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Non-ducted portable air-cooled air conditioners and air-to-air heat pumps having a single exhaust duct — Testing and rating for performance

Climatiseurs refroidis par air et pompes à chaleur portables non raccordés à simple conduit — Essais et détermination des caractéristiques des performances

Reference number
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Contents

Page

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

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*.

Introduction

Single duct portable air conditioners and heat pumps can be selected for their ease and rapidity of use, handling and installation, in particular when the use of other categories of air conditioners is not convenient or forbidden, for example in rented or holiday houses or in historical buildings where an external unit cannot be placed outdoors.

The operational mode and features of such appliances are quite different from those of the well-known non-ducted air conditioners and heat pumps largely diffused worldwide and covered by ISO 5151.

There are presently no internationally recognized standards for single duct portable air conditioners and heat pumps. The economic operators involved in the production and distribution of such products face significant problems in verifying and declaring performance and energy consumption data in an objective and internationally recognized way.

This being considered, ISO/TC 86/SC 6 decided to prepare a specific standard for single duct portable air conditioners and heat pumps.

During the discussion of its contents it was acknowledged that it is necessary to provide the users with information on the specific characteristics of single duct portable air conditioners and heat pumps, on their correct installation and on their use. This will be covered by a future Amendment to this document which is currently under discussion.

Non-ducted portable air-cooled air conditioners and air-to-air heat pumps having a single exhaust duct — Testing and rating for performance

1 Scope

This document specifies the standard conditions for capacity and efficiency ratings of non-ducted portable air-cooled air conditioners having a single exhaust duct and non-ducted portable air-cooled heat pumps having a single exhaust duct. Such air conditioners and heat pumps may include an evaporatively cooled condenser cooled by air and the evaporation of:

a) condensate collected from the evaporator;

b) external supplementary water stored in a supplementary water tank; or

c) both a) and b).

This document also specifies the test methods for determining the capacity and efficiency ratings.

This document applies to equipment that is factory-made, electrically driven and uses mechanical compression. This document is applicable to equipment utilizing one or more refrigeration systems.

This document is not applicable to the rating and testing of the following:

i) Water-source heat pumps or water-cooled air conditioners;

ii) Multi-split-system air conditioners and air-to-air heat pumps (see ISO 15042:2017 for the testing of such equipment);

iii) Individual assemblies not constituting a complete refrigeration system;

iv) Equipment using the absorption refrigeration cycle;

v) Ducted equipment (see ISO 13253:2017 for the testing of such equipment);

vi) Evaporative coolers or any other cooling systems that are not of the vapour compression type;

vii) Dehumidifiers;

viii) Spot coolers.

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.

ISO 817, *Refrigerants — Designation and safety classification*

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:

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

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

3.1
bypassed indoor airflow
rate of flow of conditioned air directly from the indoor-side outlet to the indoor-side inlet of the equipment

Note 1 to entry: See Figure 1.

3.2
coefficient of performance
COP
ratio of the heating capacity to the total power input to the device at any given set of rating conditions

Note 1 to entry: Where the COP is stated without an indication of units, it is understood that it is derived from watts/watt.

3.3
conditioned space
enclosed space, room or zone to which conditioned air is delivered

3.4
dehumidifer
encased assembly designed to remove moisture from its surrounding atmosphere using either an electrically operated refrigeration system or a desiccant type of material including a means to circulate air and a drain arrangement for collecting and storing and/or disposing of the condensate

3.5
total power input
P_t
average electrical power input to the equipment as measured during the test

Note 1 to entry: Total power input is expressed in units of watts.

3.6
ventilation airflow
rate of flow of air introduced to the conditioned space through the equipment

3.7
equalizer opening airflow
rate of flow of air from the outdoor side through the equalizer opening in the partition wall of a calorimeter to the indoor side

Note 1 to entry: See Figure 1.

3.8
evaporatively cooled condenser
heat exchanger that condenses refrigerant vapour by rejecting heat to a water and air mixture causing the water to evaporate and increase the enthalpy of air

Note 1 to entry: Desuperheating and sub-cooling of the refrigerant may also occur.

3.9
exhaust airflow
rate of flow of air from the indoor side through the equipment to the outdoor side

Note 1 to entry: See Figure 1.

