



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 It supersedes BS EN 14511-3:2018, which is withdrawn.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

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of an identical text or by endorsement, at the latest by March 2023, and conflicting national standards shall be withdrawn at the latest by March 2023.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

$$\left(q \times \Delta p_e\right) \times \frac{1-\eta}{\eta} \quad (1)$$

where

- q is the measured liquid flow rate, expressed in m³/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).

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

where

- q is the measured liquid volume flow rate, expressed in m³/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).

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

where

- q is the measured liquid flow rate, expressed in m³/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).

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

where

- q is the liquid volume flow rate, expressed in m³/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):

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

where

- q is the air volume flow rate, expressed in m³/s and set according to 4.4.1.3 ($q_{v,\text{lab}}$) or 4.4.1.4 ($q_{v,\text{outdoor,lab}}$);
- $\Delta p_{e(\text{corr})}$ 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 ($\Delta p_{e,\text{lab}}$) or 4.4.1.4 ($\Delta p_{e,\text{outdoor,lab}}$);
- 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):

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

where

- q is the air volume flow rate, expressed in m³/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):

$$\frac{q \times \Delta p_e}{\eta} \quad (7)$$

where

q is the measured liquid flow rate, expressed in m³/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):

$$\frac{q \times (-\Delta p_i)}{\eta} \quad (8)$$

where

q is the measured liquid flow rate, expressed in m³/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 compressor 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 $\pm$ 0,5 m shall be used and a cooling correction factor of 1,02 and a heating correction factor of 1,01 shall be 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 constraints 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 m².

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.

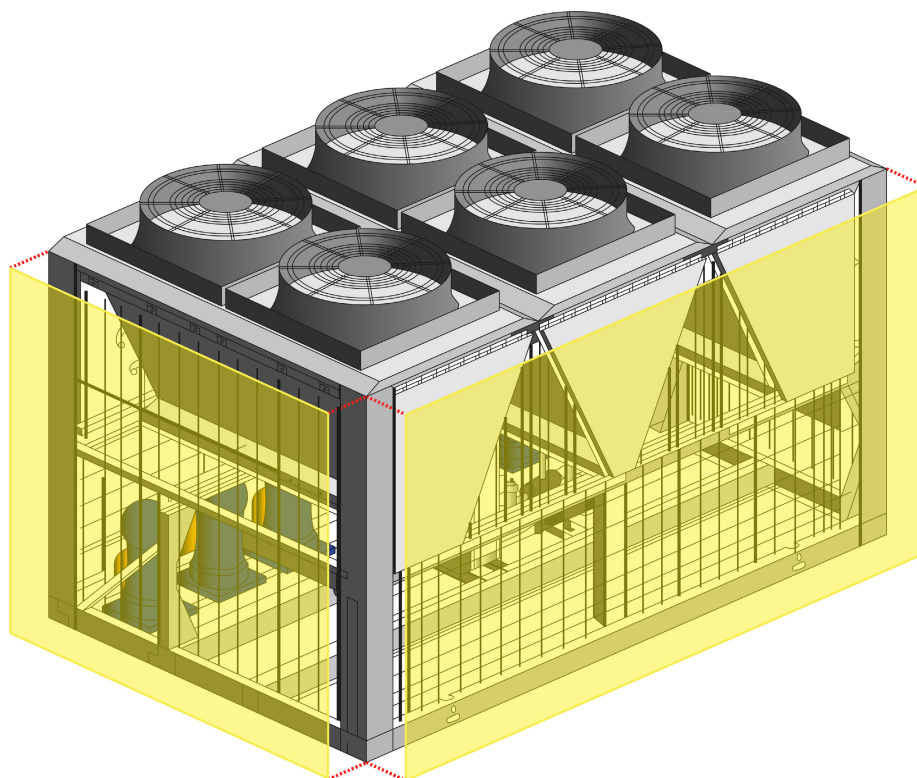


Figure 1 — Minimum enveloping surface for units with V-shaped coils (example of an outdoor unit)

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	$\pm 0,15$ K
Temperature inlet/outlet	$^{\circ}\text{C}$	$\pm 0,15$ 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	$^{\circ}\text{C}$	$\pm 0,2$ K
Wet bulb temperature	$^{\circ}\text{C}$	$\pm 0,4$ 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	$^{\circ}\text{C}$	$\pm 0,5$ K
Concentration (in volume)		
Heat transfer medium	%	± 2
Electrical quantities		
Electric power	W	± 1 %
Voltage	V	$\pm 0,5$ %
Current	A	$\pm 0,5$ %
Electrical energy	kWh	± 1 %
Compressor rotational speed (for open type compressors)	min^{-1}	$\pm 0,5$ %

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, $q_{v,declared}$, 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, $q_{v,lab}$, is as given in Formula (9).

$$q_{v,lab} = \frac{p_{std}}{p_{lab}} \times q_{v,declared} \quad (9)$$

where

$q_{v,declared}$ is the air flow rate in standard air conditions as declared by the manufacturer, expressed in m³/h;

p_{std} is the density of standard air (20° C, 101 325 Pa), equal to 1,204 kg/m³;

p_{lab} is the density of air at the actual atmospheric conditions, expressed in kg/m³.

