of measurement of these capacities is fulfilled.

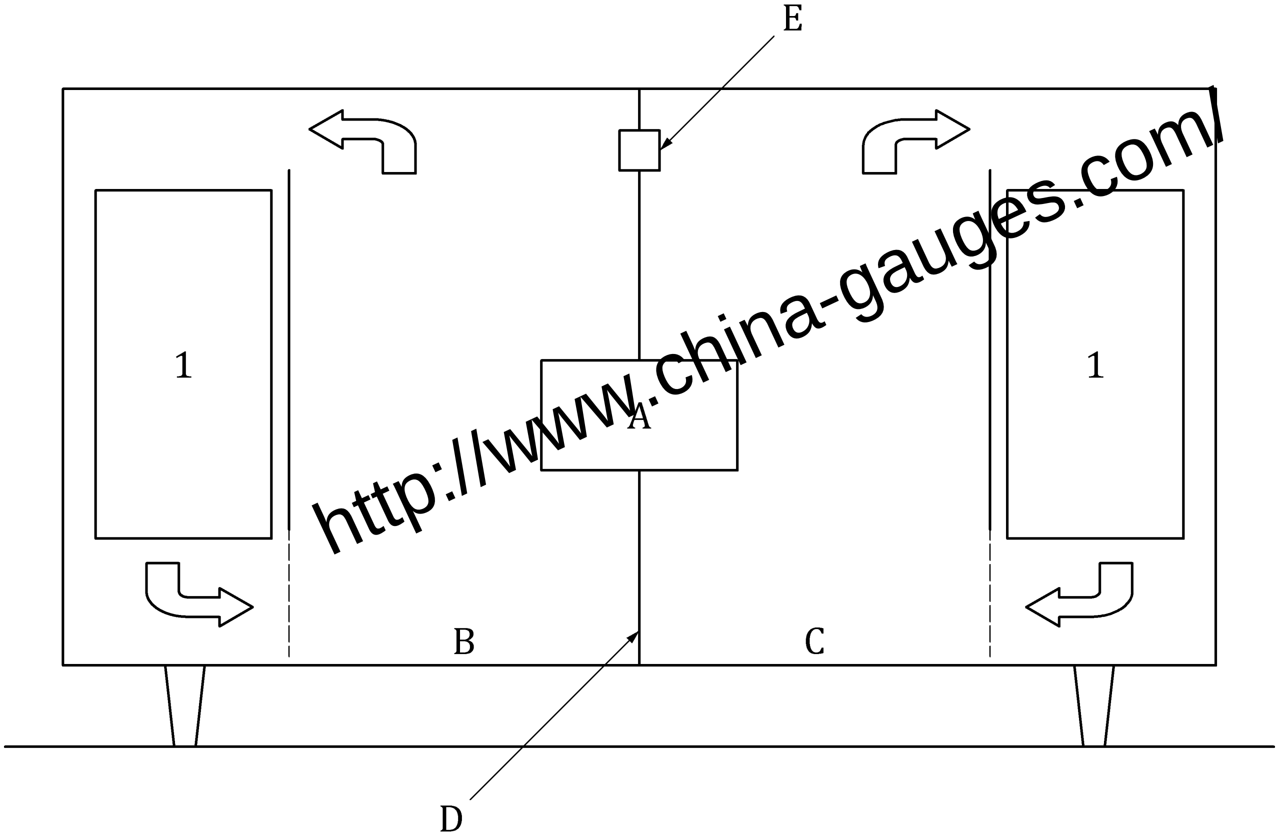
For split water(brine)-to-air units, cooling and heating capacities shall always be determined from measurements and calculations from indoor room as the outdoor room is not used as a calorimeter.

For package water(brine)-to-air units, cooling and heating capacities shall be determined from measurements and calculations from either the indoor room of the calorimeter or from the water circuit providing that the requirement on the maximum uncertainty of measurement of these capacities is fulfilled.

A confirming test of cooling or heating capacity may be carried out using the measurements of the other room or on the water side for a water(brine)-to-air unit.

A.1.2 The size of the calorimeter shall be sufficient to avoid any restriction to the intake or discharge openings of the unit. Sufficient space shall be allowed in front of any inlet or discharge grilles of the equipment to avoid interference with the air flow. Ceiling-mounted equipment should be installed at a minimum distance of 1,8 m from the floor.

A.1.3 Each room shall be provided with reconditioning apparatus to maintain the test conditions. The reconditioning apparatus for each room shall provide cooling, heating, and humidification. Reconditioning apparatus may also provide dehumidification. Figures A.1 and A.2 show examples of calorimeters. Other configurations may be used, providing that all requirements and tolerances given by this document regarding test conditions, maximum uncertainties, etc. are fulfilled.



Key

A equipment under test (in this example a package air-to-air unit)

B indoor room

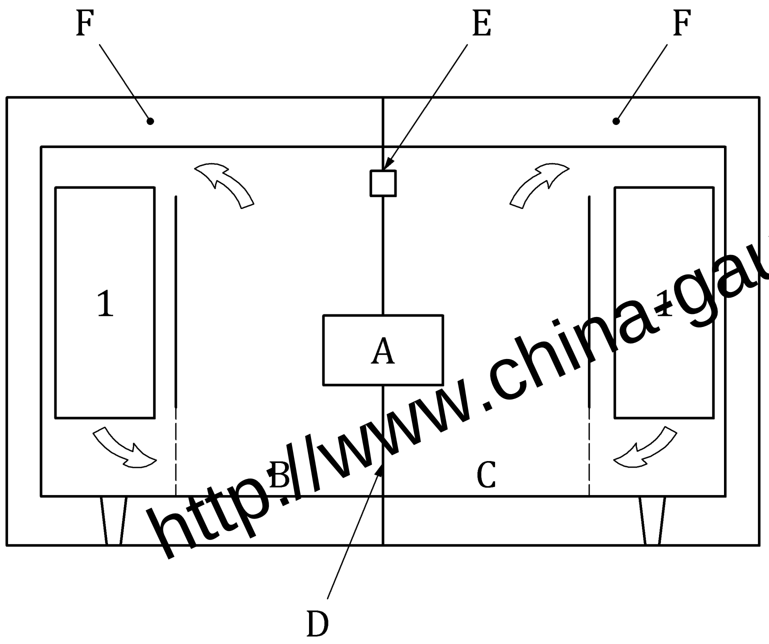
C outdoor room

D separating partition

E pressure equalizing system

1 reconditioning apparatus

Figure A.1 — Example of a calibrated ambient double room type calorimeter



Key

A equipment under test (in this example a package air-to-air unit)
B indoor room
C outdoor room
D separating partition
E pressure equalizing system
F surrounding space of each room
1 reconditioning apparatus

Figure A.2 — Example of a balanced ambient double room type calorimeter

A.1.4 For testing of package air-to-air units and single duct units, a pressure-equalizing device shall be provided between the indoor-side and the outdoor-side rooms to maintain a balanced pressure between these rooms.

Exhaust from a fan, if any, shall be such that it shall not affect the inlet air to the unit.

Measurement of the air flow rate flowing from one room to the other is not required for cooling or heating capacity measurement.

A.1.5 Interior surfaces of the calorimeter room 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.

A.2 Calibrated room-type calorimeter

A.2.1 The calibrated room-type calorimeter (see Figure A.1) is based on having different temperature inside the calorimeter room and inside the surrounding space. The heat leakage between the room and the outside space shall be kept as low as possible. It is recommended to use floor, ceiling and walls material having a heat transfer coefficient (including radiation) lower than 0,3 W/m^2.K. Heat losses shall be carefully measured so the requirement on the maximum uncertainty of measurement according to 4.3 is fulfilled. Space surrounding the calorimeter shall allow free circulation of air around the calorimeter, including the floor, to provide a uniform air temperature. Temperature in the surrounding space shall be maintained as constant as possible during the entire test.

A.2.2 Heat leakage between each room and the surrounding space shall be calibrated using the greatest temperature difference allowed by the test facility.

Heat leakage through the separating partition shall also be calibrated using the greatest temperature difference allowed by the test facility,

If the design of any partition is identical with that of the other walls, the heat leakage through the partition may be determined on a proportional area basis. Otherwise the heat leakages shall be determined individually.

A.3 Balanced ambient room-type calorimeter

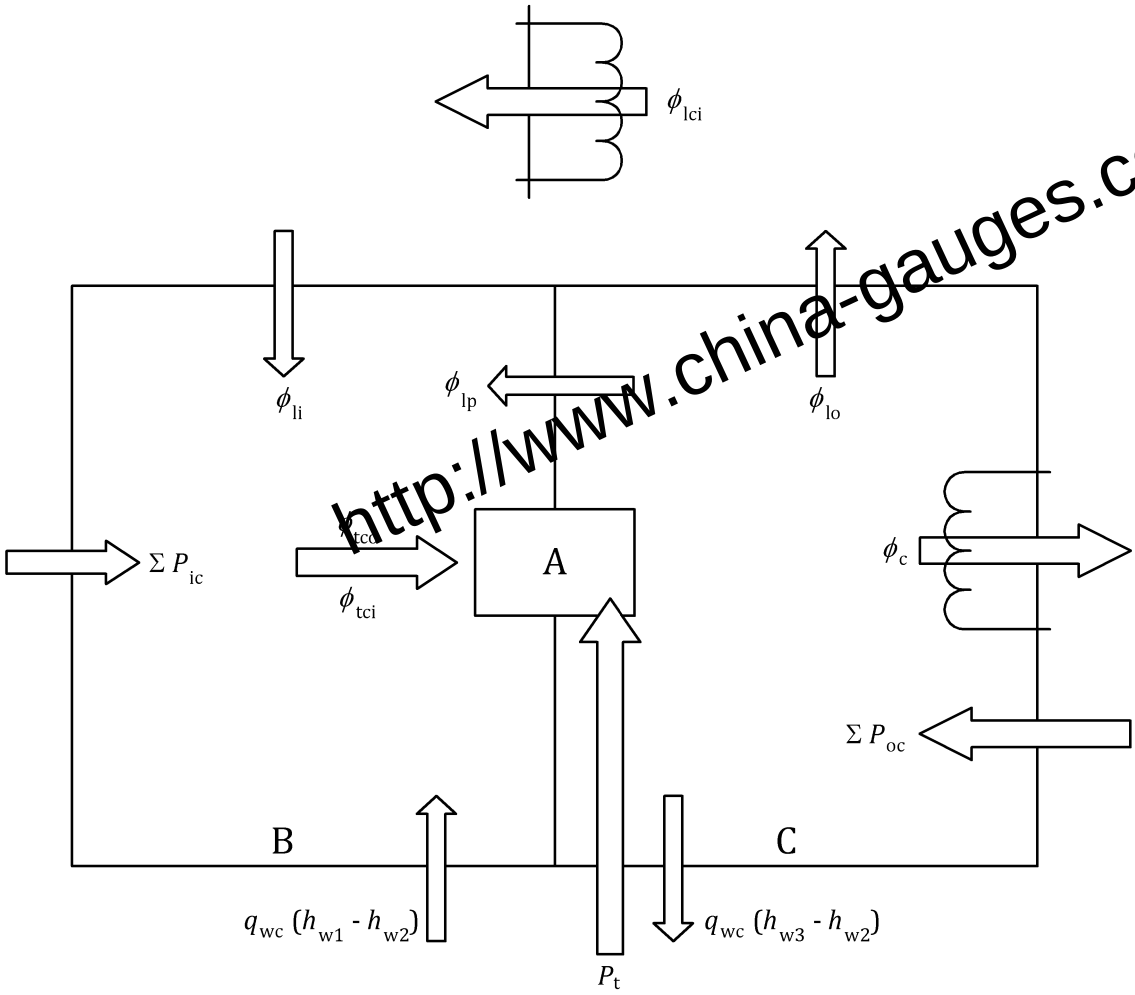
A.3.1 The balanced ambient room-type calorimeter (see Figure A.2) is based on the principle of maintaining the dry-bulb temperatures in the surrounding space of each room equal to the dry-bulb temperature maintained within this room. This principle results in minimal heat transfer between the room and the ambient conditions. Each room, including any separating partition, shall be insulated to prevent heat leakage (including radiation) so the requirement on the maximum uncertainty of measurement according to 4.3 is fulfilled. The floor, ceiling, and walls of the calorimeter rooms shall be spaced a sufficient distance away from the floor, ceiling, and walls of the surrounding spaces in which the rooms are located in order to provide a uniform air temperature in these spaces.

