International Standard

ISO 19967-2

Air to water heat pumps — Testing and rating for performance —

Part 2: Space heating and/or space cooling

Pompes à chaleur air/eau — Essais et classification des performances —

Partie 2: Chauffage des locaux et/ou refroidissement des locaux

Second edition
2024-05

Reference number
ISO 19967-2:2024(en)

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Published in Switzerland

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 86, *Refrigeration and air-conditioning*, Subcommittee SC 6, *Testing and rating of air-conditioners and heat pumps*.

This second edition cancels and replaces the first edition (ISO 19967-2:2019), which has been technically revised.

The main changes are as follows:

— the title has been changed;

— terms and definitions have been added and clarified;

— test conditions have been defined and added for space cooling and/or space heating;

— the installation of test item (object) of several parts has been clarified;

— the test report information has been updated;

— the maximum and minimum operation annex has been deleted.

A list of all parts in the ISO 19967 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Air to water heat pumps — Testing and rating for performance —

Part 2: Space heating and/or space cooling

1 Scope

This document specifies test conditions and test procedures for determining the performance characteristics of air to water heat pumps for space heating and/or space cooling with electrically driven compressors with or without supplementary heater. The purpose of this document is to rate the performance of the air to water heat pumps for space heating and/or space cooling.

In the case of air to water heat pumps for space heating and/or space cooling consisting of several parts with refrigerant or water connections, this document applies only to those designed and supplied as a complete package. This document does not apply to large chiller or large liquid chilling package for space cooling and/or heating.

This document does not apply to air to water heat pumps not intended for human comfort.

NOTE Testing procedures for simultaneous operation for hot water supply and space heating and/or space cooling are not treated in this document. Simultaneous means that hot water supply and space heating and/or space cooling generation occur at the same time and can interact.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminology 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/

3.1
air to water heat pumps
heat pump which consists of one or more factory-made assemblies which normally include at least space side refrigerant to water heat exchanger(s) (load side), electrically driven compressor(s), and outdoor-side air-to-refrigerant heat exchanger(s) (source side), including means to provide space heating and/or space cooling functions

Note 1 to entry: It can include a supplementary heater for space heating.

3.2
heating capacity
$\boldsymbol{\Phi}_{\mathbf{H}}$
heat given off by the unit to the heat transfer medium per unit of time

Note 1 to entry: Heating capacity is expressed in watts.

3.3
cooling capacity
$\boldsymbol{\Phi}_{\mathbf{C}}$
heat removed by the unit from the heat transfer medium per unit of time

Note 1 to entry: Cooling capacity is expressed in watts.

3.4
effective power input
average electrical power input of the unit within the defined interval of time obtained from:

— power input for operation of the compressor and any power input for defrosting;

— power input for all control and safety devices of the unit;

— proportional power input of the conveying devices (e.g. fans, pumps) for ensuring the transport of the heat transfer media inside the unit

Note 1 to entry: Effective power input is expressed in watts.

3.5
outdoor heat exchanger
Heat exchanger which is designed to remove/add heat from/to the outdoor ambient environment

3.6
internal static pressure difference
$\boldsymbol{\Delta p_i}$
negative pressure difference measured between the air (or water) outlet section and air (or water) inlet section of the unit, which corresponds to the total pressure drop of all components on the air (or water) side of the unit

3.7
energy efficiency ratio
EER
ratio of the cooling capacity to the effective power input in the unit at any given set of rating conditions

Note 1 to entry: Expressed in units of watt per watt.

3.8
coefficient of performance
COP
ratio of heating capacity to the effective power input of the equipment at any given set of rating conditions

Note 1 to entry: Expressed in units of watt per watt.

4 Symbols and abbreviated terms

Symbol	Definition	Units
c_p	Specific heat capacity at constant pressure	J/kg·K
C_{20}	Scaling factor equal to 0,49	—
E_{EI}	Energy efficiency index equal to 0,23	—
I_E	Motor efficiency	—
Φ_H	Heating capacity	W
Φ_C	Cooling capacity	W
P_{hyd}	Hydraulic power of the pump	W
q	Volume flow rate	m^3/s
τ	Time	s
ρ	Density of the hot water depending on the temperature at the flow meter	kg/m^3
Δh	Specific enthalpy change	J/kg
Δp_e	External static pressure difference	Pa
Δp_i	Internal static pressure difference	Pa
Δt	Difference between inlet and outlet temperatures	K
η	0,3 by convention	—

5 Installation requirements

5.1 Test apparatus and uncertainties of measurement

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

Water systems or other heat transfer liquid systems shall be sufficiently free of entrained gas as to ensure that the measured results are not significantly influenced.

