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Heat pump water heaters — Testing and rating for performance —

Part 2: Heat pump water heaters for space heating

Chauffe-eau à pompe à chaleur — Essais et classification des performances —

Partie 2: Chauffe-eau à pompe à chaleur pour le chauffage des locaux

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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 documents 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*.

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.

Heat pump water heaters — Testing and rating for performance —

Part 2: Heat pump water heaters for space heating

1 Scope

This document specifies test conditions and test procedures for determining the performance characteristics of air source heat pump water heaters for space heating with electrically driven compressors with or without supplementary heater. The purpose of this document is to rate the performance of the heat pump water heaters for space heating with no operation of any supplementary heater. In the case of heat pump water heaters for space heating consisting of several parts with refrigerant or water connections, this document applies only to those designed and supplied as a complete package.

NOTE Testing procedures for simultaneous operation for hot water supply and space heating are not treated in this document. Simultaneous means that hot water supply and space heating 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 terminological databases for use in standardization at the following addresses:

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

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

3.1
heat pump water heater for space heating
heat pump
air source heat pump water heater with electrically driven compressors with or without supplementary heater for space heating purposes

3.2
heating capacity
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.

Note 2 to entry: If heat is removed by the indoor heat exchanger for defrosting, it is taken into account.

3.3
standard heating capacity
rated heating capacity under standard rating conditions as defined in Tables 5, 6 and 7

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 air
air from the outdoor environment

3.6
operating range
working range for the heat pump as specified by the manufacturer

3.7
outdoor heat exchanger
heat exchanger which is designed to remove heat from the outdoor ambient environment, or any other available heat source, or to transfer heat to it

4 Symbols and abbreviated terms

Symbol	Definition	Units
C_p	Specific heat capacity of water	kJ/(kg*K)
C_{20}	A scaling factor equal to 0,49	—
EEI	The Energy Efficiency Index equal to 0,23	—
IE	The motor efficiency level	—
P_H	Heating capacity	W
P_{hyd}	The hydraulic power of the pump	W
q	Volume flow rate	m^3/s
t	Time	s
ρ	Density of the hot water depending on the temperature at the flow meter	kg/m^3
Δp_e	The measured available external static pressure difference	Pa
Δp_i	The measured 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 inlet and outlet water temperatures of the heat pump are measured in the centre of the flow and as close as possible to the unit. 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.

When performing measurements, set the highest 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.

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

For free air intake temperature measurements, it is required either:

— to have at least one sensor per square meter, 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 temperature sensors shall be placed at a maximum distance of 0,25 m from the free air surface.

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 and specific heat in Formulae (1), (2) and (3) 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 heat capacity 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	l/min	±1 %
Static pressure difference	kPa	±1 kPa (≤20 kPa) ±5 % (>20 kPa)
Concentration (for brine)	%	2 %
Air		
Dry bulb temperature	°C	±0,2 K
Wet bulb temperature	°C	±0,4 K
Volume flow	m^3/h	±5 %
Static pressure difference	Pa	±5 Pa (ΔP ≤ 100 Pa) ±5 % (ΔP ≥ 100 Pa)

Table 1 *(continued)*

Measured quantity	Unit	Uncertainty
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 heating 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 back-up 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 between 5 m and 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 or brine pumps, the external static pressure shall be set at the same time as the temperature difference.

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

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

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

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 flow[a]	±1 %	±2,5 %
— static pressure difference	—	±10 %
Air		
— inlet temperature		
— dry bulb	±0,3 K	±1 K
— wet bulb	±0,4 K	±1 K
— volume flow	±5 %	±10 %
— static pressure difference	—	±10 %
Voltage	±4 %	±4 %

[a] Frosting period excluded.

Table 3 — Variations allowed for the test conditions when the heat pump is running

Readings	Variations of arithmetical mean values from specified test conditions		Variation of individual readings from specified test conditions	
	Interval H[a]	Interval D[b]	Interval H[a]	Interval D[b]
Air				
— dry-bulb temperature[c]	±0,6 K	±1,5 K	±1,0 K	±5,0 K
— wet-bulb temperature	±0,4 K	±1,0 K	±0,6 K	—
Liquid				
— inlet temperature	±0,2 K	—	±0,5 K	-5 K
— outlet temperature	±0,5 K	—	±1 K	+2 K

[a] Interval H applies when the heat pump is in the heating mode, except for the first 10 min after termination of a defrost cycle, and the first 10 min after a restart of the heat pump.