A.3.2 Heat leakage through the separating partition shall also be calibrated using the greatest temperature difference allowed by the test facility,

A.4 Calculations-cooling capacities

A.4.1 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

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

NOTE All symbols with their units are defined in Annex H.

A.4.2 Total cooling capacity on the indoor-side

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 shown in Formula (A.1).

$$\phi_{tci} = \sum P_{ic} + q_{wc}\left(h_{w1} - h_{w2}\right) + \phi_{lp} + \phi_{li} - \phi_{lci} \quad \text{(A.1)}$$

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 room to the outdoor-side room, 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 room by the reconditioning equipment to maintain the required humidity.

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

When the total cooling capacity to be measured is very small, it may be necessary to cool the indoor room, the heat removed from the indoor room by the reconditioning apparatus, ϕ_{lci}, has then to be used in Formula (A.1).

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

$$\phi_{tco} = \phi_c - \sum P_{oc} - P_t + q_{wc}\left(h_{w3} - h_{w2}\right) + \phi_{lp} + \phi_{lo} \quad (A.2)$$

NOTE 2 The h_{w3} 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 room through the separating partition between the indoor-side and outdoor-side rooms may be determined from the calibrating test or, in the case of the balanced-ambient room-type room, 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 room.

A.4.3 Total cooling capacity of liquid (water)-cooled equipment deducted from the condenser side

The total cooling capacity of liquid (water)-cooled equipment deducted from the condenser side is calculated as shown in Formula (A.3).

$$\phi_{tco} = \phi_{co} - \sum P_E \quad (A.3)$$

A.4.4 Latent cooling capacity (room dehumidifying capacity)

The latent cooling capacity (room dehumidifying capacity) is calculated as shown in Formula (A.4).

$$\phi_d = K_1 q_{wc} \quad (A.4)$$

A.4.5 Sensible cooling capacity

The sensible cooling capacity is calculated as shown in Formula (A.5).

$$\phi_s = \phi_{tci} - \phi_d \quad (A.5)$$

A.4.6 Sensible heat ratio

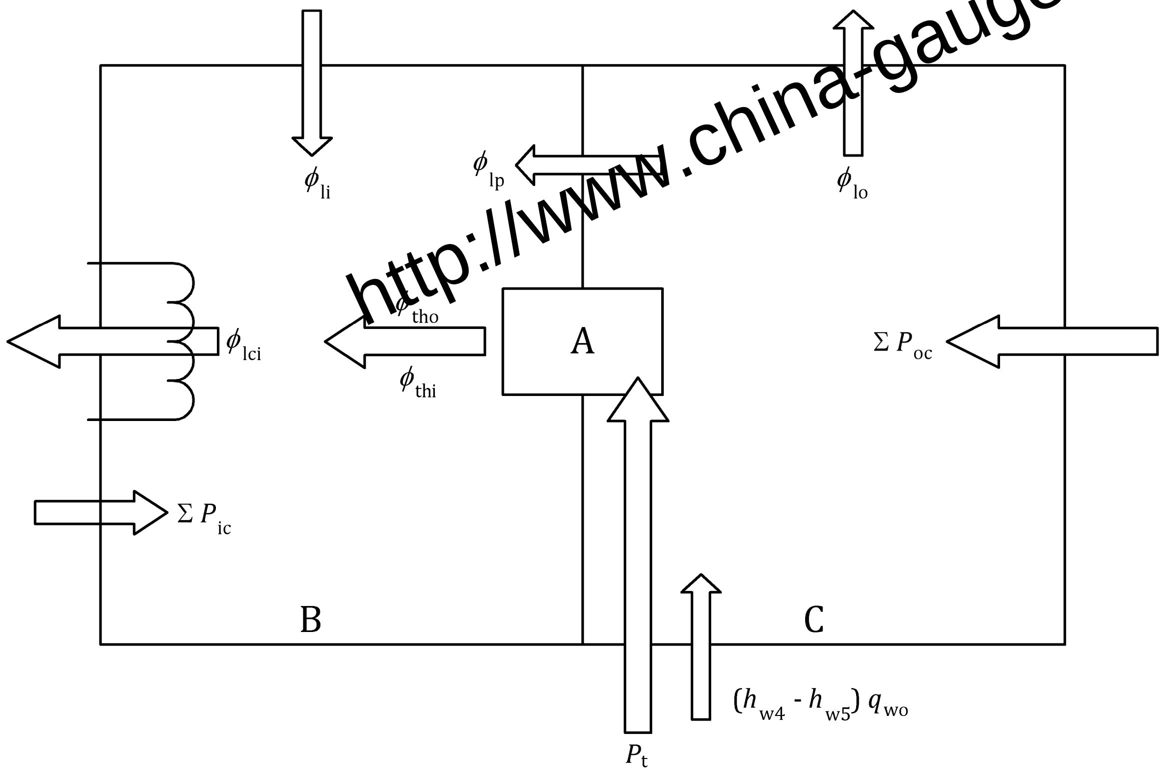
The sensible heat ratio is calculated as shown in Formula (A.6).

$$SHR = \frac{\phi_s}{\phi_{tci}} \quad (A.6)$$

A.5 Calculation-heating capacities

A.5.1 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

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

NOTE All symbols with their units are defined in Annex H.

A.5.2 Determination of the heating capacity by measurements in the indoor-side room

The heating capacity by measurements in the indoor-side room of the calorimeter is calculated as shown in Formula (A.7).

$$\phi_{thi} = \phi_{lci} - \phi_{lp} - \phi_{li} - \sum P_{ic} \tag{A.7}$$

A.5.3 Determination of the heating capacity by measurements in the outdoor-side room

The heating capacity by measurements in the outdoor-side room of the calorimeter is calculated as shown in Formula (A.8).

$$\phi_{tho} = \sum P_{oc} + P_t + q_{wo}\left(h_{w4} - h_{w5}\right) - \phi_{lp} - \phi_{lo} \tag{A.8}$$

A.5.4 Total heating capacity of liquid (water)-to-air unit deducted from the water side

The total heating capacity of liquid (water)-to-air unit deducted from the water side is calculated as shown in Formula (A.9).

$$\phi_{\text{tho}} = \phi_{\text{eo}} + \sum P_{\text{E}} \quad \text{(A.9)}$$

where

ϕ_{eo} is the heat supplied to the water coil of the unit.

Annex B
(normative)

Indoor air enthalpy method

B.1 General

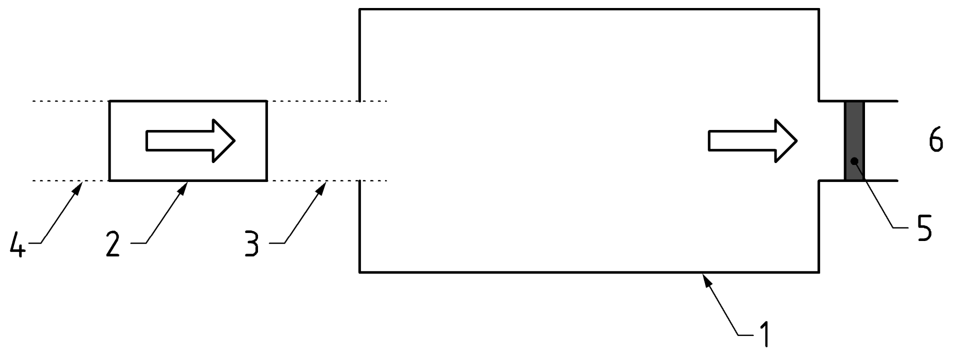
In the indoor air-enthalpy method, capacities are determined from measurements of entering and leaving air temperatures and the associated air flow rate. This requires connecting the indoor air outlet section of the unit to an air flow measuring device. This shall be done by using at least a discharge chamber and/or duct designed as per requirements in this annex.

B.2 Test installation

B.2.1 General

The unit shall be installed according to the general recommendations of Clause 4.

The general layout for an indoor air-enthalpy measurement circuit consists of having the indoor air outlet section of the unit connected to a plenum or a discharge duct followed by a discharge chamber and temperature and airflow measurement devices, as illustrated below in Figure B.1.



Key

1 discharge chamber
2 equipment under test
3 discharge duct/plenum
4 inlet section duct
5 mixer
6 to air sampler and airflow measuring apparatus

Figure B.1 — Schematic of an installation for ducted packaged and single splits units

An air mixer is recommended to improve air temperature homogeneity before the air temperature measurement.

NOTE 1 For ducted units, there is no need to insert a discharge chamber between the discharge duct and the airflow measuring device.

NOTE 2 For non-ducted units, the use of plenum is optional and depends on unit installation constraints.

The suction and/or discharge ducts and the discharge chamber shall be designed according to B.2.4 or B.2.5 respectively.

The indoor air flow rate measurement shall be made in accordance with Annex I.

Recommendations on air leakages in the air flow measuring devices are given in Annex C.

B.2.2 Air outlet section

For non-ducted units, the air outlet section can be connected to the discharge chamber by using a short plenum. If this plenum is used, it shall be designed to prevent blocking the air blowing from the unit, adapted to its air outlet section size and with a maximum length of 50 cm.

Ducted units are always installed using a discharge duct directly attached to the air outlet section.

For multisplit systems, one or more indoor units shall be connected to one or more air flow measuring devices by means of individual discharge ducts or one or more discharge chambers, where appropriate.

Each individual discharge duct shall have an adjustable damper for the purpose of adjusting the external static pressure in each of them, before the common discharge chamber, if any.

If several discharge chambers are connected to one single air flow measuring device, each discharge chamber shall also be equipped with an adjustable damper in order to set a zero external static pressure in each discharge chamber.

B.2.3 Air inlet section

For ducted units on their air inlet section, a suction duct is necessary which design is specified in B.2.5.2. The air intake temperatures shall be measured using sensors located 0,15 m to 0,3 m from the air inlet section of the duct.

For free air intake units, the air intake temperatures shall be measured according to 4.2.2.4.

B.2.4 Discharge chamber design for non-ducted units

The discharge chamber shall have at least the same size as the air outlet section of the unit and shall be constructed such as to not prevent the leaving air from expanding and according to the requirements of this clause.