3.10
full-load operation
operation with the equipment and controls configured for the maximum continuous duty refrigeration capacity specified by the manufacturer and allowed by the unit controls

3.11
heating capacity
amount of heat that the equipment can add to the conditioned space (but not including supplementary heat) in a defined interval of time

Note 1 to entry: Heating capacity is expressed in units of watts. Manually selectable supplementary heaters are disabled during capacity tests, but any automatic supplementary heaters are permitted to operate.

3.12
indoor compartment
indoor-side compartment
testing room simulating the conditioned space (and containing the tested appliance)

Note 1 to entry: See Figure 1.

3.13
indoor discharge airflow
rate of flow of air from the outlet of the equipment into the conditioned space

Note 1 to entry: See Figure 1.

3.14
indoor heat exchanger
heat exchanger which is designed to remove heat from the indoor part of the building or to transfer heat to it

Note 1 to entry: In the case of an air conditioner or heat pump operating in the cooling mode, this is the evaporator. In the case of an air conditioner or heat pump operating in the heating mode, this is the condenser.

3.15
indoor intake airflow
rate of flow of air into the equipment from the conditioned space

Note 1 to entry: See Figure 1.

3.16
latent cooling capacity
amount of latent heat that the equipment can remove from the conditioned space in a defined interval of time

Note 1 to entry: Latent cooling capacity is expressed in units of watts.

Note 2 to entry: "Latent cooling capacity" is also known as "room dehumidifying capacity".

3.17
leakage airflow
rate of flow of air interchanged between the indoor side and outdoor side through the equipment as a result of its construction features and sealing techniques

Note 1 to entry: See Figure 1.

3.18
non-ducted portable air-cooled air conditioner having a single exhaust duct
encased assembly, designed primarily to provide free delivery of conditioned air to an enclosed space, room or zone which takes its source of air for cooling the condenser from the conditioned space, and discharges this air through a duct to the outdoor space

Note 1 to entry: Such air conditioners comprise a primary source of refrigeration for cooling and dehumidification. They can also include means for heating other than a heat pump, as well as means for circulating, cleaning, humidifying, ventilating or exhausting air.

3.19
non-ducted portable air-cooled heat pump having a single exhaust duct
encased assembly designed primarily to provide free delivery of conditioned air to an enclosed space, room or zone and includes a prime source of refrigeration for heating and which takes its source of air for the evaporator from the conditioned space, and discharges this air through a duct to the outdoor space

Note 1 to entry: Such heat pumps can be constructed to remove heat from the conditioned space and discharge it to a heat sink if cooling and dehumidification are desired from the same equipment. They can also include means for circulating, cleaning, humidifying, ventilating or exhausting air.

3.20
outdoor compartment
compartment where the exhaust air is rejected through the duct of single duct air conditioner

3.21
outdoor exhaust airflow
discharge rate of flow of air from the equipment through the exhaust duct

Note 1 to entry: See Figure 1.

3.22
outdoor heat exchanger
heat exchanger that is designed to transfer heat to the outdoor ambient environment or to remove heat from it

Note 1 to entry: In the case of an air conditioner or heat pump operating in the cooling mode, this is the condenser. In the case of an air conditioner or heat pump operating in the heating mode, this is the evaporator.

3.23
rated frequency
frequency shown on the nameplate of the equipment

3.24
rated voltage
voltage shown on the nameplate of the equipment

3.25
sensible cooling capacity
amount of sensible heat that the equipment can remove from the conditioned space in a defined interval of time

Note 1 to entry: Sensible cooling capacity is expressed in units of watts.

3.26
sensible heat ratio
SHR
ratio of the sensible cooling capacity to the total cooling capacity

3.27
spot cooler
encased assembly air conditioner that lies wholly within a conditioned space and that draws air for both the evaporator and condenser from the conditioned space and expels both of these back into the conditioned space

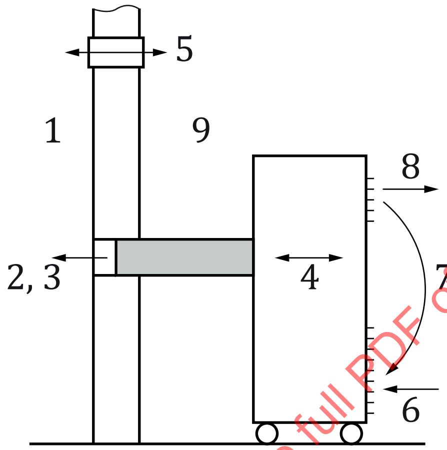
Note 1 to entry: A spot cooler is usually portable.