The response time of the temperature sensor and the sampling interval shall be chosen to maintain the uncertainties in Table 1.

Ducted air systems shall be sufficiently airtight to ensure that the measured results are not significantly influenced by exchange of air with the surroundings.

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 meter, 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 completed by four sensors for checking uniformity if the surface area 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 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, the density and specific heat in Formulae (1) and (10) shall be determined in the temperature conditions measured near the volume flow measuring device.

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 instructions on 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.

The uncertainties of measurement shall not exceed the values specified in Table 1. Additionally, the heating and/or cooling capacities measured on the liquid side shall be determined within a maximum uncertainty of 5 % independently of the individual uncertainties of measurements including the uncertainties on the properties of the fluid.

Table 1 — Uncertainties of measurement

Measured quantity	Unit	Uncertainty
Liquid		
Temperature	°C	0,15 K
Temperature difference	K	0,15 K
Volume flow	m^3/s	1 %
Static pressure difference	kPa	1 kPa (≤20 kPa) 5 % (>20 kPa)
Concentration	%	2 %
Air		
Dry bulb temperature	°C	0,2 K
Wet bulb temperature	°C	0,4 K
Volume flow	m^3/s	5 %
Static pressure difference	Pa	5 Pa ($\Delta p \leq 100$ Pa) 5 % ($\Delta p \geq 100$ Pa)
Electrical quantities		
Electric power	W	1 %
Electrical energy	kWh	1 %
Voltage	V	0,5 %
Current	A	0,5 %

5.2 Test room for the airside and remote condenser

The size of the test room shall be selected to avoid any resistance to air flow at the air inlet and air outlet orifices of the test object. The air flow through the room shall not be capable of initiating any short circuit between the two orifices, and therefore the velocity of air flow at these two locations shall not exceed 1,5 m/s when the test object is switched off.

Unless otherwise stated by the manufacturer, the air inlet and air outlet orifices shall not be less than 1 m from the surfaces of the test room.

Any direct heat radiation (e.g. solar radiation) onto space heating and/or space cooling units in the test room onto the heat pump or onto the temperature measuring points shall be avoided.

5.3 Installation and connection of the heat pump

The heat pump shall be installed and connected for the test as recommended by the manufacturer in the installation and operation manual. If a supplementary heater is provided in option or not, it shall be switched off or disconnected to be excluded from the testing. Temperature and pressure measuring points shall be arranged in order to obtain representative mean values.

5.4 Installation of heat pumps consisting of several parts

In the case of heat pumps consisting of several refrigeration parts (split heat pumps), the following installation conditions shall be complied with for the tests:

a) each refrigerant line shall be installed in accordance with the manufacturer's instructions; the length of each line 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 lines shall be installed so that the difference in elevation does not exceed 2,5 m;

c) thermal insulation shall be applied to the lines in accordance with the manufacturer's instructions;

d) unless constrained by the design, at least half of the interconnecting lines shall be exposed to the outdoor conditions with the rest of the lines exposed to the indoor conditions.

6 Setting and test conditions

6.1 General

Set points for internal control equipment of the unit, i.e. thermostats, pressure switches or mixing valves, shall be set to the values as stated in the installation and operating instructions.

If several set points or a range are stated, the manufacturer shall indicate the one to be used for the tests.

6.2 Settings for non-ducted units

For non-ducted units, the adjustable settings, i.e. louvers and fan speed, shall be set according to the installations and operating instructions.

Without information from the manufacturer, louvers and fan speed shall be set for maximum air flow rate.

6.3 Setting the external static pressure difference for ducted units

The volume flow and the pressure difference shall be related to standard air and with dry heat exchanger. If the air flow rate is given by the manufacturer with no atmospheric pressure, temperature and humidity conditions, it shall be considered as given for standard air conditions.

The air flow rate as stated in the installation and operating instructions shall be converted into standard air conditions. The air flow rate setting shall be made when the fan only is operating.

The rated air flow rate as stated in the installation and operating instructions shall be set and the resulting external static pressure (ESP) measured.