[b] Interval D applies during a defrost cycle and during the first 10 min after the termination of a defrost cycle when the heat pump is operating in the heating mode.

[c] For units with outdoor heat exchanger surfaces greater than 5 m^2, the deviation on the air inlet dry bulb temperature is doubled.

6.5 Test conditions

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

The airflow rate shall be set to nominal, as indicated by the manufacturer. When only a range is given, tests are to be carried out at the maximum value.

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	Dry bulb temperature Wet bulb temperature	Air inlet temperatures (see Tables 5 6 and 7)

Table 5 — Test conditions for space heating (Low temperature)

	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 flow rate obtained during the test at the standard rating conditions.

Table 6 — Test conditions for space heating (Medium temperature)

	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 flow rate obtained during the test at the standard rating conditions.

Table 7 — Test conditions for space heating (High temperature)

	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 flow rate obtained during the test at the standard rating conditions.

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 or brine 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.

For steady state operation, the heating capacity shall be determined using the following formula:

$$P_{\mathrm{H}} = q \times \rho \times C_{\mathrm{p}} \times \Delta t \qquad (1)$$

where

P_H is the heating capacity in watts;

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

ρ is the density, measured at the flow meter location, expressed in kilograms per cubic meter;

C_p is the specific heat, measured at the flow meter location, at constant pressure, expressed in joules per kilogram and kelvin;

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

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 and/or outdoor fans and/or pumps, integrated into the unit or not as follows.

7.2.2 Capacity 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 difference, and which are equipped with an integral fan, no capacity correction due to heat provide by the fan shall apply.

7.2.3 Capacity correction due to indoor fan for ducted units

7.2.3.1 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 (6) (see 7.2.5.3.1) shall be:

— subtracted from the measured heating capacity.

7.2.3.2 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 (7) (see 7.2.5.3.2) shall be:

— added to the measured heating capacity.

7.2.4 Capacity correction due to indoor liquid pump

7.2.4.1 Units with integrated liquid pump

If the liquid pump is an integrated part of the unit, the capacity correction as defined in 7.2.4.3 or 7.2.4.4 shall be:

— subtracted from the measured heating capacity.

7.2.4.2 Units with non-integrated liquid pump

If the liquid pump is not an integral part of the unit, the capacity correction as defined in 7.2.4.5 shall be:

— added to the measured heating capacity.

7.2.4.3 Capacity correction for integrated glandless circulators

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

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

where

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

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

q is the measured liquid flow rate, in cubic meters per second.

7.2.4.4 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):

$$(q \times \Delta p_\mathrm{e}) \times \left[\frac{(\mathrm{IE}-\eta)}{\eta} \right] \tag{3}$$

where

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

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

q is the measured liquid flow rate, in cubic meters per second;

IE is the motor efficiency level.

7.2.4.5 Capacity correction for non-integrated liquid pumps

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

$$\left[q \times (-\Delta p_\mathrm{i}) \right] \times \left[\frac{(1-\eta)}{\eta} \right] \tag{4}$$

where

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

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

q is the measured liquid flow rate, in cubic meters per second.

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

$$\left[q \times (-\Delta p_\mathrm{i}) \right] \times \left[\frac{(\mathrm{IE}-\eta)}{\eta} \right] \tag{5}$$

where

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

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

q is the measured liquid flow rate, in cubic meters per second;

IE is equal to 0,88 (the average the motor efficiency level for IE3 efficiency level).

7.2.5 Effective power input

7.2.5.1 General

The effective power input shall include the correction due to power input of indoor and/or outdoor fans and/or pumps, integrated or no to the unit as follows.

7.2.5.2 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.

7.2.5.3 Power input correction of fans for units with duct connection

7.2.5.3.1 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):

$$\frac{(q \times \Delta p_{\mathrm{e}})}{\eta} \tag{6}$$

where

η is 0,3 by convention;

Δp_{e} is the measured available external static pressure difference, in Pascals;

q is the nominal air flow rate, in cubic meters per second.

7.2.5.3.2 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):

$$\frac{(q \times -\Delta p_{\mathrm{i}})}{\eta} \tag{7}$$

where

η is 0,3 by convention;

Δp_{i} is the measured available internal static pressure difference, in Pascals;

q is the nominal air flow rate, in cubic meters per second.

7.2.5.4 Power input correction of liquid pumps

7.2.5.4.1 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):

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

where

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

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

q is the measured liquid flow rate, in cubic meters per second.

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 7.2.5.3.2.