The minimum length of the discharge chamber shall be as given in Formula (B.1).

$$L_{min} = 2 \cdot \sqrt{\frac{4 \cdot \left(A \cdot B\right)}{\pi}} \tag{B.1}$$

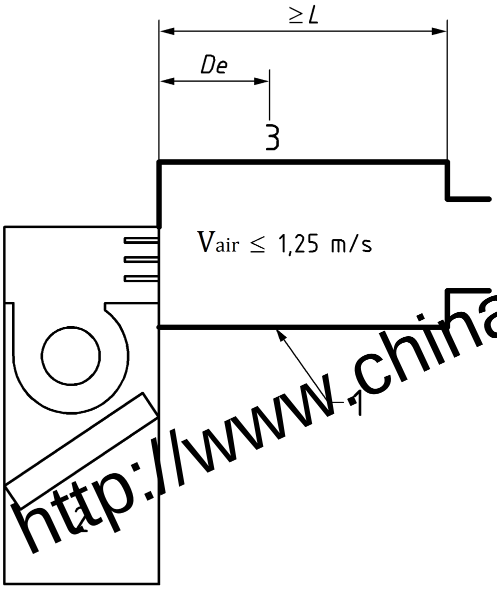
where

A is the width of outlet section of the unit;

B is the height of outlet section of the unit.

The cross-sectional area of the airflow channel through the discharge chamber shall be such that the average air velocity is not greater than 1,25 m/s. The static pressure difference between the discharge chamber and the air inlet section of the unit shall be equal to zero.

An example of test set-up is shown in Figure B.2.



Key

1 discharge chamber

2 unit under test

3 static pressure tappings at the distance D_e from the air outlet section of the unit

D_e is equal to $\sqrt{\frac{4AB}{\pi}}$ and A and B are the dimensions of the air outlet section of the unit

V_{air} average air velocity at the cross-sectional area of the discharge chamber

L length of discharge chamber

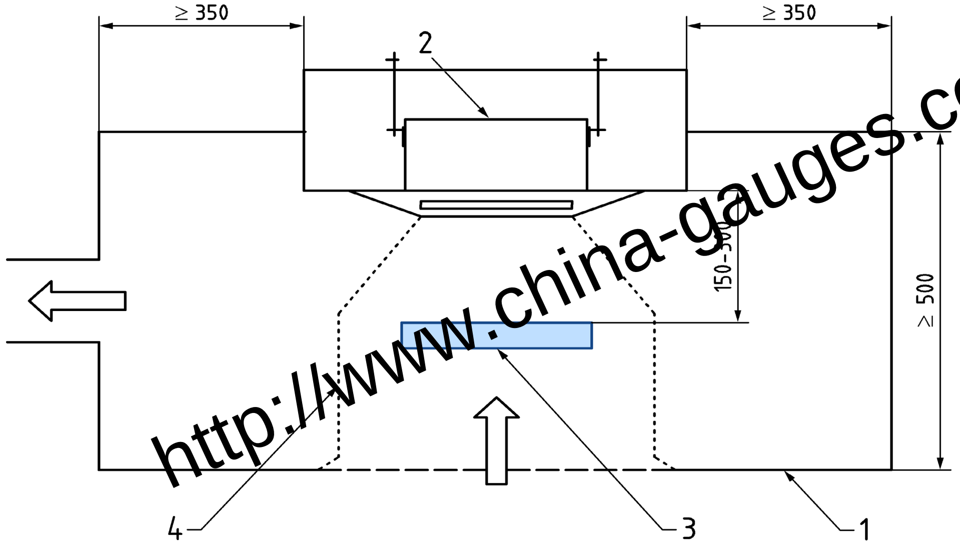
Figure B.2 — Schematic of a discharge chamber design for non-ducted units

The average air velocity V_{air} is calculated as the measured airflow rate divided by the cross-sectional area of the designed discharge chamber, attached to the air outlet section of the unit.

The installation shall be made to ensure minimal interferences such as resistance or recirculation with the normal air flow behaviour of the unit.

For cassette-type units, a free blow of at least 0,5 m and 0,35 m to the side walls of the discharge chamber shall be guaranteed as illustrated on Figure B.3.

Dimensions in millimetres



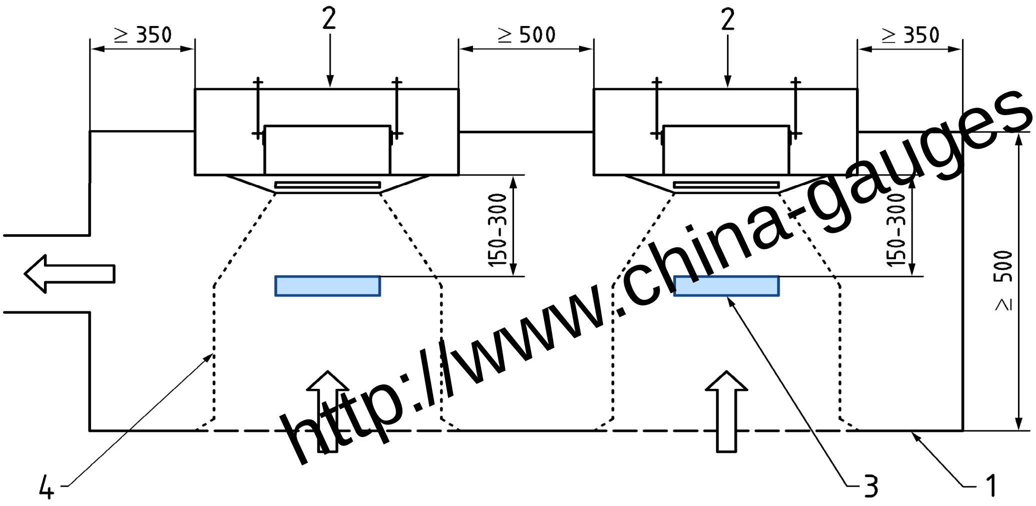
Key

1 discharge chamber
2 unit under test
3 air sampling tree
4 partition

Figure B.3 — Set-up for a ceiling cassette indoor unit

For multisplit units with more than one cassette-type unit, recirculation shall be avoided by placing the units at least 0,5 m from each other and 0,35 m from the side walls of the discharge chamber as illustrated in Figure B.4.

Dimensions in millimetres



Key

1 discharge chamber

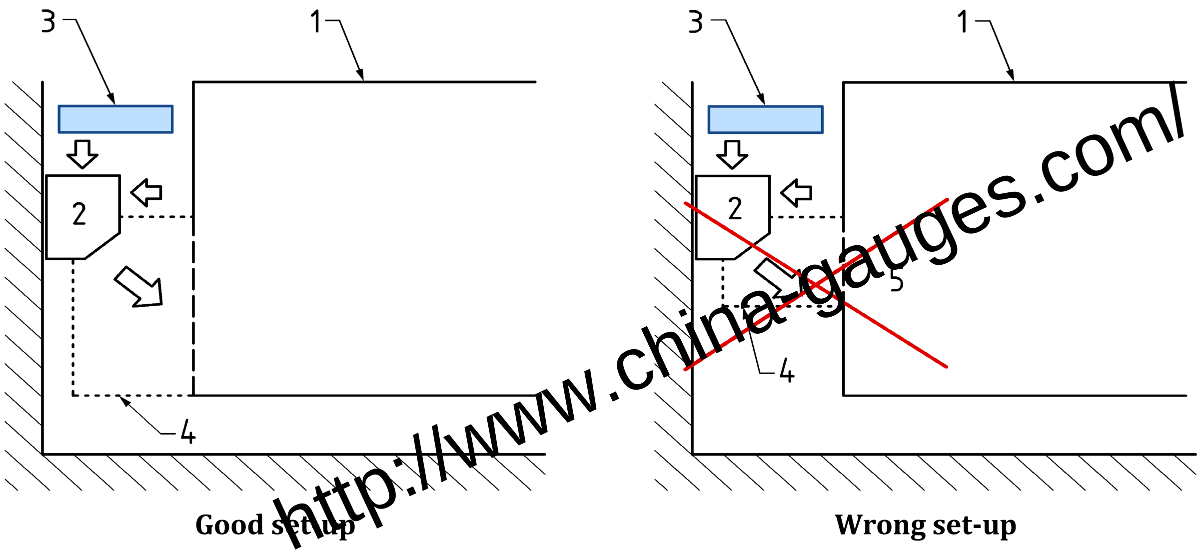
2 unit under test

3 air sampling tree

4 partition

Figure B.4 — Set-up for a multi split ceiling cassette type units

For wall mounted units, the plenum shall not create any obstruction of the suction and discharge air flows as illustrated in Figure B.5.



Key

1 discharge chamber

2 unit under test

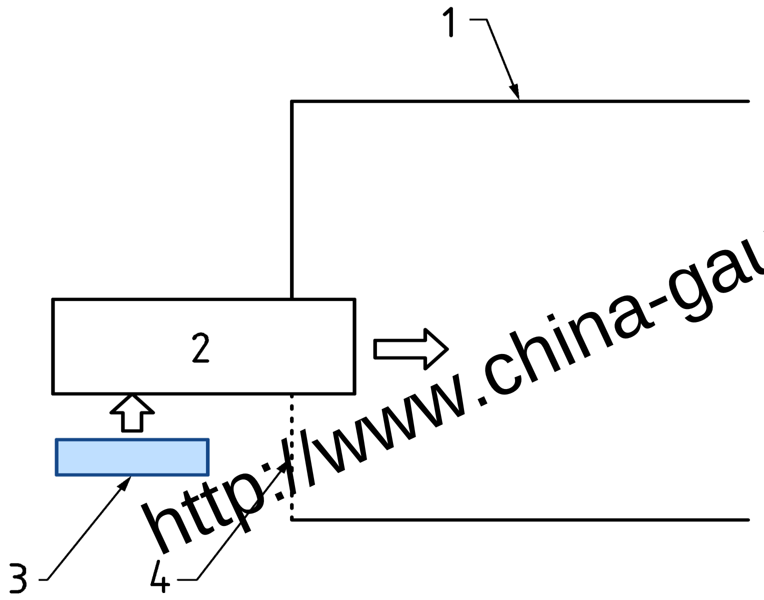
3 air sampling tree

4 plenum

5 Resistance to discharge air is high

Figure B.5 — Set-up for a wall mounted unit

For ceiling suspended units, the installation shall be made as illustrated in Figure B.6.



Key

1 discharge chamber
2 unit under test
3 air sampling tree
4 partition

Figure B.6 — Set-up for a ceiling suspended unit

B.2.5 Duct requirements for ducted units

B.2.5.1 Air outlet duct

For units with circular air outlet section, the minimum length of the discharge duct shall be at least $2,5 \cdot \sqrt{D}$, being D the diameter of the air outlet section.

Static pressure readings are taken at a distance of $\sqrt{\pi} \cdot D$ from the air outlet section of the unit.

For units with rectangular air outlet section, the length L_{min} of the discharge duct shall be at least as given in Formula (B.2).

$$L_{min} = 2,5 \cdot \sqrt{\frac{4 \cdot (A \cdot B)}{\pi}} \qquad \text{(B.2)}$$

where

A is the width of the air outlet section of the unit;

B is the height of the air outlet section of the unit.

Static pressure readings are taken at a distance of $2 \cdot \sqrt{A \cdot B}$ from the air outlet section of the unit.

B.2.5.2 Air inlet duct

For units with circular air inlet section, the minimum length of the air inlet duct shall be at least $\frac{3}{4} \cdot \sqrt{\pi} \cdot D$, D being the diameter of the air inlet section of the unit.

Static pressure readings are taken at a distance of $\frac{1}{4} \cdot \sqrt{\pi} \cdot D$ from the air inlet section of the unit.

For units with rectangular air inlet section, the minimum duct length L_{min} at the air inlet section is given by Formula (B.3).

$$L_{min} = 1{,}5 \cdot \sqrt{E \cdot F} \quad \text{(B.3)}$$

where

E is the width of the air inlet section;

F is the height of the air inlet section.

Static pressure readings are taken at a distance of $0{,}5 \cdot \sqrt{E \cdot F}$ measured from the air inlet section of the unit.