If the ESP is lower than 30 Pa, the air flow rate is decreased to reach this minimum value. The apparatus used for setting the ESP shall be maintained in the same position during all the tests.

If the installation and operating instructions state that the maximum allowable duct length is for inlet and outlet together less than 2 m, then the unit shall be tested with the duct length and the ESP is considered to be 0.

6.4 Setting of units with integral pumps

For units with integral water pumps, the external static pressure shall be set at the same time as the temperature difference.

Deviations from set values shall not exceed values indicated in Table 2. Variations from specified conditions shall not exceed values indicated in Table 3.

Table 2 — Permissible deviations from set values for steady-state operation

Measured quantity	Permissible deviation of the arithmetic mean values from set values	Permissible deviations of 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[a]	±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)	±0,3 K	—
temperature difference[b]		
— 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 double. 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 1 K, the temperature difference is thus allowed to vary between 0,7 K and 1,3 K.

Table 3 — Permissible deviations from set values for transient operation

Readings	Permissible deviation of the arithmetic mean values from set values		Permissible deviations of individual measured values from set values	
	Interval H	Interval D	Interval H	Interval D
Air (entering outdoor-side)				
— dry-bulb temperature [a]	±0,6 K	±1,5 K	±1,0 K	±5,0 K
— wet-bulb temperature [a]	±0,4 K	±1,0 K	±1,0 K	—
— temperature difference (dry bulb-wet bulb)[d]	±0,6 K	—	—	—
Liquid				
— inlet temperature	±0,2 K [c]	—	±0,5 K [c]	[b]
— outlet 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 1 K, The temperature difference is thus allowed to vary between 0,4 K and 1,6 K.

6.5 Test conditions

The space heating and/or space cooling tests shall be carried out under the environmental conditions specified in Table 4 depending on the location of the unit. For all units, electrical power voltage and frequency shall be given by the manufacturer.

For the rating heating tests, the appropriate test conditions shall be applied in accordance with Tables 5, 6 and 7.

For the rating cooling tests, the appropriate test conditions shall be applied in accordance with Tables 8 and 9.

Table 4 — Environmental conditions

Type	Measured quantities	Environmental temperature
Air to water units installed indoors	Dry bulb temperature	15 °C to 30 °C
Air to water units installed outdoors (Heating conditions)	Dry bulb temperature Wet bulb temperature	Air inlet temperatures (see Tables 5, 6 and 7)
Air to water units installed outdoors (Cooling conditions)	Dry bulb temperature Wet bulb temperature	Air inlet temperatures (see Tables 8 and 9)

Table 5 — Test conditions for air to water units: heating mode (35 °C application [b])

	Outdoor heat exchanger		Indoor heat exchanger Low temperature applications	
	Inlet dry bulb temperature °C	Inlet wet bulb temperature °C	Inlet temperature °C	Outlet temperature °C
Standard rating conditions	7	6	30	35
Application Rating conditions	2	1	[a]	35
	−7	−8	[a]	35
	−15	—	[a]	35
	12	11	[a]	35

[a] The test is performed at the fixed flow rate or the Δt obtained during the test at the corresponding standard rating conditions for units with variable flow rate. If the resulting flow rate is below the minimum flow rate, then this minimum is used with the outlet temperatures. If the resulting flow rate is above the maximum flow, then this maximum is used with the outlet temperature.

[b] Temperature 35 °C application means the indoor heat exchanger water outlet temperature of 35 °C meets the design temperature

Table 6 — Test conditions for air to water units: heating mode (45 °C application [b])

	Outdoor heat exchanger		Indoor heat exchanger Medium temperature applications	
	Inlet dry bulb temperature °C	Inlet wet bulb temperature °C	Inlet temperature °C	Outlet temperature °C
Standard rating conditions	7	6	40	45
Application Rating conditions	2	1	[a]	45
	−7	−8	[a]	45
	−15	—	[a]	45
	12	11	[a]	45

[a] The test is performed at the fixed flow rate or the *Δt* obtained during the test at the corresponding standard rating conditions for units with variable flow rate. If the resulting flow rate is below the minimum flow rate, then this minimum is used with the outlet temperatures. If the resulting flow rate is above the maximum flow, then this maximum is used with the outlet temperature.

[b] Temperature 45 °C application means the indoor heat exchanger water outlet temperature of 45 °C meets the design temperature.