3.28
standard air
dry air at 20 °C and at a standard barometric pressure of 101,325 kPa, having a mass density of 1,204 kg/m^3

3.29
supplementary water tank
tank designed as an integral part of the unit to contain external supplementary water which is fed to the evaporatively cooled condenser

3.30
total cooling capacity
amount of sensible and latent heat that the equipment can remove from the conditioned space in a defined interval of time

Note 1 to entry: Total cooling capacity is expressed in units of watts.



Key

1 outdoor compartment (3.20)
2 outdoor exhaust airflow (3.21)
3 exhaust airflow (3.9)
4 leakage airflow (3.17)
5 equalizer opening airflow (3.7)
6 indoor intake airflow (3.15)
7 bypassed indoor airflow (3.1)
8 indoor discharge airflow (3.13)
9 indoor compartment (3.12)

Figure 1 — Airflow diagram illustrating the airflow definitions

4 Symbols

Symbol	Description	Unit
A_l	coefficient, heat leakage	J/(s·K)
A_n	area, nozzle	m[2]
C_d	nozzle discharge coefficient	a
c_{pa}	specific heat of air, moist air	J/(kg·K)
c_{pw}	specific heat of water	J/(kg·K)
D_n	nozzle throat diameter	m
D_t	outside diameter of refrigerant tube	m
f	factor, dependent on temperature, for R_e	—
h_{w1}	specific enthalpy of water or steam supplied to indoor side compartment	J/kg
h_{w2}	specific enthalpy of condensed moisture leaving indoor side compartment	J/kg

Symbol	Description	Unit
h_{w3}	specific enthalpy of condensed moisture leaving outdoor-side comportment	J/kg
h_{w4}	specific enthalpy of the water supplied to the outdoor side test chamber	J/kg
h_{w5}	specific enthalpy of the condensed water (in the case of H1 test condition) and the frost, respectively (in the case of H2 or H3 test conditions) in the test unit	J/kg
K_1	latent heat of vaporization of water (2 460 × 10^3 J/kg at 15 °C)	J/kg
R_e	Reynolds number	—
p_a	barometric pressure	kPa
p_c	test chamber equalization pressure	Pa
p_n	absolute pressure at nozzle throat	Pa
p_v	velocity pressure at nozzle throat or static pressure difference across nozzle	Pa
ϕ_{ci}	heat removed from indoor-side compartment	W
ϕ_c	heat removed by cooling coil in outdoor-side compartment	W
ϕ_{lp}	heat leakage into indoor-side compartment through partition separating indoor side from outdoor side	W
ϕ_{li}	heat leakage into indoor-side compartment through walls, floor and ceiling	W
ϕ_{lci}	latent cooling capacity (indoor-side data)	W
ϕ_{sc}	sensible cooling capacity	W
ϕ_{sci}	sensible cooling capacity (indoor-side data)	W
ϕ_{ho}	heating capacity, outdoor-side compartment	W
ϕ_{tci}	total cooling capacity (indoor-side data)	W
ϕ_{tco}	total cooling capacity (outdoor-side data)	W
ϕ_{thi}	total heating capacity (indoor-side data)	W
ϕ_{tho}	total heating capacity (outdoor-side data)	W
ΣP_{ic}	other power input to the indoor-side compartment (e.g. illumination, electrical and thermal power input to the compensating device, heat balance of the humidification device)	W
ΣP_{oc}	sum of all total power input to the outdoor-side compartment, not including power to the equipment under test	W
P_t	total power input to equipment	W
q_m	air-mass flow rate	kg/s
q_{mo}	airflow, outdoor, measured	m^3/s
q_v	air-volume flow rate	m^3/s
q_{wo}	water mass flow supplied to the outside compartment for maintaining the test conditions	kg/s
q_{wc}	rate at which water vapour is condensed by the equipment	g/s
t_a	temperature, ambient	°C
v_a	velocity of air, at nozzle	m/s
v_n	specific volume of dry air portion of mixture at nozzle	m^3/kg
v'_n	specific volume of air-water vapour mixture at nozzle	m^3/kg
μ	kinematic viscosity of air	kg/m·s
W_{i1}	specific humidity of air entering indoor side[b]	kg/kg [b]
W_{i2}	specific humidity of air leaving indoor side[b]	kg/kg [b]

Symbol	Description	Unit
W_n	specific humidity at nozzle inlet[b]	kg/kg [b]
W_r	water vapour (rate) condensed by the equipment	kg/s

[a] Dimensionless value.