B.3 Calculations-cooling capacities

The total, sensible and latent cooling capacities based on the indoor-air enthalpy data are calculated by the following formulae:

$$\phi_{tci} = \frac{q_{vi}\left(h_{a1} - h_{a2}\right)}{v'_n\left(1 + W_n\right)} \quad \text{(B.4)}$$

Each enthalpy h is calculated as follows for the corresponding temperature t:

$$h = \left(cp_{air} + cp_v\right) \cdot t + K_2 \cdot W \quad \text{(B.5)}$$

$$\phi_s = \frac{q_{vi\left(c_{pa1}t_{a1} - c_{pa2}t_{a2}\right)}}{v'_n\left(1 + W_n\right)} \quad \text{(B.6)}$$

$$\phi_d = \frac{K_1 q_{vi}\left(W_{i1} - W_{i2}\right)}{v'_n\left(1 + W_n\right)} \quad \text{(B.7)}$$

$$\phi_d = \phi_{tci} - \phi_s \quad \text{(B.8)}$$

$$\phi_d = K_1 q_{WC} \quad \text{(B.9)}$$

NOTE 1 Formulae (B.4), (B.5) and (B.6) do not provide allowance for heat leakage in the duct section.

The leaving air may be close to saturation, and in that case its water content is sometimes not easy to measure directly (e.g. measuring its wet bulb temperature). An alternative method is to measure directly q_{wc} and to calculate W_{i2} by Formula (B.10).

$$W_{i2} = W_{i1} - \frac{q_{wc}\left(1+W_{i1}\right)v'_n\left(1+W_n\right)}{q_{vi}} \qquad \text{(B.10)}$$

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

B.4 Calculations-heating capacities

The heating capacity based on indoor air enthalpy data are calculated by Formula (B.11).

$$\phi_{thi} = \frac{q_{vi}\left(h_{a2}-h_{a1}\right)}{v'_n\left(1+W_n\right)} \qquad \text{(B.11)}$$

Alternatively, Formula (B.12) can be used.

$$\phi_{thi} = \frac{q_{vi}\left(c_{pa2}\cdot t_{a2}-c_{pa1}\cdot t_{a1}\right)}{v_n} = \frac{q_{vi}\left(c_{pa2}\cdot t_{a2}-c_{pa1}\cdot t_{a1}\right)}{v'_n\cdot\left(1+W_n\right)} \qquad \text{(B.12)}$$

NOTE 1 Same value can be considered for C_{pa1} and C_{pa2}.

NOTE 2 Formulae (B.11) and (B.12) do not provide allowance for heat leakage in the duct section.

NOTE 3 All symbols and their units are specified in Annex H.

Annex C
(informative)

Recommendations for reducing the indoor air enthalpy method uncertainty

C.1 General

In the air-enthalpy method, capacities are determined from measurements of entering and leaving air water content and dry-bulb temperatures and the associated air flow rate.

The individual measurement uncertainties required in Table 2 do not guarantee the final measurements uncertainties on the total cooling capacity, heating capacity nor efficiencies will be within any specific limit. Provisions given in this annex are developed aiming to reduce those uncertainties and improve reproducibility.

C.2 Uncertainty of measurement

C.2.1 General

For air-to-air heat pumps and air conditioners having a capacity below or equal to 12 kW, the maximum individual uncertainties (if all applied together) of Table 2 does not allow to automatically reach these requirements. A combination of reduced individual uncertainties compared to the ones of Table 2 is then required.

An example of expanded uncertainties (95 % coverage factor) for the individual measurements allowing to achieve the requirement are provided in the Table C.1 for units tested and running with an air flow rate of 0,05 m^3/(s.kW) or less.

Table C.1 — Individual measurement uncertainties

Parameter	Units	Example of uncertainty allowing to reach maximum capacity uncertainty	Maximum uncertainty from Table 2
Dry bulb temperature	°C	±0,11 K	±0,2 K
Wet bulb temperature	°C	±0,11 K	±0,4 K
Air volume flow	m^3/s	±1 %	±5 %
Static pressure difference	Pa	±4 Pa	±5 Pa (Δp ≤ 100 Pa) or ± 5 %(Δp > 100 Pa)

C.2.2 Guidance on temperature measurement

C.2.2.1 General

The uncertainty on the dry and wet bulb temperature is the major factor impacting the capacity uncertainty in an air-enthalpy room. A special attention should be given to those measurements. This chapter is providing some recommendations in order to achieve a maximum uncertainty of ± 0,11 K on both dry and wet bulb temperatures.

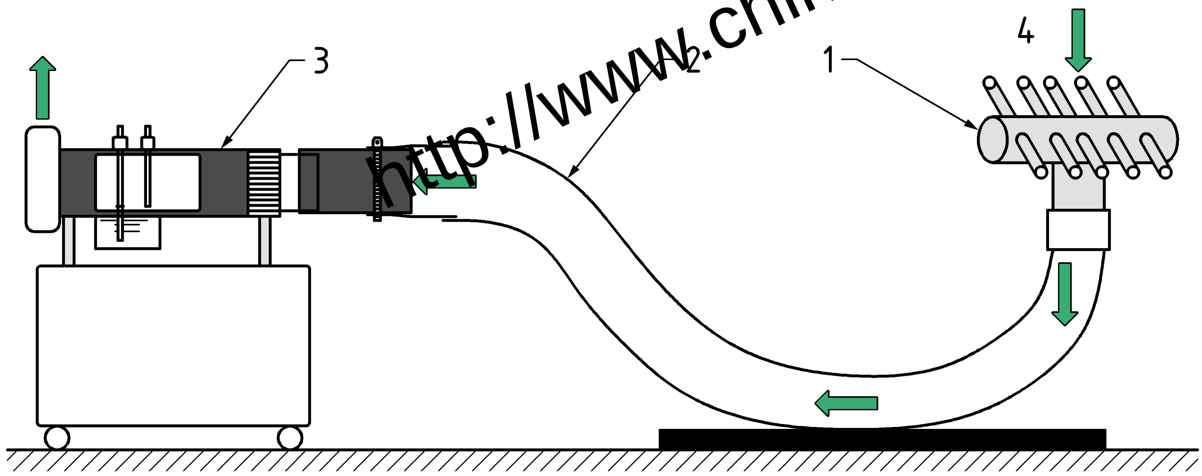
C.2.2.2 Measuring device

The temperatures (dry and wet bulb) should be measured using a sampling device as shown in Figure C.1, including:

— an air sampling tree;

— a connection tube or hose;

— a measuring vein including the instrumentation and a fan.



Key

1 air sampling tree

2 connection tube or hose

3 measuring vein including the instrumentation and a fan

4 airflow direction

Figure C.1 — Measuring devices set-up

The air sampling tree is intended to draw a sample of the air at the critical locations of a unit under test. It has a main flow trunk tube with a series of branch tubes connected to the trunk tube. Holes are on the side of the sampler facing the upstream direction of the air source. The branch tubes of the tree shall have appropriately spaced holes sized to provide equal airflow through all the holes. An example is shown on Figure C.2. The hole size should increase as you move further from the trunk tube to account for the static pressure regain effect in the branch and trunk tubes. A minimum hole density of six holes per 0,1 m^2 of area to be sampled is recommended.

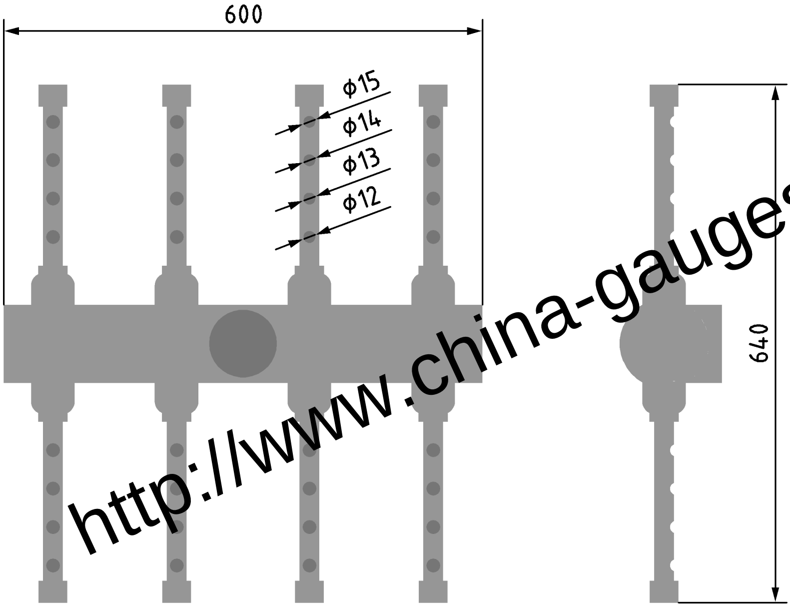
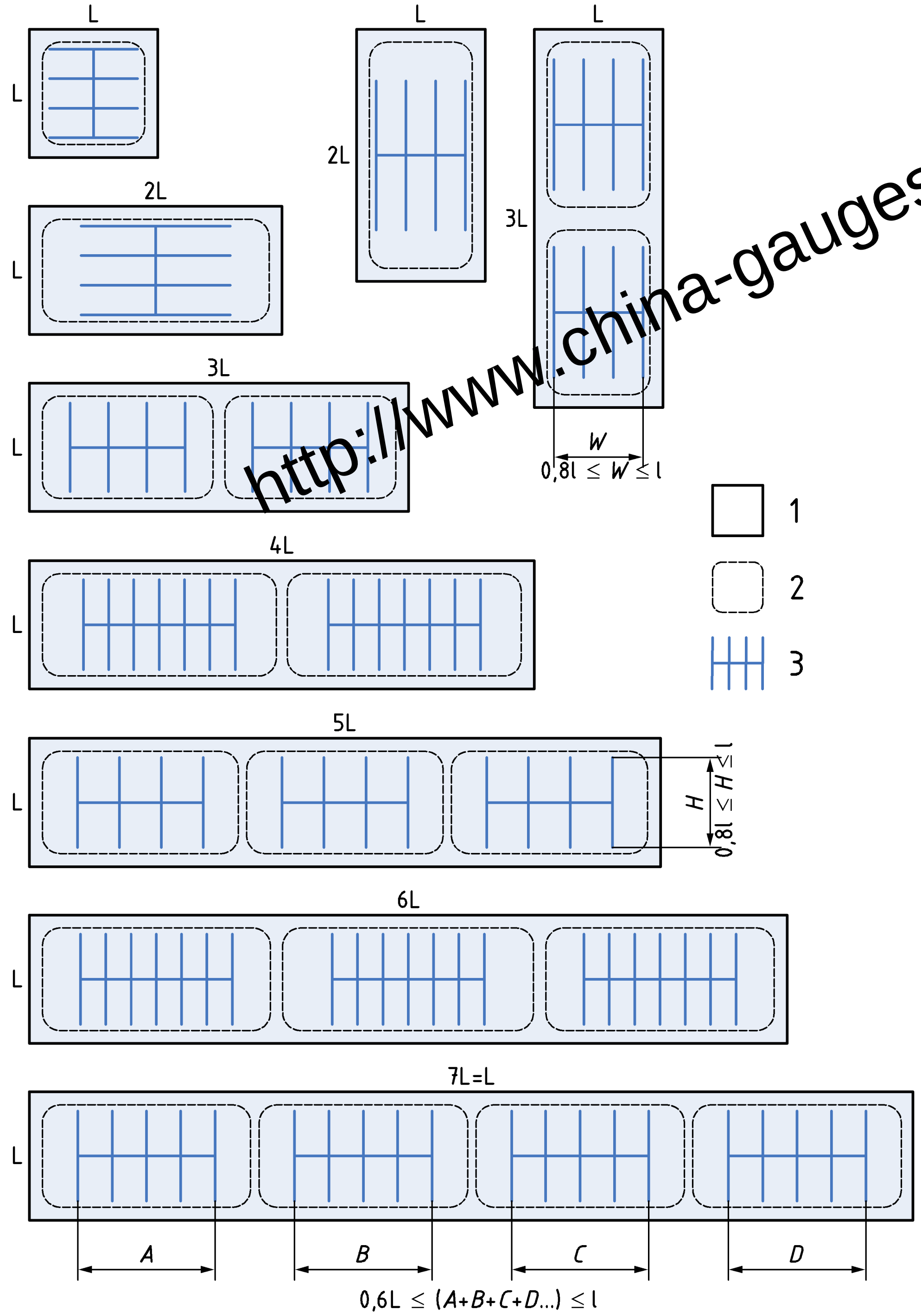


Figure C.2 — Example of air sampling tree

The sampling tree(s) should cover at least 80 % of the shortest direction and 60 % of the longest direction of the heat exchanger (example: 80 % of the height and 60 % of the width for long horizontal coils). The number and position of the sampling tree(s) shall be selected depending on the width to height ratio as shown in Figure C.3.