Table 7 — Test conditions for air to water units: heating mode (55 °C application [b])

	Outdoor heat exchanger		Indoor heat exchanger High temperature applications	
	Inlet dry bulb temperature °C	Inlet wet bulb temperature °C	Inlet temperature °C	Outlet temperature °C
Standard rating conditions	7	6	47	55
Application Rating conditions	2	1	[a]	55
	−7	−8	[a]	55
	−15	—	[a]	55
	12	11	[a]	55

[a] The test is performed at the fixed flow rate or the *Δt* obtained during the test at the corresponding standard rating conditions for units with variable flow rate. If the resulting flow rate is below the minimum flow rate, then this minimum is used with the outlet temperatures. If the resulting flow rate is above the maximum flow, then this maximum is used with the outlet temperature.

[b] Temperature 55 °C application means the indoor heat exchanger water outlet temperature of 55 °C meets the design temperature.

Table 8 — Test conditions for air to water units: cooling mode (7 °C application [b])

	Outdoor heat exchanger		Indoor heat exchanger Low temperature applications	
	Inlet dry bulb temperature °C	Inlet wet bulb temperature °C	Inlet temperature °C	Outlet temperature °C
Standard rating conditions	35	-	12	7
Application Rating conditions	27	-	[a]	7
	46	-	[a]	7

[a] The test is performed at the fixed flow rate or the Δt obtained during the test at the corresponding standard rating conditions for units with variable flow rate. If the resulting flow rate is below the minimum flow rate, then this minimum is used with the outlet temperatures. If the resulting flow rate is above the maximum flow, then this maximum is used with the outlet temperature.

[b] Temperature 7 °C application means the indoor heat exchanger water outlet temperature of 7 °C meets the design temperature.

Table 9 — Test conditions for air to water units: cooling mode (18 °C application [b])

	Outdoor heat exchanger		Indoor heat exchanger Low temperature applications	
	Inlet dry bulb temperature °C	Inlet wet bulb temperature °C	Inlet temperature °C	Outlet temperature °C
Standard rating conditions	35	-	23	18
Application Rating conditions	27	-	[a]	18

[a] The test is performed at the fixed flow rate or the Δt obtained during the test at the corresponding standard rating conditions for units with variable flow rate. If the resulting flow rate is below the minimum flow rate, then this minimum is used with the outlet temperatures. If the resulting flow rate is above the maximum flow, then this maximum is used with the outlet temperature.

[b] Temperature 18 °C application means the indoor heat exchanger water outlet temperature of 18 °C meets the design temperature.

7 Space heating test

7.1 Heating capacity test

The heating capacity of heat pumps shall be determined in accordance with the direct method at the water heat exchanger at test conditions of Tables 5, 6 and 7, by determination of the volume flow of the heat transfer medium, and the inlet and outlet temperatures, taking into consideration the specific heat capacity and density of the heat transfer medium. The measured heating capacity shall be corrected for the heat from the indoor liquid pump as specified in 7.2. The heating capacity test for steady state operation is referred in 7.5.1. The heating capacity for transient operation is referred in 7.5.2.

For steady state operation, the heating capacity shall be determined using Formula (1):

$$\Phi_H = q \times \rho \times c_p \times \Delta t \quad (1)$$

where

Φ_H is the heating capacity in W;

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

ρ is the density, measured at the flow meter location, expressed in kg/m^3;

c_p is the specific heat, measured at the flow meter location, at constant pressure, expressed in J/(kg·K);

Δt is the difference between inlet and outlet temperatures, expressed in K;

NOTE 1 The mass flow rate can be determined directly instead of the term ($q \times \rho$).

NOTE 2 The enthalpy change Δh can be directly measured instead of the item ($c_p \times \Delta t$).

7.2 Heating capacity correction

7.2.1 General

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

7.2.2 Capacity correction due to indoor liquid pump

7.2.2.1 Units with integrated liquid pump

If the liquid pump is an integrated part of the unit, the capacity correction as defined in 7.2.3 or 7.2.4 shall be:

— subtracted from the measured heating capacity.

7.2.2.2 Units with non-integrated liquid pump

If the liquid pump is not an integral part of the unit, the capacity correction as defined in 7.2.5 shall be:

— added to the measured heating capacity.