[b] The mass of dry air. The mass, kg, of the denominator in this unit is based on dry air (DA). For units practically used in the air conditioning field, gkg, (DA)h is very often used for the denominator. Example J/kg(DA), m^3/kg (DA), kg/kg(DA).

NOTE All parameters are in relation to the unit being tested unless specified otherwise.

5 Cooling tests

5.1 Cooling capacity test

5.1.1 General conditions

5.1.1.1 All equipment within the scope of this document shall have the cooling capacities and energy efficiency ratios determined in accordance with the provisions of this document and rated at the cooling test conditions specified in Table 1. All tests shall be carried out in accordance with the requirements of Annex A and the test methods specified in Clause 7. All tests shall be conducted with the equipment functioning at full-load operation, as defined in 3.10. The electrical input values used for rating purposes shall be measured during the cooling capacity test.

Units that evaporate condensate collected from the evaporator shall be allowed to do so during the capacity test (see 5.1.2). Units that have a supplementary water tank intended to contain supplementary water that is fed to the evaporatively cooled condenser shall have capacity tests performed with and without this feature operating, subject to the requirements of 5.1.3 and Annex B. If a unit automatically turns off once the supplementary water tank becomes empty, a capacity test with this feature operating is the only capacity test required. See Table B.1 for a summary of these requirements.

If the manufacturer of equipment having a variable-speed compressor does not provide information on the full-load frequency and on how to achieve it during the cooling capacity test, the equipment shall be operated with its thermostat or controller set to its minimum allowable temperature setting.

5.1.2 Condensate containers

5.1.2.1 The duration of the cooling capacity test shall not be interrupted by a full condensate container triggering a cut-off switch. If necessary, condensate containers shall be modified to drain away excess condensate into a larger container in the test chamber before the volume that activates the cut-off switch is reached.

NOTE Many units have an in-built drain hose to facilitate this.

5.1.3 Tests using supplementary water evaporation feature

5.1.3.1 Performance and cooling capacity tests shall be performed using the supplementary water evaporation feature as per the manufacturer's instructions, if applicable. Water added to a unit's supplementary water tank shall be 35 °C ± 1 °C. All performance parameters for the standard rating test shall also be recorded for any cooling capacity tests that use the supplementary water evaporation feature. The test procedure includes determining the duration of time that the supplementary water tank can operate at standard cooling rating conditions. These procedures are specified in Annex B.

NOTE Some units are fitted with a supplementary water evaporation feature designed to provide additional water for the evaporatively cooled condenser and/or compressor. They generally require the user to fill a supplementary water tank and manually select an operational mode via the unit's control panel or remote control that turns this supplementary water evaporation feature on. This operational mode can override other thermostat and fan settings and is designed to achieve higher cooling capacities and greater energy efficiency while this feature is active. When these units deactivate their supplementary water evaporation feature (for instance, when they detect that there is insufficient water in the supplementary water tank), they can automatically revert to cooling without the aid of the supplementary water evaporation feature, or they can switch themselves off.

5.1.4 Temperature conditions

The temperature conditions stated in Table 1 shall be considered standard rating conditions for the determination of cooling capacity.

If the unit is rated for operation at two frequencies or, in some cases, if the equipment has a dual-rated voltage, then the cooling capacity test shall be conducted at each frequency and voltage in accordance with the conditions of Tables 1 and 2.

Table 1 — Cooling capacity rating conditions

Parameter	Standard rating conditions
Temperature of air entering indoor-side:	
— dry-bulb	35 °C
— wet-bulb	24 °C
Temperature of air entering outdoor-side:	
— dry-bulb	35 °C
— wet-bulb	24 °C
Test frequency[a]	Rated frequency
Test voltage	See Table 2

[a] Equipment with dual-rated frequencies shall be tested at each frequency.