Key

1 heat exchanger air inlet nominal face area

2 equal area rectangles

3 air sampler tree

Figure C.3 — Number and position of the sampling tree(s)

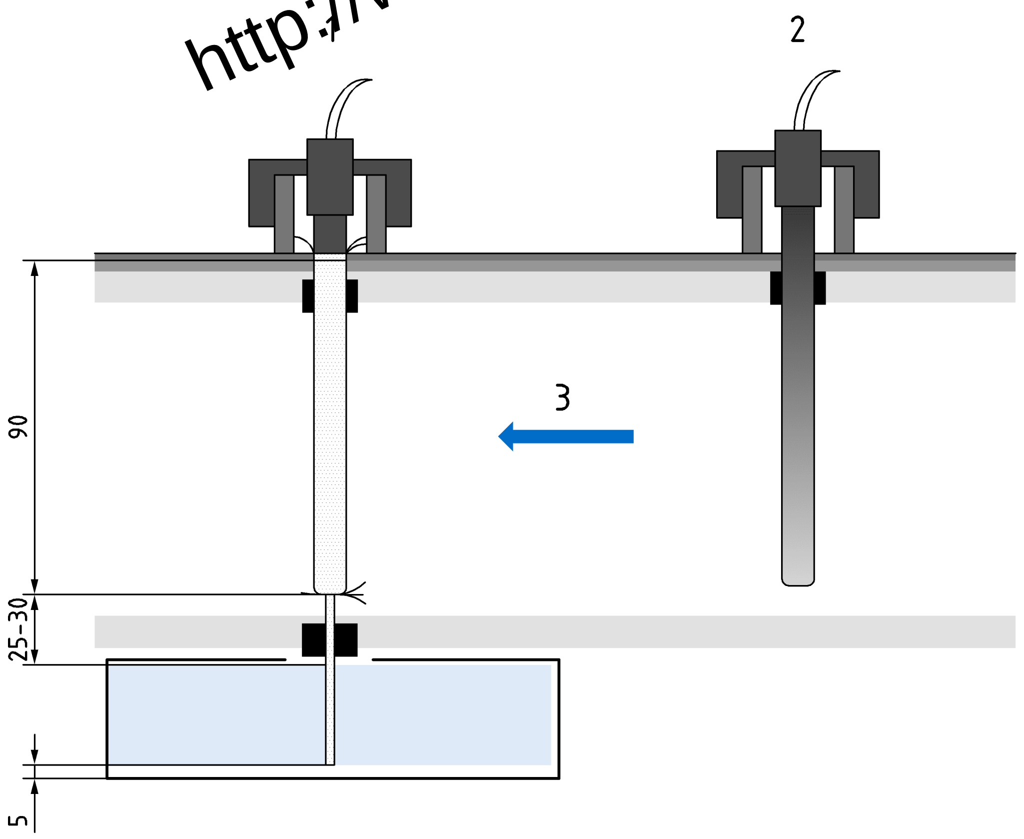
The connection hose between the air sampling tree and the measuring vein should not touch the ground and include as less curve and height difference as possible.

The measuring vein should include filtering device to guarantee a fully developed turbulent flow and to avoid particles disturbing the measurements to enter the vein. The air speed in the vein should be kept between 5 and 6 m/s.

C.2.2.3 Dry and wet bulb sensors

The sensors should be chosen to reduce the intrinsic inaccuracy of the measurement. Four-wires Platinum RTD (Pt100) with a maximum drift of 0,07K are recommended for both dry and wet bulb temperatures.

The wet bulb temperature should be measured using a distilled water-soaked wick attached around the temperature sensor. The wick should be degreased using boiled distilled water and soaked before installation with distilled water. A constant humidification of the wick shall be guaranteed by immerging a loose end of the wick in a water supply bath (see Figure C.4).



Key

1 Pt-100 sensor wet bulb

2 Pt-100 sensor dry bulb

3 airflow direction

Figure C.4 — Dry bulb and wet bulb sensors

The wick should be kept in place using two threads: one at the top of the sensor and one just below the sensor bulb. No excessive tightening should be used to avoid bad absorption of water in the wick.

Water and wick recommended replacement periods vary depending on usage, ambient dust, presence of air filtering or not in the devices. For non-filtering devices working every day, it is recommended to replace the wicks daily and the water, at least once a week. For less intensive usage, the wick and the water supply can be replaced over longer periods. For instance, a sign of alert requiring wick replacement is the presence of visible dust on the wick or when the wick shows evidence of (partial) dryness.

C.2.2.4 Calibration and zero-point check

The temperature sensors calibration is done using a minimum of 5 points, including at least 3 in the measuring range (5 °C to 45 °C) of the temperature probes and executed periodically in periods of time, aiming to guarantee a maximum recommended drift of 0,07 K.

The zero-point check procedure has proven to improve the measurement accuracy (reduce bias). It should be applied at the beginning of every test campaign and every time the sensors are moved, replaced or modified, in order to reduce systematic errors.

Firstly, all the sensors are installed in their respective position in the air samplers (suction and discharge) without wicks or any water in the air samplers.

The installation is made to avoid interference on the temperature measurement (dry coil, stop valves closed, no power supplied to the unit, drain pipes blocked, External heat/cooling (lights, heater, etc…) source removed).

An air flow at 20 °C in heating mode and 27 °C in cooling mode at the expected nominal air flow rate is generated by an external device and the temperatures are measured for 20 min.

All measured temperatures should remain within 0,1 K from each other. The average temperature measured by all sensors is calculated and an offset is applied in order that all sensors are measuring between 0,02 K from this average value.

In case the maximum deviation is not respected, the sensors should be replaced and/or recalibrated.

Secondly, the procedure is restarted for the wet bulb sensors only with the wick and water supply installed. The wet bulb temperature should be within 0,05K from each other.

In case the maximum deviation is exceeded, the wicks should be reinstalled.

C.2.2.5 Twin sensors approach

The twin sensors approach consists of duplicating those sensors involved in the measurement that are identified as a major source of uncertainty, like it happens when we are measuring the air enthalpy by means of PT100 sensors.

When using two sensors to measure the same parameter, the measurement accuracy can be increased by considering the measuring result is the average of the readings of both sensors. Duplicating a specific sensor and working with the average sensors reading, enables a reduction of 30 % on the individual measurement uncertainty when compared to a single sensor measurement uncertainty.

C.3 Air leakage tests

The measured cooling and heating capacities determined by means of the air enthalpy method is directly proportional to the measured airflow rate during the test. Thus, the impact of air leakage in the airflow rate measuring circuits is a net contribution to the final measurement uncertainty which reduces any test results accuracy and thus, should be controlled. The procedure described hereafter allows determining the air leakage which shall be considered as a contribution to the airflow rate measurement uncertainty.

Discharge chamber and airflow measurement devices shall be checked for leakage at least every two years. All joints and connections between the different compartments shall be visually inspected for damage every 6 months. In case any damage is observed in any sealing or joint, the damaged element shall be replaced or repaired, and an ad hoc air flow leakage test shall be done.

Any air leakage from the unit under test air leaving section to the airflow measurement section, will impact the final test results. Thus, it is recommended to evaluate and limit the airflow leakage in the test facilities in every section from the unit under test to the airflow measurement section within the airflow measuring device (airflow rate measurement circuit). The air flow leakage determined by following the procedure hereafter should be limited to be below 1 % of the test airflow rate. This value is the addition of the estimated possible leakages of all compartments related to the measured airflow rate.

The test results shall not be corrected for compensating the results of the airflow leakage test as the leakage is normally dependent on the specific test pressures and sample set-up.

The ideal gases equation given in the following formulae rules the leakage process.

$$p \cdot V = n \cdot R \cdot T \tag{C.1}$$

or

$$p \cdot V = \frac{m}{M} \cdot R \cdot T \tag{C.2}$$

or

$$p = \frac{\rho \cdot R \cdot T}{M} \tag{C.3}$$

The leaking airflow rate because of air leakage at constant pressure, can be calculated deriving Formula (C.2) against time, as shown in Formula (C.4).

$$p \cdot \frac{dV}{dt} = \frac{R \cdot T}{M} \cdot \frac{dm}{dt} \tag{C.4}$$

where

dV/dt is the leaking airflow rate q_{lin} in m^3/s.

Considering the constant volume of the airflow measuring device and deriving again Formula (C.2) against time:

$$V \cdot \frac{dp}{dt} = \frac{RT}{M} \cdot \frac{dm}{dt} \tag{C.5}$$

From Formula (C.4) and Formula (C.5), it is possible to calculate Formula (C.6).

$$V \cdot \frac{dp}{dt} = p \cdot \frac{dV}{dt}$$

$$\frac{dV}{dt} = \frac{V}{p} \cdot \frac{dp}{dt}$$

$$q_l = \frac{V}{p} \cdot \frac{dp}{dt} \tag{C.6}$$

where:

p is the static pressure, in Pa

V is the gas volume (chamber volume), in m^3

m is the gas mass in the gas volume

R is the ideal gas constant

n is the number of moles

m is the molar mass, in kg/mol

T is the gas absolute temperature, in K

ρ is the air density, in kg/m^3

The term dp/dt can be estimated from the slope $\Delta p/\Delta t$ by analysing how the pressurized airflow meter losses pressure across time using the following procedure:

1) First pressurize the airflow meter until a steady static pressure is achieved.

2) Close the air injection into the airflow meter and record the static pressure inside the airflow meter every second (Δt = 1s).

3) Evaluate the slope across time of the static pressure.

NOTE Additional air leakage methods can be found in EN ISO 5801:2017, Annex C.

C.4 Zero latent capacity confirmation

The actual latent capacity can be evaluated by measurements in the refrigerant side of the unit by adding two pressure sensors in the inter-connection piping between the outdoor and the indoor unit. These should be inserted directly at the inlet and the outlet of the indoor unit using T-joints. The piping diameter of the interconnection piping shall follow everywhere the installation manual of the unit.

For pure refrigerants, azeotropic mixtures of gases and low glide refrigerants, like R410A, the evaporating temperature of the refrigerant can be calculated from the arithmetic mean of the two sensors. If the evaporating temperature is at all time during the data acquisition period 1,5 °C above the dew point, the latent capacity can be considered as 0. Under such conditions it can be assumed the water contents in the air remains constant and thus, it is recommended to base all air enthalpy calculations on the air inlet absolute humidity measurements which are more accurate. This approach may dramatically reduce the uncertainty under zero latent capacity test conditions.