7.2.3 Capacity correction for integrated glandless circulators

If the unit is equipped with a glandless circulator, the capacity correction is calculated using Formula (2):

$$(q \times \Delta p_e) \times \left[\frac{(1-\eta)}{\eta} \right] \quad (2)$$

where

η is the global efficiency of the pump calculated according to Annex B;

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

q is the measured liquid flow rate, in m^3/s.

7.2.4 Capacity correction for integrated dry motor pumps

If the unit is equipped with a dry-motor pump, the capacity correction shall be calculated using Formula (3):

$$(q \times \Delta p_e) \times \left[\frac{(I_E - \eta)}{\eta} \right] \quad (3)$$

where

η is the global efficiency of the pump calculated according to Annex B;

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

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

I_E is the motor efficiency as specified in IEC 60034-30-1.

7.2.5 Capacity correction for non-integrated liquid pumps

If the measured hydraulic power according to Annex B is ≤300 W, the liquid pump is considered as a glandless circulator. The capacity correction is calculated using Formula (4):

$$[q\times(-\Delta p_i)]\times\left[\frac{(1-\eta)}{\eta}\right] \quad (4)$$

where

η is the global efficiency of the pump calculated according to Annex B;

Δp_i is the measured internal static pressure difference, in Pa;

q is the measured liquid flow rate, in m^3/s.

If the measured hydraulic power according to Annex B is >300 W, the liquid pump is considered as a dry-motor pump. The capacity correction is calculated using Formula (5):

$$[q\times(-\Delta p_i)]\times\left[\frac{(I_E-\eta)}{\eta}\right] \quad (5)$$

where

η is the global efficiency of the pump calculated according to Annex B;

Δp_i is the measured internal static pressure difference, in Pa;

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

I_E is equal to 0,88 (average motor nominal efficiency for IE3 efficiency in IEC 60034-30-1).

7.3 Effective power input

7.3.1 General

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

7.3.2 Power input correction of fans for units without duct connection

In the case of units which are not designed for duct connection, i.e. which do not permit any external pressure differences, 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.

7.3.3 Power input correction of fans for units with duct connection

7.3.3.1 Power input correction for 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 shall be calculated using Formula (6):

$$\frac{(q \times \Delta p_e)}{\eta} \tag{6}$$

where

- η is 0,3 by convention;
- Δp_e is the measured available external static pressure difference, in Pa;
- q is the nominal air flow rate, in m^3/s.

7.3.3.2 Power input correction for 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 shall be calculated using the Formula (7):

$$\frac{[q \times (-\Delta p_i)]}{\eta} \tag{7}$$

where

- η is 0,3 by convention;
- Δp_i is the measured available internal static pressure difference, in Pa;
- q is the nominal air flow rate, in m^3/s.

7.3.4 Power input correction of liquid pumps

7.3.4.1 Power input correction for 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 shall be calculated using Formula (8):

$$\frac{(q \times \Delta p_e)}{\eta} \tag{8}$$

where

- η is the efficiency of the pump calculated according to Annex B;
- Δp_e is the measured available external static pressure difference, in Pa;
- q is the measured liquid flow rate, in m^3/s.

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 7.3.4.2.

7.3.4.2 Power input correction for 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 shall be calculated using Formula (9):

$$\frac{[q \times (-\Delta p_i)]}{\eta} \tag{9}$$

where

η	is the efficiency of the pump calculated according to Annex B;
Δp_i	is the measured available internal static pressure difference, in Pa;
q	is the measured liquid flow rate, in m^3/s.

7.4 Test procedure

The test procedure consists of three periods: a preconditioning period, an equilibrium period and a data collection period. The duration of the data collection period differs depending on whether the heat pump's operation is steady-state or transient. The heating capacity test procedure shall be carried out as described in Annex A.

7.5 Heating capacity calculation

7.5.1 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.

7.5.2 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.

7.6 Effective power input calculation

7.6.1 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 capacity calculation.

7.6.2 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.

7.6.3 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.

8 Space cooling test

8.1 Cooling capacity test

The cooling capacity of heat pumps shall be determined in accordance with the direct method at the water heat exchanger at test conditions of Table 8 and 9 by determination of the volume flow of the heat transfer medium, and the inlet and outlet temperatures, taking into consideration the specific heat capacity and density of the heat transfer medium.

For steady state operation, the cooling capacity shall be determined using Formula (10):

$$\Phi_C = q \times \rho \times c_p \times \Delta t \tag{10}$$

where

Φ_C is the cooling capacity in W;

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

ρ is the density, measured at the flow meter location, expressed in kg/m^3;

c_p is the specific heat, measured at the flow meter location, at constant pressure, expressed in J/(kg·K);

Δt is the difference between inlet and outlet temperatures, expressed in K.