NOTE The measured performance of single duct, portable air conditioners and heat pumps is sensitive to even a small difference in the enthalpy of the air entering the indoor chamber from the outdoor chamber. Therefore, it is desirable to have the indoor and outdoor chamber temperatures as close as possible during the tests.

Table 2 — Voltages for capacity and performance tests

Rated (nameplate) voltage[a] V	Test voltage V
90 to 109	100
110 to 127	115
180 to 207	200
208 to 253	230
254 to 341	265
342 to 420	400
421 to 506	460
507 to 633	575

[a] For equipment with dual-rated voltages such as 115/230 and 220/440, the test voltages would be 115 V and 230 V in the first example, and 230 V and 460 V in the second example. For equipment with an extended voltage range, such as 110 V to 120 V or 220 V to 240 V, the test voltage would be 115 V or 230 V, respectively. Where the extended voltage range spans two or more of the rated voltage ranges, the mean of the rated voltages shall be used to determine the test voltage from the table.

EXAMPLE For equipment with an extended voltage range of 200 V to 220 V, the test voltage would be 230 V, based on the mean voltage of 210 V.

5.1.5 Airflow conditions — Air quantity

Tests shall be conducted at standard rating conditions (see Table 1) with 0 Pa static pressure maintained at the air discharge of the equipment and with the refrigeration means in operation if required. All air quantities shall be expressed as litres per second (L/s) of standard air, as defined in 3.28.

Airflow measurements should be made in accordance with the provisions specified in Annex C, as appropriate, as well as the provisions established in other appropriate appendices of this document.

NOTE Additional guidance for making airflow measurements can be found in ISO 3966 and ISO 5167-1.

5.1.6 Test conditions

5.1.6.1 General

Tests shall be conducted under the rating conditions with no changes made in fan speed or system resistance to correct for variations from the standard barometric pressure (see 3.28).

5.1.6.2 Preconditions

The test room reconditioning apparatus and the equipment under test shall be operated until equilibrium conditions, as required by 7.3, are attained. Equilibrium conditions shall be maintained for not less than 1 h before capacity test data are recorded.

5.1.6.3 Testing requirements

The test shall provide for the determination of the sensible, latent and total cooling capacities as determined in the indoor-side compartment. See 5.1.1, 5.1.3 and Annex B for additional requirements associated with units that have a supplementary water tank.

5.1.6.4 Duration of test

The data shall be recorded at equal intervals as required by 7.3.3. The recording of the data shall continue for at least a 30 min period during which the tolerances specified in 7.3 shall be met. Many units exhibit pronounced cyclic behaviour in cooling mode. If a unit exhibits this type of cyclic behaviour, data shall be recorded and averaged over at least 120 min.

5.2 Maximum cooling performance test

5.2.1 General conditions

The test shall be conducted with the equipment functioning at full-load operation, as defined in 3.10. If the unit includes an in-built condensate collection and evaporation process, it shall be allowed to function (see 5.1.2). Units with a supplementary water tank may require two tests, subject to the requirements of Annex B. This feature shall be operated in accordance with manufacturer's instructions, if applicable.

The test voltages in Table 2 shall be maintained at the specified percentages under running conditions. In addition, the test voltage shall be adjusted so that it is not less than 86 % of the rated voltage at the moment of restarting the equipment after the shutdown required by 5.2.4.2. The determination of cooling capacity and electrical power input is not required for this performance test. The unit shall be set up as specified in Annex A.

5.2.2 Temperature conditions

The conditions, which shall be used during the maximum cooling test, are given in Table 3. If applicable, water added to a supplementary water tank shall be at 35 °C ± 1 °C.

Table 3 — Maximum cooling performance test conditions

Parameter	Standard rating conditions
Temperature of air entering indoor-side:	
— dry-bulb	43 °C
— wet-bulb	26 °C
Temperature of air entering outdoor-side:	
— dry-bulb	43 °C
— wet-bulb	26 °C
Test frequency[a]	Rated frequency
Test voltage	See Table 2
[a] Equipment with dual-rated frequencies shall be tested at each frequency.	

5.2.3 Temperature conditions

5.2.3.1 Preconditions

The controls of the equipment shall be set for maximum cooling. In-built condensate containers shall be emptied at the commencement of this test (see 5.1.2).