C.5 Thermal loses from ducts, chambers and plenums

The laboratory shall evaluate the need of corrections on the measured capacities because of the ducts and discharge chamber and plenums, between the air temperatures sampling sections at the air inlet and air outlet of the indoor units. Conclusions shall be integrated in the estimated measurement uncertainties.

Annex D
(normative)

Liquid enthalpy test method

D.1 General

In the liquid enthalpy test method, capacities are determined from measurements of entering and leaving temperatures and the associated liquid flow rate.

In addition, Annex E provides recommendations on the installation and connection of the measuring devices to the unit under test.

NOTE For water(brine)-to-water(brine) units, the liquid enthalpy test method can be used on the outdoor heat exchanger for establishing an energy balance and verifying the conformance criteria as given in Annex J.

D.2 Calculations-heating capacities

The measured heating capacity, ϕ_{thi}, shall be determined using the Formula (D.1):

$$\phi_{thi} = q_v \times \rho \times \left(c_{p\_out} \times t_{out} - c_{p\_in} \times t_{in} \right) \tag{D.1}$$

The measured heat recovery capacity, ϕ_{hr}, shall be determined using the Formula (D.2):

$$\phi_{hr} = q_{v\_hr} \times \rho_{hr} \times \left(c_{p\_hr\_out} \times t_{hr\_out} - c_{p\_hr\_in} \times t_{hr\_in} \right) \tag{D.2}$$

NOTE 1 The mass flow rate can directly be determined instead of the term (q_{v_hr} x ρ).

NOTE 2 The specific enthalpy H can be directly used instead of the term (C_p x t).

NOTE 3 All symbols and their units are specified in Annex H.

D.3 Calculations-cooling capacities

The measured cooling capacity, ϕ_{tci}, shall be determined using the Formula (D.3):

$$\phi_{tci} = -q_v \times \rho \times \left(c_{p\_out} \times t_{out} - c_{p\_in} \times t_{in} \right) \tag{D.3}$$

NOTE 1 The mass flow rate can directly be determined instead of the term (q_v x ρ).

NOTE 2 The specific enthalpy H can be directly used instead of the term (C_p x t).

NOTE 3 All symbols and their units are specified in Annex H.

Annex E
(informative)

Test installation and measurements for the liquid enthalpy method

E.1 General

This annex provides recommendations on the measurements and the connection of the unit to the measuring devices to ensure representative measurements.

E.2 Connecting the unit

The connecting pipes that include temperature and pressure measurements shall be of the same diameter as the inlet/outlet water connections of the unit. If otherwise not possible, the diameter just above can be used.

Table E.1 shows standardized piping diameters that can be used.

Table E.1 — Standardized connecting pipe diameters

Nominal diameter in inches																				
¼	3/8	½	¾	1	1 ¼	1 ½	2	2 ½	3	3 ½	4	4 ½	5	6	7	8	9	10	11	12

They shall be insulated from the unit for a distance of a least 3 times the inner diameter beyond the temperature measuring points.

Preferably connections shall also be insulated, especially when large temperature difference with ambient air is foreseen.

E.3 Liquid temperature measuring points

Liquid temperature measurements shall be made ensuring that the sensors readings are representative of the mean temperature value of the fluid.

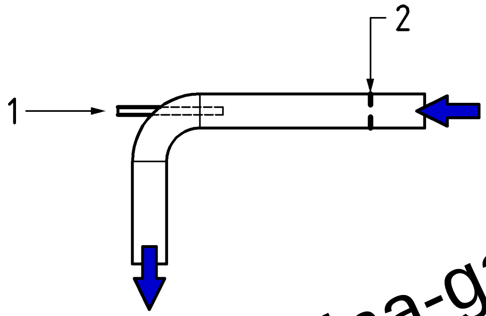
Liquid temperature shall be measured at a point as close as possible to the unit's water connection and in any case within 20 times the inner diameter of the connecting pipe.

Where the temperatures are measured by probes immersed in the connecting pipes, it shall be ensured temperature stratification and flow patterns do not influence the accuracy of the measurements. Figures E.1 and E.2 show recommended installation of immersed temperature probes.

Where the temperatures are measured on the outside of the connecting pipes, they shall be measured at two opposite points of the same cross section and, if the pipe is horizontal, there shall be one point above and one below. Good thermal contact between the pipe and the probe at the measuring point shall be ensured.

For liquid connection having an inner diameter of less than 0,075 m, immersed probes shall preferably be used.

Where the inner diameter of the water outlet pipe is equal or greater than 0,15 m, 3 inside tubes with a 120° arrangement as shown in Figure E.3 can be used.

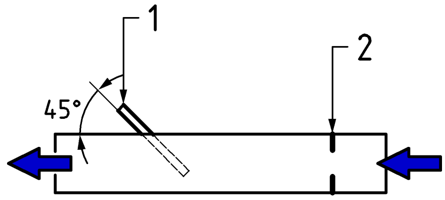


Key

1 thermowell

2 diaphragm

Figure E.1 — Temperature probe in an elbow

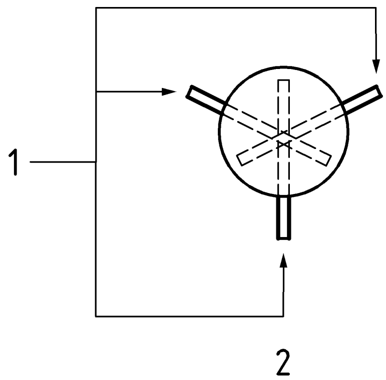


Key

1 thermowell

2 diaphragm

Figure E.2 — Temperature probe in a straight length



Key

1 thermowell

2 Cut view

Figure E.3 — Installation of temperature probes in a pipe with an inner diameter > 0,15 m

When measuring at flow rates under non turbulent flow conditions, provisions shall be made to force flow turbulence before measuring the liquid temperature.

At the outlet of the unit, and after the pressure measuring device a turbulator made of a diaphragm can be part of a straight length, to ensure turbulent flow and uniform temperatures. Figures E.4 to E.6 show different types of turbulators that can be used.

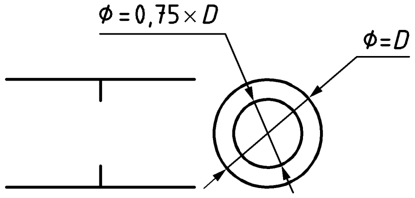


Figure E.4 — Diaphragm

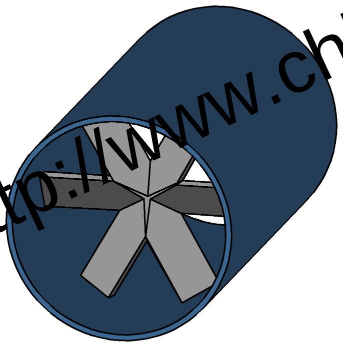


Figure E.5 — Cross-brace

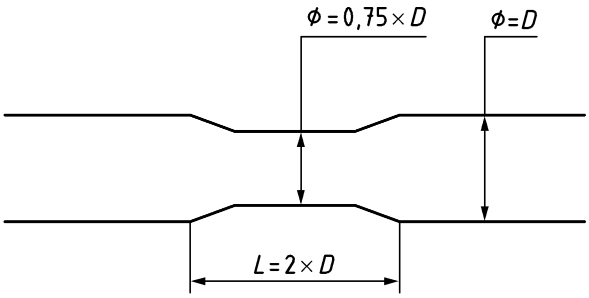


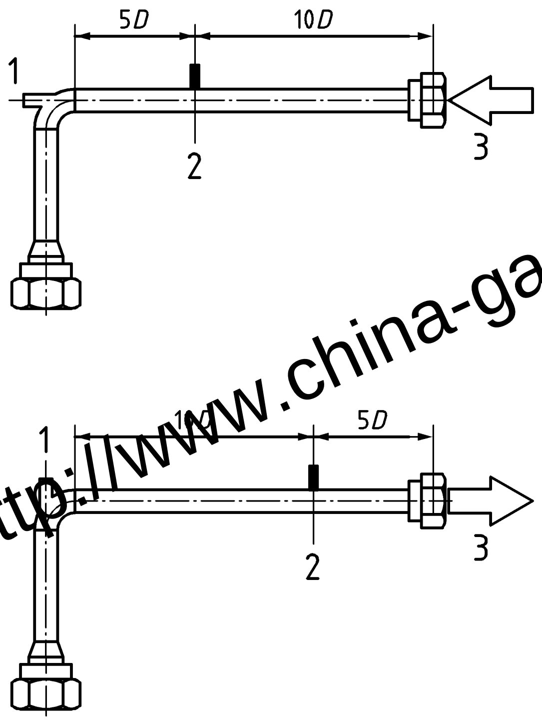
Figure E.6 — Convergent / Divergent

E.4 Pressure measuring points

The liquid pressure measuring points shall be located in the middle of a straight part of the connecting pipe of constant diameter and equal to the unit water connections, between the liquid connections of the unit and the temperature measuring points at a minimum distance depending on the inner diameter of the unit connection as specified in Table E.2 and as shown in Figure E.7.

Table E.2 — Static pressure measurement location (minimum distances)

Inner diameter of unit connection, D	Up flow minimum distance from pressure port length	Down flow minimum distance from pressure port
D ≤ 0,06 m	10D	3D
0,06 < D < 0,2 m	6D	2D
D ≥ 0,2 m	3D	D



Key

1 temperature probe port

2 static pressure port

3 to/from unit

Figure E.7 — Example of location of pressure ports on the inlet and outlet connecting lines to the unit

E.5 Liquid flow rate measurement

The liquid flow rate shall be measured using a measuring device, calibrated and installed in accordance with the instructions of the measuring device manufacturer.

Annex F
(normative)

Determination of the liquid pump efficiency

F.1 General

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

F.2 Hydraulic power of the liquid pump

F.2.1 The liquid pump is an integral part of the unit

When the liquid pump is an integral part of the unit, the hydraulic power of the pump, expressed in W is defined using the Formula (F.1):

$$P_{hyd} = q \times \Delta p_e \tag{F.1}$$

where

q is the measured liquid volume flow rate, expressed in m^3/s;

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

F.2.2 The liquid pump is not an integral part of the unit

When the liquid pump is not an integral part of the unit, the hydraulic power of the pump, expressed in W is defined using the Formula (F.2):

$$P_{hyd} = q \times (-\Delta p_i) \tag{F.2}$$

where

q is the measured liquid volume flow rate, expressed in m^3/s;

Δp_i is the measured internal static pressure difference, expressed in Pa.