7.2.5.4.2 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):

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

where

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

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

q is the measured liquid flow rate, in cubic meters per second.

7.3 Test procedure

7.3.1 General

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

7.3.2 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.

7.3.3 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.

7.3.4 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 (watt-hour) 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 a sampling rate of at least every.

7.4 Heating capacity calculation

7.4.1 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.

7.4.2 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.

7.5 Effective power input calculation

7.5.1 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.

7.5.2 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.

7.5.3 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 Test results and test report

8.1 Data to be recorded

The data to be recorded for the heating capacity tests are given in Table 8. 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 8 — Data to be recorded

Measured quantity of result	Unit	Water enthalpy method Nonducted	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 or brine			
inlet temperature	°C	x	x
outlet temperature	°C	x	x
volume flow	m³/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	m³/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

8.2 Test report

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.

9 Marking

Each heat pump shall have a durable, permanently fixed marking that is easily readable when the unit is in position for use, bearing at least the information required by safety standards. If the heat pump consists of several parts, the information shall be marked on each of these parts together with the model designation of the complementary parts.

Annex A
(informative)

Maximum and minimum operation

A.1 General

The test shall be conducted with the equipment functioning at full-load operation. The safety protection components should not start operating and cause the heat pump water heater to stop running.

A.2 Maximum operation

A.2.1 General

During the entire test process, there should be no damage for any part of the heat pump water heater. The heat pump water heater should also be able to operate normally.

A.2.2 One-time heating heat pump water heater

At the rated frequency, adjust the test voltages respectively to 90 % and 110 % of the rated voltage. Start operation for the heat pump water heater under the maximum operating conditions stipulated in Table A.1. After achieving stabilization, operate it continuously for 30 min. Stop the machine for 3 min (at this point, the voltage rise should not exceed 3 %) and then restart operation for 30 min.

A.2.3 Circulated heating heat pump water heater and static heating

At the rated frequency, adjust the test voltages respectively to 90 % and 110 % of the rated voltage. Start operation for the heat pump water heater under the maximum operating conditions stipulated in Table A.1 until the outlet water temperature reaches the set value (at this point, the voltage rise should not exceed 3 %). Stop the machine and discharge the water at a flow equivalent to the hot water production capacity. At the same time, inject the same flow of cold water at 29 °C until the heat pump starts operating again. At this point, stop the water discharge and water injection. Cause the heat pump water heater to continue operating until the set temperature. After that, stop the machine.

A.3 Minimum operation

A.3.1 One-time heating minimum operation test

Operate the heat pump water heater under the minimum operating conditions stipulated in Table A.1 until the operating conditions stabilize. After that, operate for another 4 h.

A.3.2 Circulated heating minimum operation test

Connect the self-equipped standard water tank of the heat pump water heater or the external water tank (it is required for this external water tank to be of the same volume as the water tank for the hot water heating capacity test). Under the minimum operating conditions stipulated in Table A.1, start the machine and operate it until the heat pump water heater reaches the highest set temperature. Stop the machine after that.

A.3.3 Static heating minimum operation test

Connect the self-equipped standard water tank (water tank of largest volume) of the heat pump water heater. Under the minimum operating conditions stipulated in Table A.1, start the machine and operate it until the heat pump water heater reaches the highest set temperature. Stop the machine after that.

Table A.1 — Test operating conditions for air source heat pump water heater

Item	Water side		Air side	
	Inlet water Temperature/°C	Outlet water Temperature/°C	Dry bulb Temperature/°C	Wet bulb Temperature/°C
Maximum operating conditions	29	55	43	26
Minimum operating conditions	9	55	7	6
NOTE Maintain the same water flow rate.				

Annex B
(normative)

Heating capacity test procedures given in 7.2 and 7.3

B.1 General

The test procedure shall identify whether the unit will operate in steady state conditions or in transient regime due to defrost cycles that may occur depending on the operating conditions.

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

The test procedure is described by the following flowchart (See Figure B.1). The different steps of the procedure are explained in the following subclauses. The steps of the flowchart shall immediately follow each other.