5.2.3.2 Duration of test

The equipment shall be operated continuously for 1 h after the specified air temperatures in Table 3 have been established in accordance with the tolerances in Table 9 Thereafter, all power to the equipment shall be cut off for 3 min and then restored. The operation of the equipment may be restarted either automatically or through the use of a remote controller or similar device. The test shall continue for 60 min after the equipment restarts.

5.2.4 Performance requirements

5.2.4.1 General

Air conditioners and heat pumps shall meet the following requirements when operating at the conditions specified in Table 3.

a) During one entire test, the equipment shall operate without any indication of damage.

b) The motors of the equipment shall operate continuously for the first hour of the test without tripping any protective device.

c) After the interruption of power, the equipment shall resume operation within 30 min and run continuously for 1 h, except as specified in 5.2.4.2 and 5.2.4.3.

5.2.4.2 Protective device

A protective device may trip only during the first 5 min of operation after the shutdown period of 3 min. During the remainder of that 1 h test period, no protective device shall trip.

5.2.4.3 Exception

For those models so designed that resumption of operation does not occur after the initial trip within the first 5 min, the equipment may remain out of operation for not longer than 30 min. It shall then operate continuously for 1 h.

5.3 Condensate control and enclosure sweat performance test

5.3.1 General conditions

Any modifications to the condensate collection system made in accordance with 5.1.2 shall be removed. The conditions which shall be used during the condensate control and enclosure sweat performance test are given in Table 4. The test shall be conducted with the equipment functioning at full-load operation, as defined in 3.10, except as required in 5.3.3. The determination of cooling capacity and electrical power input is not required for this performance test.

5.3.2 Temperature conditions

The temperature conditions that shall be used during this test are given in Table 4.

Table 4 — Condensate control and enclosure sweat performance test conditions

Parameter	Standard rating conditions
Temperature of air entering indoor-side: — dry-bulb — wet-bulb	 27 °C 24 °C
Temperature of air entering outdoor-side: — dry-bulb — wet-bulb	 27 °C 24 °C
Test frequency[a]	Rated frequency
Test voltage	See Table 2
[a] Equipment with dual-rated frequencies shall be tested at each frequency	

5.3.3 Airflow conditions

The controls, fans, dampers and grilles of the equipment shall be set to produce the maximum tendency to sweat, provided such settings are not contrary to the manufacturer's operating instructions.

5.3.4 Test conditions

5.3.4.1 Preconditions

After establishment of the specified temperature conditions, the equipment shall be run until the condensate flow has become uniform.

5.3.4.2 Duration of test

The equipment shall be operated for a period of 4 h. If the equipment has a condensate drain container that becomes full and triggers a cut-off switch, the container shall be emptied and the equipment restarted as required until the 4 h test period is complete.

5.3.5 Performance requirements

5.3.5.1 Condensate water

When operating under the test conditions specified in Table 4, no condensed water shall drip, run or blow from the equipment.

5.3.5.2 Condense air

Equipment which rejects condensate to the evaporatively cooled condenser shall dispose of all condensate rejected by this means and there shall be no dripping or blowing-off of water from the equipment such that the building or surroundings become wet.

6 Heating tests

6.1 Heating capacity tests

6.1.1 General conditions

6.1.1.1 General

For all heating capacity tests, the requirements specified in Annex A shall apply. Testing shall be conducted using the method(s) and instrumentation that meet the requirements of 7.1 and 7.2. Standard rating conditions for heating capacity tests are specified in Table 5. All Clause 6 heating capacity tests shall be conducted with the heat pump at full-load operation, as defined in 3.10. The electrical input values used for rating purposes shall be measured during the heating capacity test.

If the manufacturer of the equipment having a variable-speed compressor does not provide information on the full-load frequency and on how to achieve it during the heating capacity test, the equipment shall be operated with its thermostat or controller set to its maximum allowable temperature setting.

6.1.1.2 Selectable resistive elements

Selectable resistive elements used for heating indoor air shall be prevented from operating during all heating capacity tests.

6.1.1.3 Condensate containers

The duration of the heating capacity test shall not be interrupted by a full condensate container triggering a cut-off switch. If necessary, condensate containers shall be modified to drain away excess condensate into a larger container in the test chamber before the volume that activates the cut-off switch is reached.

NOTE Many units have an in-built drain hose to facilitate this.

If the unit's operating instructions recommend using continuous drain during heating mode these instructions shall be followed for the heating test.