F.3 Efficiency of integrated pumps

F.3.1 Glandless circulators

For glandless circulators, the calculation of the global efficiency η is based on the Energy Efficiency Index EEI as defined in Regulation (EC) No 641/2009 modified by Regulation (EU) No 622/2012 and using the Formula (F.3):

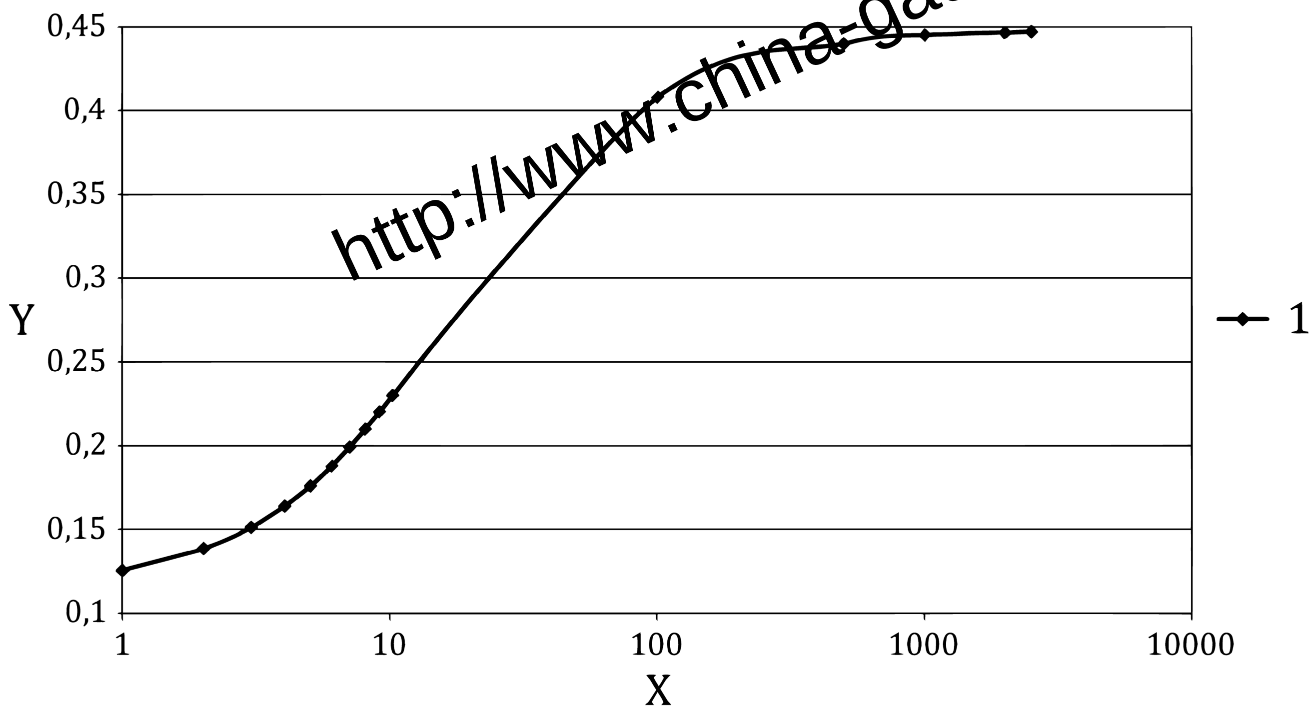
$$\eta = \frac{0{,}358\ 44 \times P_{hyd}}{1{,}7 \times P_{hyd} + 17 \times \left(1 - e^{-0{,}3 \times P_{hyd}}\right)} \times \frac{C_{20}}{EEI} \tag{F.3}$$

where

P_{hyd} is the hydraulic power of the pump, expressed in W;

C_{20} is a scaling factor equal to 0,49;

EEI is the Energy Efficiency Index equal to 0,23.



Key

1 liquid pump

X hydraulic power P_{hyd} (W) [1 W ≤ 2500 W]

Y efficiency η (-) [0,1250 ≤ η ≤ 0,4474]

Figure F.1 — Dependence of the efficiency of the glandless circulators on the hydraulic power

F.3.2 Dry motor pumps

For dry motor pumps, the global efficiency η shall be calculated using either Formula (F.4) or Formula (F.5) with respect of the hydraulic power of the pump:

a) When the hydraulic power of the liquid pump, calculated according to (F.1), is lower or equal to 500 W, then the efficiency of the pump is determined using the Formula (F.4):

$$\eta = 0{,}072\,1 P_{hyd}^{0{,}318\,3} \quad \text{(F.4)}$$

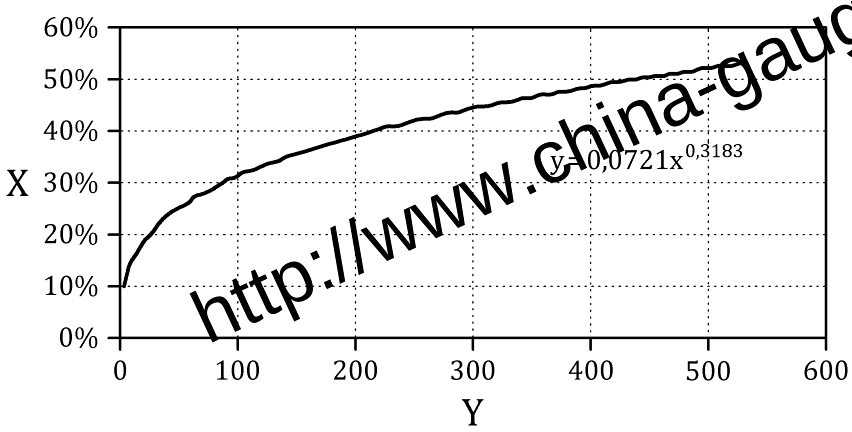
b) When the hydraulic power of the liquid pump, calculated according to (F.1), is greater than 500 W, then the global efficiency η of the pump is determined using the Formula (F.5):

$$\eta = 0{,}092 L_n\left(P_{hyd}\right) - 0{,}0403 \quad \text{(F.5)}$$

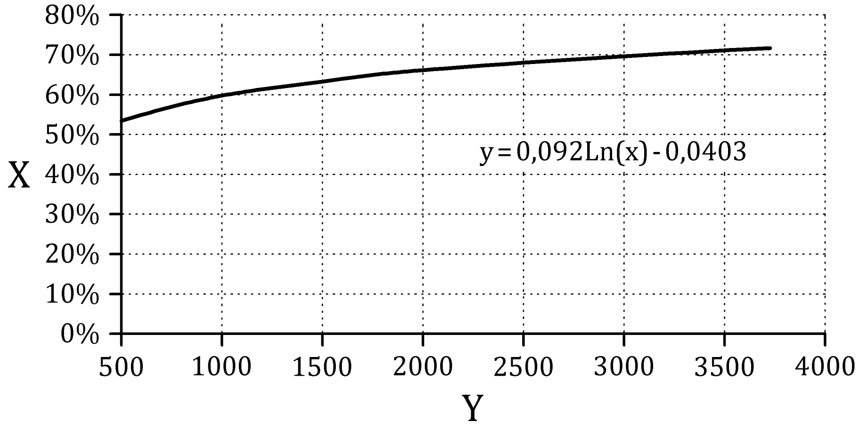
where

P_{hyd} is the measured hydraulic power of the pump, expressed in W.

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



a) Efficiency of circulating pumps with a hydraulic power lower or equal to 500 W (source: COSTIC)



b) Efficiency of circulating pumps with a hydraulic power greater than 500 W (extrapolation of COSTIC curve above 1kW)

Key

X efficiency η (%)

Y Phyd (W)

Figure F.2 — Efficiency of the pump versus its hydraulic power graphs

F.4Efficiency of non-integrated pumps

When the liquid pump is not an integral part of the unit, the calculation of the global efficiency to be taken into account in the pump correction is as follows:

a) When the hydraulic power calculating according to (F.2) is lower or equal to 300 W then the efficiency of the pump is determined using Formula (F.3);

b) When the hydraulic power calculating according to (F.2) is greater than 300 W but lower or equal to 500 W, then the efficiency of the pump is determined using Formula (F.4);

c) When the hydraulic power calculating according to (F.2) is greater than 500 W the efficiency of the pump is determined using Formula (F.5).

Annex G
(informative)

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

G.1 General

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

G.2 Terms and definitions

In addition to the terms and definitions given in EN 14511-1:2022, the following apply.

G.2.1

outdoor cooling capacity

$P_{C,outdoor}$

total cooling capacity of the outdoor unit measured as the total indoor cooling capacity unit

Note 1 to entry: Expressed in kW.

G.2.2

outdoor heating capacity

$P_{H,outdoor}$

heating capacity of the outdoor unit measured as the indoor heating capacity unit

Note 1 to entry: Expressed in kW.

G.2.3

outdoor power input

$P_{E,outdoor}$

effective power input measured on the outdoor unit

Note 1 to entry: Expressed in kW.

G.2.4

indoor power input

$P_{E,indoor}$

effective power input measured on the indoor unit

Note 1 to entry: Expressed in kW.

G.2.5

outdoor energy efficiency ratio

***EER* outdoor**

ratio of the outdoor cooling capacity to the outdoor power input

Note 1 to entry: Expressed in kW/kW.

G.2.6

outdoor energy efficiency ratio

***COP* outdoor**

ratio of the outdoor heating capacity to the outdoor power input

Note 1 to entry: Expressed in kW/kW.

G.3 Rating of indoor units

G.3.1 General

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

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

G.3.2 Air flow rate measurement

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

G.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 4.1.5.

G.4 Rating of outdoor units

G.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.

G.4.2 Test procedure

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

The rated performance of outdoor units shall include the following if applicable:

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

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

— outdoor energy efficiency ratio: $EER_{outdoor}$;

— coefficient of performance: $COP_{outdoor}$.

Annex H
(informative)

Symbols used in annexes

Symbol	Description	Unit
c_{pa1}	Specific heat of moist air entering indoor-side	kJ/(kg·K)
c_{pa2}	Specific heat of moist air leaving indoor-side	kJ/(kgK)
cp_{air}	is the specific heat of dry air at constant pressure	kJ/(kg.K)
cp_{v}	is the specific heat of vapour at constant pressure	kJ/(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
K_1	Latent heat of vaporization of water at 15 °C (constant = 2 460)	kJ/kg
K_2	Latent heat of vaporization of water at 0 °C (constant = 2 501,6)	kJ/kg
ϕ_c	Heat removed by cooling coil in the outdoor-side compartment	kW
ϕ_{co}	Heat removed by the condenser coil of the equipment	kW
ϕ_d	Latent cooling capacity (dehumidifying)	kW
ϕ_{eo}	Heat supplied to the evaporator coil of the equipment	kW
ϕ_{lci}	Heat removed from indoor-side compartment	kW
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	kW
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	kW

Symbol	Description	Unit
ϕ_{lp}	Heat leakage flow through the separating partition into the indoor-side compartment from the outdoor-side compartment	kW
ϕ_s	Sensible cooling capacity	kW
ϕ_{tci}	Total cooling capacity, from indoor-side data	kW
ϕ_{tco}	Total cooling capacity, from outdoor-side data	kW
ϕ_{thi}	Total heating capacity, from indoor-side data	kW
ϕ_{tho}	Total heating capacity, from outdoor-side data	kW
P_t	Total power input to equipment	kW
$\sum P_E$	Effective power input to the equipment	kW
$\sum P_{ic}$	Sum of all power inputs to the indoor-side compartment	kW
$\sum P_{oc}$	Sum of all power inputs to any apparatus in the outdoor-side compartment (e.g. reheaters, fans, etc.)	kW
q_{vi}	Indoor air flow rate	m^3/s
q_{wo}	Mass flow rate of water supplied to the outdoor-side calorimeter compartment	kg/s
SHR	Sensible heat ratio	kW/kW
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	kg/s
W	Specific humidity of air	kg water / kg dry air
W_{i1}	Specific humidity of air entering indoor-side compartment	kg water / kg dry air
W_{i2}	Specific humidity of air leaving indoor-side compartment	kg water / kg dry air
W_n	Specific humidity at the nozzle inlet	kg water / kg dry air

Annex I
(normative)

Air flow rate measurement

I.1 General

This annex provides information and describes the test procedure for rating the indoor and/or outdoor air flow rate of ducted or non-ducted air conditioners, chillers or heat pumps.

I.2 Test installation

Test installation is done as per requirements in B.2.