NOTE 1 The mass flow rate can be determined directly instead of the term ($q \times \rho$).

NOTE 2 The enthalpy change Δh can be directly measured instead of the item ($c_p \times \Delta t$).

8.2 Cooling capacity correction

8.2.1 General

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

8.2.2 Capacity correction due to indoor liquid pump

8.2.2.1 Units with integrated liquid pump

If the liquid pump is an integrated part of the unit, the capacity correction as defined in 8.2.3 or 8.2.4 shall be:

— added to the measured cooling capacity.

8.2.2.2 Units with non-integrated liquid pump

If the liquid pump is not an integral part of the unit, the capacity correction as defined in 8.2.5 shall be:

— subtracted from the measured cooling capacity.

8.2.3 Capacity correction for integrated glandless circulators

If the unit is equipped with a glandless circulator, the capacity correction is calculated using Formula (11):

$$(q \times \Delta p_e) \times \left[\frac{(1-\eta)}{\eta} \right] \tag{11}$$

where

η is the global efficiency of the pump calculated according to Annex B;

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

q is the measured liquid flow rate, in m^3/s.

8.2.4 Capacity correction for integrated dry motor pumps

If the unit is equipped with a dry-motor pump, the capacity correction shall be calculated using Formula (12):

$$(q \times \Delta p_e) \times \left[\frac{(I_E-\eta)}{\eta} \right] \tag{12}$$

where

η is the global efficiency of the pump calculated according to Annex B;

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

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

I_E is the motor efficiency as specified in IEC 60034-30-1.

8.2.5 Capacity correction for non-integrated liquid pumps

If the measured hydraulic power according to Annex B is ≤300 W, the liquid pump is considered as a glandless circulator. The capacity correction is calculated using Formula (13):

$$[q \times (-\Delta p_i)] \times \left[\frac{(1-\eta)}{\eta} \right] \tag{13}$$

where

η is the global efficiency of the pump calculated according to Annex B;

Δp_i is the measured internal static pressure difference, in Pa;

q is the measured liquid flow rate, in m^3/s.

If the measured hydraulic power according to Annex B is >300 W, the liquid pump is considered as a dry-motor pump. The capacity correction is calculated using Formula (14):

$$[q \times (-\Delta p_i)] \times \left[\frac{(I_E-\eta)}{\eta} \right] \tag{14}$$

where

η is the global efficiency of the pump calculated according to Annex B;

Δp_i is the measured internal static pressure difference, in Pa;

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

I_E is equal to 0,88 (average motor nominal efficiency for IE3 efficiency in IEC 60034-30-1).

8.3 Effective power input

8.3.1 General

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

8.3.2 Power input correction of liquid pumps

8.3.2.1 Power input correction for 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 shall be calculated using Formula (15):

$$\frac{(q \times \Delta p_e)}{\eta} \qquad (15)$$

where

η is the efficiency of the pump calculated according to Annex B;

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

q is the measured liquid flow rate, in m^3/s.

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 8.3.2.2.

8.3.2.2 Power input correction for 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 shall be calculated using Formula (16):

$$\frac{[q \times (-\Delta p_i)]}{\eta} \qquad (16)$$

where

η is the efficiency of the pump calculated according to Annex B;

Δp_i is the measured available internal static pressure difference, in Pa;

q is the measured liquid flow rate, in m^3/s.

8.4 Test procedure

8.4.1 Steady-state conditions

This condition is considered obtained and maintained when all the measured quantities remain constant without having to alter the set values, for a minimum duration of 1 h, with respect to the tolerances given in Table 2. 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 2.

8.4.2 Measurement of cooling capacity

The measurement period starts after the steady-state conditions have been achieved according to 8.4.1.

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 to measured at least once every 30 s. The output shall be measured in the steady-state condition. The duration of measurement shall not be less than 35 min.

8.5 Cooling capacity calculation

An average cooling capacity shall be determined from the set of cooling 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.

8.6 Effective power input calculation

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 cooling capacity calculation.