Table 5 — Heating capacity rating conditions

Parameter	Standard rating conditions
Temperature of air entering indoor-side:	
— dry-bulb	20 °C
— wet-bulb	15 °C
Temperature of air entering outdoor-side	
— dry-bulb	20 °C
— wet-bulb	15 °C

Table 5 *(continued)*

Parameter	Standard rating conditions
Test frequency[a]	Rated frequency
Test voltage	See Table 2

[a] Equipment with dual-rated frequencies is tested at each frequency.

NOTE The measured performance of single duct, portable air conditioners and heat pumps is sensitive to even a small difference in the enthalpy of the air entering the indoor chamber from the outdoor chamber. Therefore, it is desirable to have the indoor and outdoor chamber temperatures as close as possible during the tests.

6.1.2 Temperature conditions

All heat pumps shall be rated based on testing at the Table 5 temperature conditions.

If the heat pump is rated for operation at two frequencies or, in some cases, if the equipment has a dual-rated voltage, then the heating capacity test shall be conducted at each frequency and voltage in accordance with the conditions of Table 5 and Table 2.

6.1.3 Airflow conditions — Air quantity

Tests shall be conducted at standard rating conditions (see Table 5) with 0 Pa static pressure maintained at the air discharge of the equipment and with the refrigeration means in operation if required. All air quantities shall be expressed as litres per second (L/s) of standard air, as defined in 3.28.

Airflow measurements should be made in accordance with the provisions specified in Annex C, as appropriate, as well as the provisions established in other appropriate appendices of this document.

NOTE Additional guidance for making airflow measurements can be found in ISO 3966 and ISO 5167-1.

6.1.4 Test conditions

6.1.4.1 General

Tests shall be conducted under the rating conditions with no changes made in fan speed or system resistance to correct for variations from the standard barometric pressure (see 3.28).

6.1.4.2 Preconditions

The test room reconditioning apparatus and the equipment under test shall be operated until equilibrium conditions, as required by 7.3, are attained. Equilibrium conditions shall be maintained for not less than 1 h before capacity test data are recorded.

6.1.4.3 Testing requirements

The test shall provide for the determination of the total heating capacities as determined in the indoor-side compartment.

6.1.4.4 Duration of test

The data shall be recorded at equal intervals as required by 7.3.3. The recording of the data shall continue for at least a 30 min period during which the tolerances specified in 7.3 shall be met.

Many units exhibit pronounced cyclic behaviour in heating mode. If a unit exhibits this type of cyclic behaviour, data shall be recorded and averaged over at least 120 min.

6.2 Maximum heating performance test

6.2.1 General conditions

The test shall be conducted with the equipment functioning at full-load operation, as defined in 3.10. The determination of heating capacity and electrical power input is not required for this performance test.

6.2.2 Temperature conditions

The temperature conditions given in Table 6 shall be used during this test.

Table 6 — Test temperature conditions

Parameter	Standard test conditions
Temperature of air entering indoor-side: — dry-bulb — wet-bulb	 24 °C 18 °C
Temperature of air entering outdoor-side: — dry-bulb — wet-bulb	 24 °C 18 °C
Test frequency[a]	Rated frequency
Test voltage	See Table 2

[a] Equipment with dual-rated frequencies shall be tested at each frequency.

6.2.3 Airflow conditions

The maximum heating performance test shall be conducted with an indoor heat exchanger fan speed setting as determined in A.2.5, except as required in 6.2.4.1.

6.2.4 Test conditions

6.2.4.1 Preconditions

The controls of the equipment shall be set for maximum heating.

6.2.4.2 Duration of the test

The equipment shall be operated for 1 h after the specified air temperatures have been attained. The equipment shall be permitted to stop and start under the control of an automatic limit device, if provided.

6.2.4.3 Performance requirements

The equipment shall operate under the conditions specified in Table 6 and 6.2.4.2, without indication of damage.

7 Test methods and uncertainties of measurements

7.1 Test methods

7.1.1 General

Capacity tests shall be conducted in accordance with the testing requirements specified in Annex A, using the calorimeter test method (see Annex D), subject to the provision that the test results are within the limits of uncertainties of measurements established in 7.2.