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

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

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

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/m³;

p_{lab} is the density of air at the actual atmospheric conditions, expressed in kg/m³.

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.

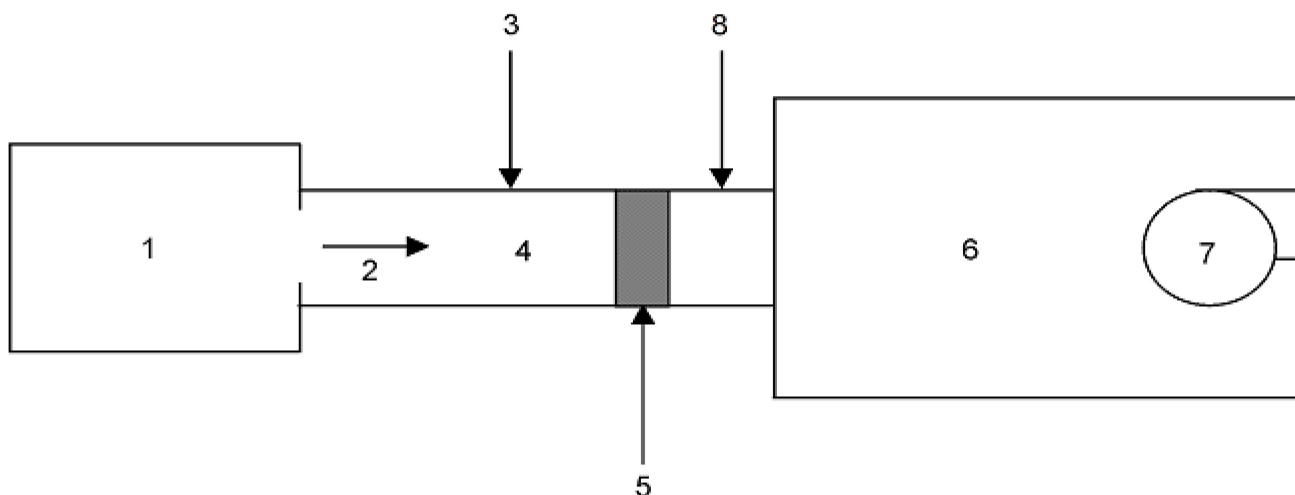
For ducted units to be tested in a calorimeter room, the ESP shall be set at point 3 while the pressure at point 8 shall be equal to 0. The air flow measurement device can be disconnected after the damper once the air flowrate/ESP are set.

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
$8 \leq Q < 12$	37
$12 \leq Q < 20$	50
$20 \leq Q < 30$	62
$30 \leq Q < 45$	75
$45 \leq Q < 82$	100
$82 \leq Q < 117$	125
$117 \leq Q < 147$	150
$Q \geq 147$	175
^a For equipment tested without an air filter installed, the minimum external static pressure shall be increased by 10 Pa. ^b If the 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, $q_{v,outdoor,declared}$, 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, $q_{v,outdoor,lab}$, is as given in Formula (11).

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

where

$q_{v,outdoor,declared}$ is the air flow rate in standard air conditions as declared by the manufacturer, expressed in m³/h;

p_{std} is the density of standard air (20° C, 101 325 Pa), equal to 1,204 kg/m³;

p_{lab} is the density of air at the actual atmospheric conditions, expressed in kg/m³.

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

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 $\Delta p_{e,outdoor,std}$.

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

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/m³;

p_{lab} is the density of air at the actual atmospheric conditions, expressed in kg/m³.

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:

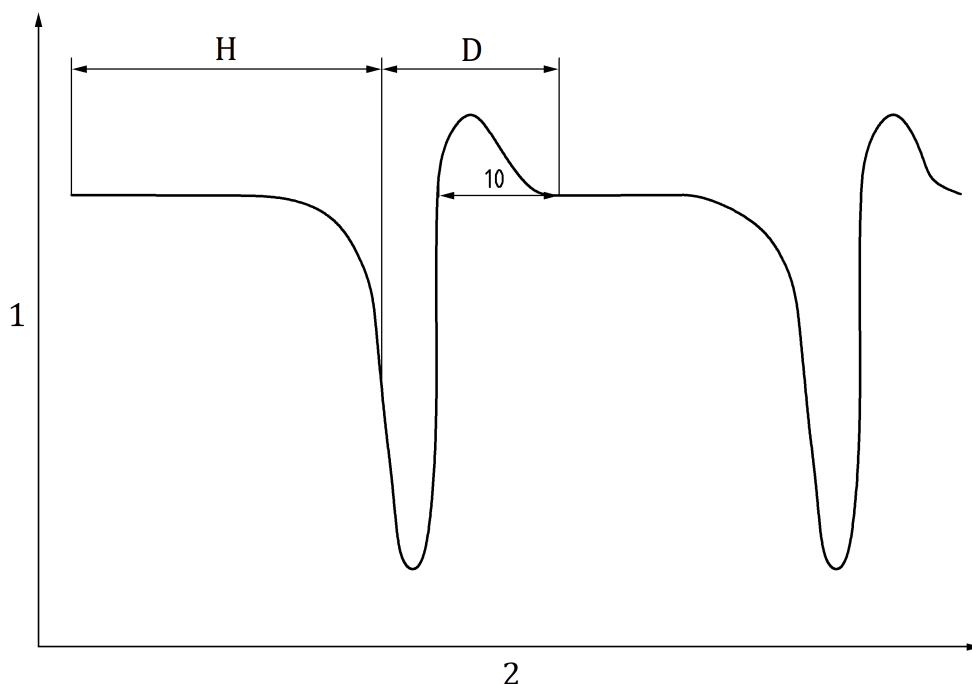
- The 4-way valve signal indicates a change of state;
- The water temperature difference between inlet and outlet is smaller than 0,2 K;
- One or several compressor(s) stop(s).

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.

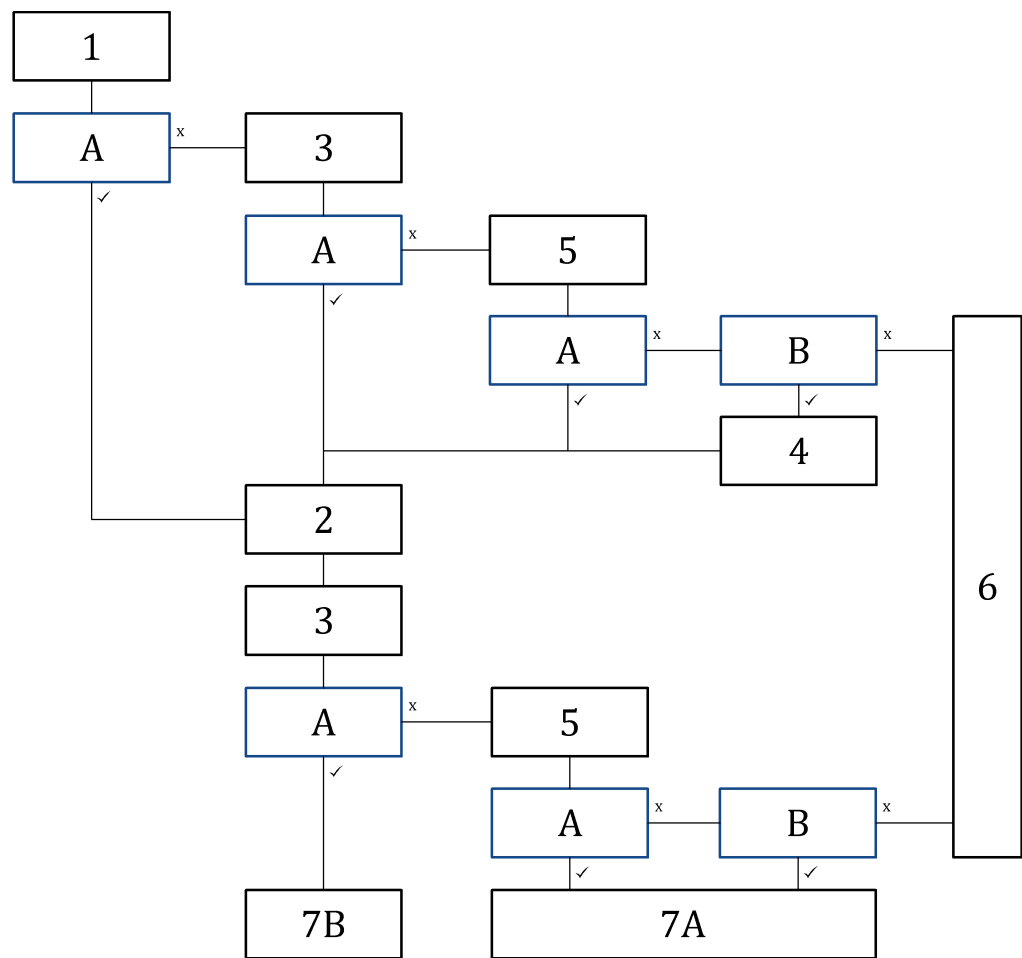
The test procedure is described by the following flowchart (see Figure 4). The steps of the flowchart shall immediately follow each other.

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
×	no
A	Did a defrost cycle occur?
B	Did the quantity $\% \Delta T$ exceed 2,5 %?
1	Step 1: Preconditioning
2	Step 2: End of defrost cycle
3	Step 3: Equilibrium period
4	Step 4: Defrost cycle
5	Step 5: Data collection
6	Step 6: Steady-state operation
7A	Step 7A: Transient operation
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.