9 Test results and test report

9.1 Data to be recorded

The data to be recorded for the heating and cooling capacity tests is indicated in Table 10. This 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 10 — Data to be recorded

Measured quantity of result	Unit	Water enthalpy method Non ducted	Water enthalpy method Ducted
Ambient conditions			
Air temperature, dry bulb	°C	x	x
Atmospheric pressure	kPa	x	x
Electrical quantities			
Voltage	V	x	x
Total current	A	x	x
Total power input, P_T	W	x	x
Effective power input, P_E	W	x	x
Thermodynamic quantities			
a) Water			
inlet temperature	°C	x	x

Table 10 *(continued)*

Measured quantity of result	Unit	Water enthalpy method Non ducted	Water enthalpy method Ducted
outlet temperature	°C	x	x
volume flow	m^3/s	x	x
pressure difference	kPa	x	x
b) Air source heat exchanger			
Air			
inlet temperature, dry bulb	°C	x	x
inlet temperature, wet bulb	°C	x	x
For duct connection			
external/internal static pressure difference	Pa		x
volume flow rate, *q*	m^3/s		x
c) Compressor			
rotational speed of open type	min^{-1}	x	x
power input of motor	W	x	x
d) Defrost			
defrost period	s	x	x
Operating cycle with defrost	min	x	x
Data collection period	min	x	x
Heating Capacities	W	x	x
Cooling Capacities	W	x	x

9.2 Test report

The test report shall at least contain:

a) date;

b) test institute;

c) test location;

d) test method (e.g. international standard used, test procedure and so on);

e) test supervisor;

f) test conditions;

g) testing data (e.g. data recorded, heating capacity, cooling capacity, effective power of given test conditions, COP, EER, any unusual features observed and so on);

h) test information:

1) type;

2) serial number;

3) name of the manufacturer and so on;

i) type of refrigerant;

j) mass of refrigerant;

k) properties of fluids.

Annex A
(normative)

Heating capacity test procedures

A.1 General

A.1.1 Preconditioning period

The test room reconditioning apparatus and the heat pump under test shall be operated until the test tolerances specified in Table 2 are attained for at least 10 min. A defrost cycle may end a preconditioning period. If a defrost cycle does end a preconditioning period, the heat pump shall operate in the heating mode for at least 10 min after defrost termination prior to beginning the equilibrium period.

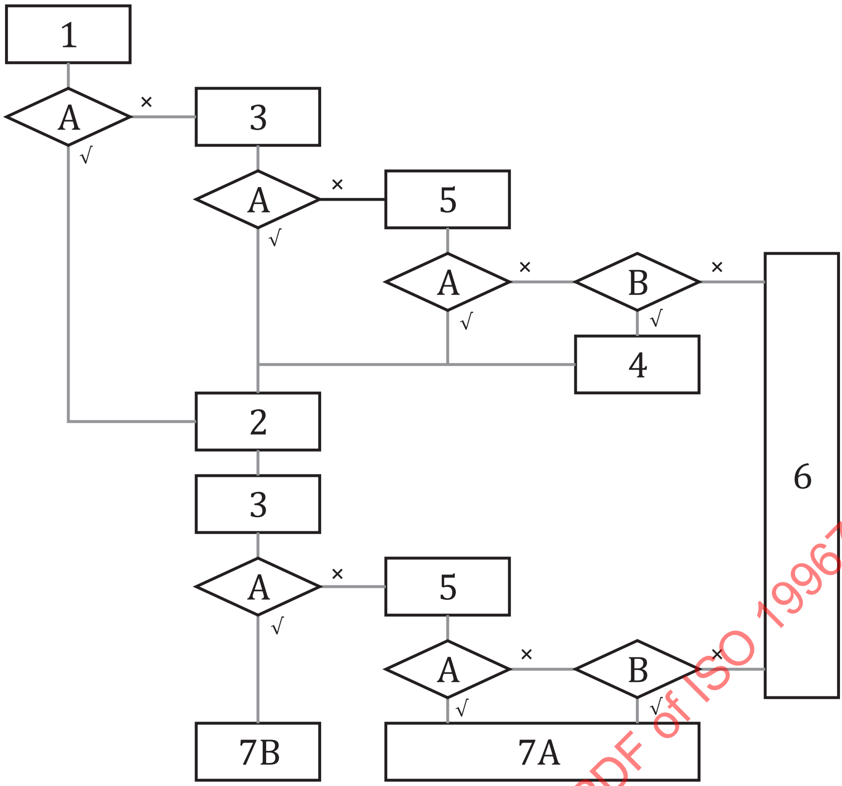
A.1.2 Equilibrium period

A complete equilibrium period is 1 h in duration. Except as specified in transient test, the heat pump shall operate while meeting the test tolerances in Table 2.