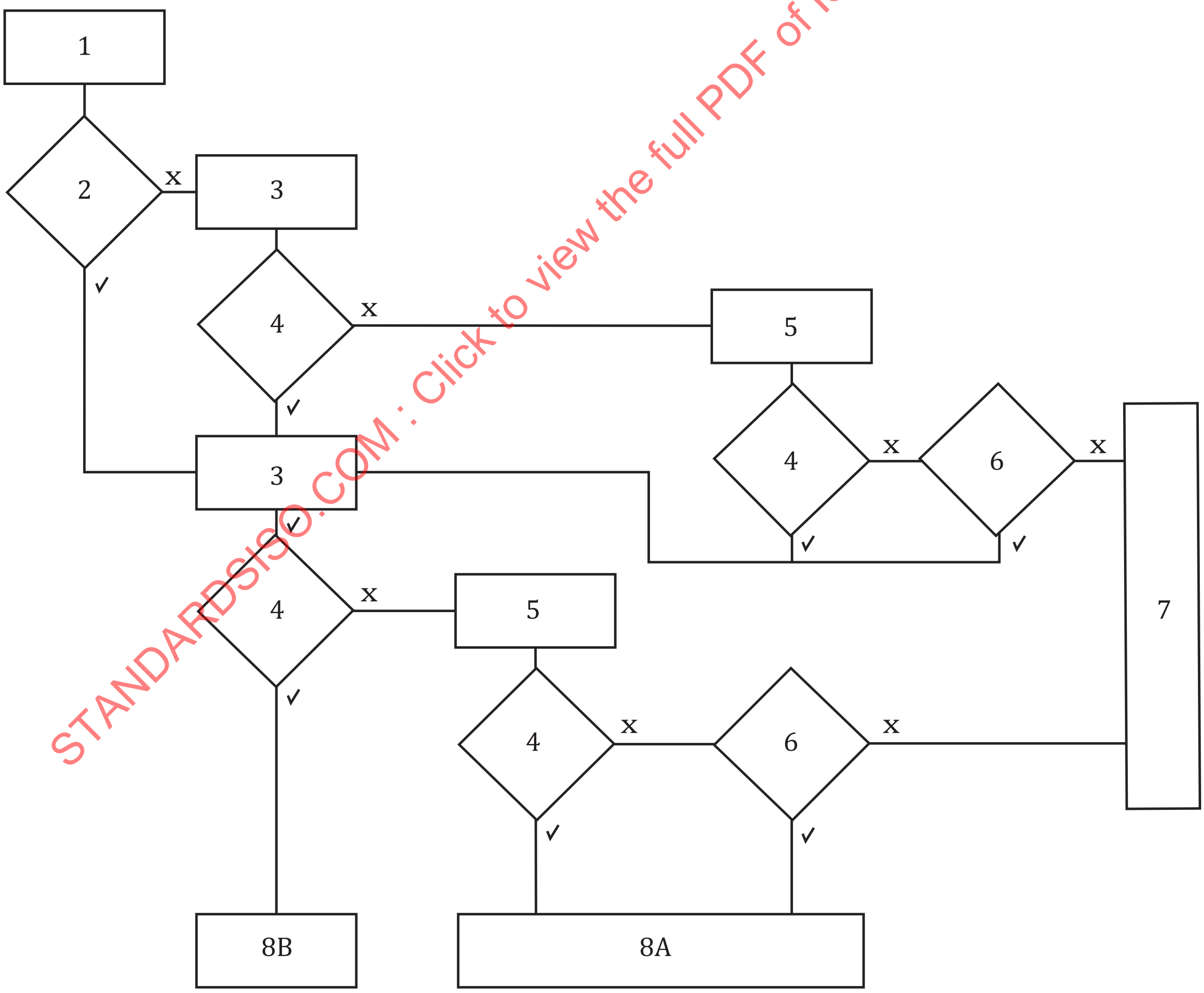

Figure B.1 — Flowchart of steps procedure

B.2 Step 1: Preconditioning

The test room reconditioning apparatus and the heat pump water heater under test shall start and operate until the test tolerances 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 when testing at any rating conditions for outdoor air stated in Tables 3, 4, 5, 6 and 7.

For heat pump water heater units having defrost cycles at the standard rating condition, the water flow rate shall be set at the corresponding time averaged inlet/outlet water temperatures measured on a 5-min period starting 20 min after the end of a defrost cycle, manually or automatically induced.

B.3 Step 2: Forced defrost cycle

It is recommended to terminate Step 1 with a manually or automatically induced defrost cycle, so that the procedure can continue with no or very small influence on the unit of the way the operating conditions were achieved.

Step 2 checks whether the recommendation has been followed or not to decide the next step of the flowchart.

B.4 Step 3: Equilibrium period

During an equilibrium period of one hour, the heat pump water heater shall operate, while meeting the test tolerances specified in Table 2, except if a defrost occurs during this period in which case the test tolerances specified in Table 3 apply.