I.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 4.4.1.3 for units ducted on in the indoor heat exchanger and with 4.4.1.4 for units ducted on the outdoor heat exchanger.

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

I.4 Air flow measurement

Air flow measurements shall be made so that the requirement on the uncertainty of measurement given in Table 2 is fulfilled.

NOTE The airflow measurements can be made using nozzle systems in accordance with the provisions for the airflow measurement devices specified in EN ISO 5801, the EN ISO 5167 series as appropriate, and the provisions in this annex.

Annex J
(informative)

Conformance criteria

J.1 Water(brine)-to-water(brine) units

For water(brine)-to-water(brine) units for which a heat balance on the cooling and/or heating capacity may be calculated, this balance should not exceed 5 %.

This heat balance may be calculated as the difference between the direct measured cooling (heating) capacity and the indirect cooling (heating) capacity related to the direct capacity.

The indirect cooling capacity is determined as the heat rejection capacity minus the compressor power input.

The indirect heating capacity is the sum of the cooling capacity and the compressor power input.

For water(brine)-cooled liquid chilling packages including a heat recovery heat exchanger, the heat balance between the direct measured cooling capacity and the indirect cooling capacity calculation should not exceed 5 %.

The indirect cooling capacity is calculated as the sum of the heat rejection capacity and the heat recovery capacity minus the compressor power input.

J.2 Calorimeter room method

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(brine)-cooled condensers, the heat flow rejected via the cooling water(brine) is measured instead of the measurement in the outdoor-side compartment.

J.3 Heat recovery of multisplit systems

The sum of the cooling capacity of the indoor units (see A.4.2) and the power input to the compressor and any fans should differ by not more than 5 % from the sum of the heating capacity of the indoor units (see A.5.2) and the heat from the outdoor unit. The heat from the outdoor unit may be negative if the unit is absorbing heat, or positive if the unit is rejecting heat.

Annex K
(informative)

Individual unit tests

K.1 General

K.1.1 Methods

The described methods provide means to determine the capacity of an individual indoor unit, either operating on its own with the other indoor units disconnected, or with all indoor units operating.

In Commission Regulation (EU) 2016/2281, indoor units of air conditioners and heat pumps are designated as fan coil units in which the refrigerant is the heat transfer medium. Therefore, for that purpose, indoor units of multisplit air conditioners and multisplit heat pumps shall be rated according to the procedure described in EN 14825:2018.

K.1.2 Calorimeter method

If measurements are made by the calorimeter method, then the testing of an individual unit, with all others operating needs at least a three-room calorimeter test facility. If only one unit is operating, a two-room calorimeter is sufficient. Each calorimeter should satisfy requirements described in Annex A.

For the result to be valid, the total capacity calculated from the two indoor rooms should differ by not more than 5 % from the capacity calculated from the outdoor unit.

K.1.3 Air-enthalpy method

If measurements are made by the air-enthalpy method, then the testing should be done with one or more indoor rooms and one or more air measuring devices connected to the indoor units. The outdoor unit should be situated at least in an environmental test room.

The test facility should satisfy the requirements described in Annex B, except that the individual indoor unit to be tested should have its own plenum and air flow measuring device.

K.2 Test results

Test results should be recorded and expressed as specified in 4.5.

K.3 Published results

Results should state if the units not being tested are disconnected or running during the test.

Annex ZA
(informative)

Relationship between this European Standard and the ecodesign requirements of Commission Regulation (EU) No 206/2012 [OJEU L 72/7-27, 10.3.2012] aimed to be covered

This European Standard has been prepared under a Commission's standardization request M/488 to provide one voluntary means of conforming to the ecodesign requirements of Commission Regulation (EU) No 206/2012 of 6 March 2012 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for air conditioners [OJEU L 72/7-27, 10.3.2012].

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Table ZA.1 — Correspondence between this European Standard and Commission Regulation (EU) No 206/2012 of 6 March 2012 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for air conditioners [OJEU L 72/7–27, 10.3.2012] and Commission's standardization request M/488

Ecodesign Requirements of Regulation (EU) No 206/2012	Clause(s)/sub-clause(s) of this EN	Remarks/Notes
Annex I 2. c) Table 6 - EER_{rated} Annex I 3. d) Table 2 - EER_{d}	4.1.1 4.1.3.2 4.1.4.2 4.2.1.1, 4.2.1.2 4.2.2.1, 4.2.2.4 4.3 4.4.1.1, 4.4.1.2 4.4.3 4.5.2, 4.5.4, 4.5.5 Annex A	EER_{rated} of single duct and double duct air conditioners EER_{d} in Table 2 is understood as EER_{rated}
Annex I 2. c) Table 6 - COP_{rated} Annex I 3. d) Table 2 - COP_{d}	4.1.1 4.1.3.2 4.1.4.2 4.2.1.1, 4.2.1.2 4.2.2.1, 4.2.2.4 4.3 4.4.1.1, 4.4.1.2 4.4.4 4.5.3, 4.5.4, 4.5.5 Annex A	COP_{rated} of single duct and double duct air conditioners COP_{d} in Table 2 is understood as COP_{rated}

Ecodesign Requirements of Regulation (EU) No 206/2012	**Clause(s)/sub-clause(s) of this EN**	**Remarks/Notes**
Annex I 2. d) Table 7 - P_{SB} Annex I 3. d)Table 2 - P_{SB}	5.1	P_{SB}, maximum power consumption in standby mode for single duct and double duct air conditioners
Annex I 2. d) Table 7 - P_{OFF}	5.2	P_{OFF} maximum power consumption in off-mode for single duct and double duct air conditioners
Annex I 3. d) Table 2 - P_{rated} for cooling	4.1.1 4.1.3.2 4.1.4.2 4.2.1.1, 4.2.1.2 4.2.2.1, 4.2.2.4 4.3 4.4.1.1, 4.4.1.2 4.4.3 4.5.2 Annex A	Cooling capacity of single duct and double duct air conditioners
Annex I 3. d) Table 2 - P_{rated} for heating	4.1.1 4.1.3.2 4.1.4.2 4.2.1.1, 4.2.1.2 4.2.2.1, 4.2.2.4 4.3 4.4.1.1, 4.4.1.2 4.4.4 4.5.3 Annex A	Heating capacity of single duct and double duct air conditioners
Annex I 3. d) Table 2 - P_{EER}	4.1.1 4.1.4.2 4.2.1.1, 4.2.1.2 4.2.2.1, 4.2.2.4 4.3 4.4.1.1, 4.4.1.2 4.5.4 Annex A	Rated power input for cooling, of single duct and double duct air conditioners

Ecodesign Requirements of Regulation (EU) No 206/2012	Clause(s)/sub-clause(s) of this EN	Remarks/Notes
Annex I 3. d) Table 2 - P_{COP}	4.1.1 4.1.4.2 4.2.1.1, 4.2.1.2 4.2.2.1, 4.2.2.4 4.3 4.4.1.1, 4.4.1.2 4.5.4 Annex A	Rated power input for cooling of single duct and double duct air conditioners
Annex I 3. c) Table 1 - Rated air flow (indoor/outdoor)	6 Annex I	

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Annex ZB
(informative)

Relationship between this European Standard and the energy labelling requirements of Commission Delegated Regulation (EU) No 626/2011 [OJEU L 178/1-72, 6.7.2011] aimed to be covered

This European Standard has been prepared under a Commission's standardization request M/495 to provide one voluntary means of conforming to the energy labelling requirements of Commission Delegated Regulation (EU) No 626/2011 of 4 May 2011 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of air conditioners [OJEU L 178/1-72, 6.7.2011].

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Table ZB.1 — Correspondence between this European Standard and Commission Delegated Regulation (EU) No 626/2011 of 4 May 2011 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of air conditioners [OJEU L 178/1–72, 6.7.2011] and Commission's standardization request M/495

Energy labelling requirements of Regulation (EU) No 626/2011	Clause(s)/sub-clause(s) of this EN	Remarks/Notes
Annex IV – 4. (b) - Q_{DD} Annex VI – 1. (c) (iii) - Q_{DD}	5.3	Hourly electricity consumption for double duct air conditioners
Annex IV – 4. (c) - Q_{SD} Annex VI – 1. (c) (iv) - Q_{SD}	5.3	Hourly electricity consumption for single duct air conditioners
Annex IV – 4. (d) - P_{rated} Annex VI – 1. (c) (ii) - rated capacity	4.1.1 4.1.3.2 4.1.4.2 4.2.1.1, 4.2.1.2 4.2.2.1, 4.2.2.4 4.3 4.4.1.1, 4.4.1.2 4.4.3 4.5.2 Annex A	Cooling capacity of single duct and double duct air conditioners It is understood to declared rated capacity for both cooling and heating

Energy labelling requirements of Regulation (EU) No 626/2011	**Clause(s)/sub-clause(s) of this EN**	**Remarks/Notes**
Annex IV – 4. (e) - P_{rated} Annex VI – 1. (c) (ii) - rated capacity	4.1.1 4.1.3.2 4.1.4.2 4.2.1.1, 4.2.1.2 4.2.2.1, 4.2.2.4 4.3 4.4.1.1, 4.4.1.2 4.4.4 4.5.3 Annex A	Heating capacity of single duct and double duct air conditioners It is understood to declared rated capacity for both cooling and heating
Annex V - (f) - (v) -EER_{rated} Annex VI – 1. (c) (i) - EER	4.1.1 4.1.3.2 4.1.4.2 4.2.1.1, 4.2.1.2 4.2.2.1, 4.2.2.4 4.3 4.4.1.1, 4.4.1.2 4.4.3 4.5.2, 4.5.4, 4.5.5 Annex A	EER_{rated} of single duct and double duct air conditioners EER is understood as EER_{rated}
Annex V - (f) - (v) - COP_{rated} Annex VI – 1. (c) (i) - COP	4.1.1 4.1.3.2 4.1.4.2 4.2.1.1, 4.2.1.2 4.2.2.1, 4.2.2.4 4.3 4.4.1.1, 4.4.1.2 4.4.4 4.5.3, 4.5.4, 4.5.5 Annex A	COP_{rated} of single duct and double duct air conditioners COP is understood as COP_{rated}

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Annex ZC
(informative)

Relationship between this European Standard and the ecodesign requirements of Commission Regulation (EU) No 2016/2281 [OJEU L346/1-50, 20.12.2016] aimed to be covered

This European Standard has been prepared under a Commission's standardization request M/560 C(2019) 1725 of 11.03..019 to provide one voluntary means of conforming to the ecodesign requirements of Commission Regulation (EU) 2016/2281 of 30 November 2016 implementing Directive 2009/125/EC of the European Parliament and of the Council establishing a framework for the setting of ecodesign requirements for energy-related products, with regard to ecodesign requirements for air heating products, cooling products, high temperature process chillers and fan coil units [OJEU L346/1-50, 20.12.2016].

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Table ZC.1 — Correspondence between this European Standard and Commission Regulation (EU) 2016/2281 of 30 November 2016 implementing Directive 2009/125/EC of the European Parliament and of the Council establishing a framework for the setting of ecodesign requirements for energy-related products, with regard to ecodesign requirements for air heating products, cooling products, high temperature process chillers and fan coil units [OJEU L346/1–50, 20.12.2016] and Commission's standardization request M/560

Ecodesign Requirements of Regulation No 2016/2281	Clause(s)/sub-clause(s) of this EN	Remarks/Notes
Annex II 5. Outdoor air flow rate Table 10 Table11, Table 14,	Clause 6 and Annex I	Outdoor air flow rate For air-cooled comfort chillers For air-to-air air conditioners For air-to-air heat pumps

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