A.1.3 Data collection period

The data collection period immediately follows the equilibrium period. Data shall be collected as specified for the test method(s).

An integrating electrical power (Wh) meter or measuring system shall be used for measuring the electrical energy supplied to the equipment. During defrost cycles and for the first 10 min following a defrost termination, the meter or measuring system shall have the sampling rate for data collection of at least every 10 s.



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 excood 2,5 %?	6	step 6: steady-state operation
1	step 1: preconditioning	7	step 7: transient operation
2	step 2: end of defrost cycle		

Figure A.1 — Flowchart of steps procedure on heating capacity test.

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 The following are 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.

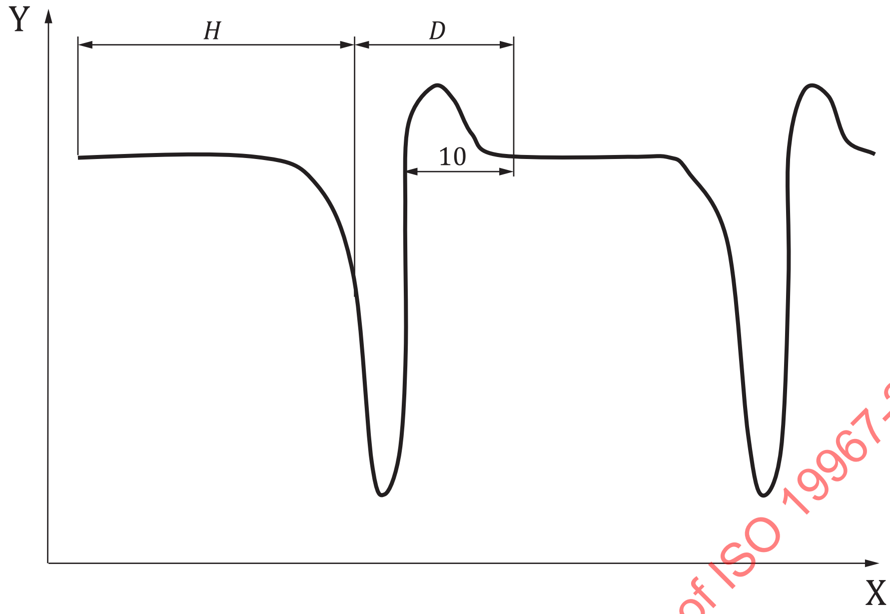
NOTE 2 The following are examples of modified operation which define the end of a defrost cycle:

— 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 A.2).



Key

X time, in min

Y water temperature, in °C

Figure A.2 — 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.

The test procedure is described by the flowchart in Figure A.1. 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 2 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.

A.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 2 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.

A.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 3 apply.

A.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 2. If a defrost occurs during this period, the permissible deviations specified in Table 3 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.

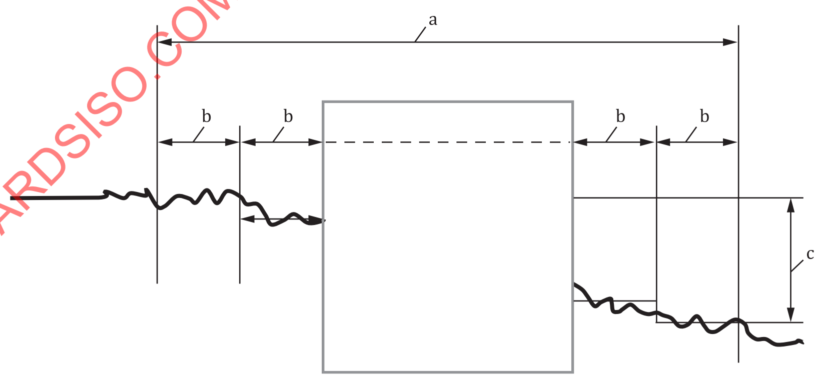
— If Step 3 does not end with a defrost cycle, go to Step 5.

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.

A.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.

A.6 Step 5: Data collection



a 70 min.

b 5 min.

c %ΔT.

Figure A.3 — Data collection

Data shall be collected for a duration of 70 min (Figure A.3).