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.

B.5 Step 4: Defrost cycle

It is checked whether the unit operated a defrost cycle during the previous step (Step 3 or Step 5).

B.6 Step 5: Data collection

Data shall be sampled at equal intervals that span every 30 s or less, except during defrost cycles as specified below, for a duration of 70 min.

During defrost cycles, plus the first 10 min following defrost termination, data used in evaluating the integrated heating capacity and the integrated power input of the heat pump water heater 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 pump water heaters 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 difference between the leaving and entering temperatures of the heat transfer medium at the indoor heat exchanger shall be measured during the data collection period (Step 5). 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, ΔT_i (t = 0), shall be saved for the purpose of calculating the following percent change:

$$\%\Delta T = \frac{\Delta T_i(\tau = 0) - \Delta T_i(\tau)}{\Delta T_i(\tau = 0)} \qquad \text{(B.1)}$$

The following Figure B.2 illustrates the temperature decrease during Step 5 and the calculation of %ΔT.

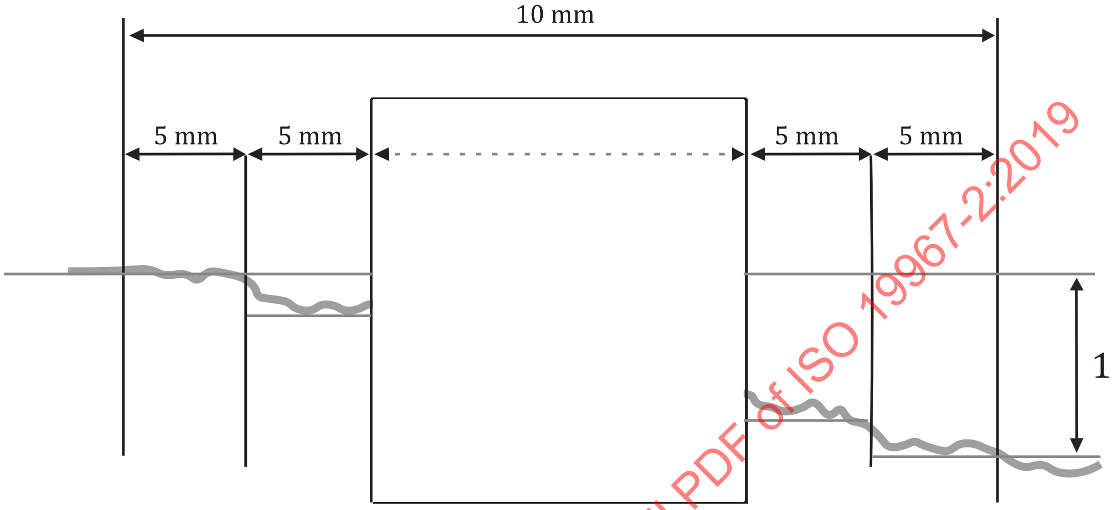

Figure B.2 — Data collection

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.

B.7 Step 6: Variation of %ΔT

If the quantity %ΔT does not exceed 2,5 % and the test tolerances specified in Table 2 are satisfied during the data collection period (Step 5), then the heat capacity test shall be designated a steady-state test (Step 7).

If at any time during Step 5, the quantity %ΔT exceeds 2,5 % then the test shall directly continue with the next step of the flowchart.

B.8 Step 7: Steady state operation

The test is considered to be steady state and shall be terminated after the data collection (Step 5) during which test tolerances specified in Table 2 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 2.

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

B.9 Step 8: Transient operation

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

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 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 initial state.

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 is larger than 0,2 K.

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

As noted in Table 3, the test tolerances are specified for two sub-intervals. Interval H consists of data collected during each heating interval, with the exception of the first 10 min after defrost termination. Interval D consists of data collected during each defrost cycle plus the first 10 min of the subsequent heating interval.

All data collected during each interval, H or D, shall be used to evaluate compliance with the Table 3 test tolerances. Data from two or more H intervals or two or more D intervals shall not be combined and then used in evaluating Table 3 compliance. Compliance is based on evaluating data from each interval separately.

B.10 Step 8b

In Step 8b, the data shall be recorded until 3 h have elapsed or until the heat pump water heater 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 8a, the test tolerances specified in Table 3 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 water heater 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 units, the data is recorded and calculated over a 3-hour duration whatever the state of cycling of the different refrigerant circuits.