7.1.2 Calorimeter test method

When using the calorimeter method for cooling capacity tests and for steady-state heating capacity tests, two simultaneous methods of determining capacities shall be used. One method determines the capacity on the indoor side, the other measures the capacity on the outdoor side. The capacity determined using the outdoor-side data shall agree within 5 % of the value obtained using the indoor-side data for the test to be valid. Steady-state conditions are achieved when the measured capacity at each 10-min time interval does not vary by more than 2 % from the average measured capacity over the previous 30 min.

7.1.3 Capacity tests

On the cooling cycle, it is recommended that the latent cooling capacity be determined using the cooling condensate method (see Annex E) subject to the provision that the test results are within the limits of uncertainties of measurements established in 7.2.

7.2 Uncertainties of measurement

The uncertainties of measurement shall not exceed the values specified in Table 7.

The steady-state cooling and heating capacities determined using the calorimeter method shall be determined with a maximum uncertainty of 10 %. This value is an expanded uncertainty of measurement expressed at the level of confidence of 95 %.

7.3 Test tolerances for steady-state cooling and heating tests

7.3.1 Variation of individual observations

The maximum permissible variation of any individual observation from a specified test condition during a steady-state cooling and heating capacity test is listed in Column 3 of Table 8. When expressed as a percentage, the maximum allowable variation is the specified percentage of the arithmetical average of the observations.

Table 7 — Uncertainties of measurement

Measured quantity	Uncertainty of measurement[a]
Water:	
— temperature	0,1 °C
— temperature difference	0,1 °C
— volume flow	1 %
— static pressure difference	5 %
Air:	
— dry-bulb temperature	0,2 °C
— wet-bulb temperature[b]	0,2 °C
— volume flow	5 %
— static pressure difference	5 %
	5 %
Electrical inputs	0,5 %
Time	0,2 %
Mass	1,0 %
Volume	1,0 %
Speed	1,0 %

NOTE Uncertainty of measurement comprises, in general, many components. Some of these components can be estimated on the basis of the statistical distribution of the results of series of measurements and can be characterized by experimental standard deviations. Estimates of other components can be based on experience or other information.

[a] Uncertainty of measurement is an estimate characterizing the range of values within which the true value of the measurement lies, based on a 95 % confidence interval (see ISO/IEC Guide 98-3).

[b] This may be measured directly or indirectly.

Table 8 — Variations allowed during steady-state cooling and heating capacity tests

Reading	Variation of arithmetical mean values from specified test conditions	Maximum variation of individual readings from specified test conditions
Temperature of air entering indoor-side:		
— dry-bulb	±0,3 K	±0,5 K
— wet-bulb	±0,2 K	±0,3 K
Temperature of air entering outdoor-side:		
— dry-bulb	±0,3 K	±0,5 K
— wet-bulb	±0,2 K[a]	±0,3 K[a]
Voltage	±1 %	±2 %

[a] Only applicable to cooling capacity tests if equipment rejects condensate to the outdoor coil.

7.3.2 Variation of average observations

The maximum variations of the average observations from the standard or specified test conditions are shown in Column 2 of Table 8.

7.3.3 Sampling rate

All applicable parameters shall be sampled at equal intervals spanning 1 min or less.

7.3.4 Tolerances for capacity calculations

For the data collection period used in determining the equipment's measured space conditioning capacity, compliance with the applicable Table 8 test tolerances shall be achieved.

7.4 Test tolerances for performance tests

The maximum allowable variation of any individual observation made during a performance test from the specified test condition is established in Table 9

Table 9 — Test tolerances for performance tests

Reading	Maximum variation of individual readings from specified test conditions[a]
Air temperature:	
— dry-bulb	±1 K
— wet-bulb	±0,5 K
Voltage	±2 %

[a] The test tolerances do not apply when the equipment is stopped, or when changing compressor speed. During these intervals, dry-bulb temperature tolerances of ±2,5 K shall apply.

8 Test capacity results

8.1 Capacity results

8.1.1 General

The results of a capacity test shall express quantitatively the effects produced on air by the equipment tested. For given test conditions, the capacity test results shall include the following quantities as applicable to cooling or heating:

a) total cooling capacity, in watts as measured on the indoor-side;

b) sensible cooling capacity, in watts as measured on the indoor-side;

c) latent cooling capacity, in watts as measured on the indoor-side;

d) heating capacity, in watts as measured on the indoor-side;

e) indoor-discharge airflow, l/s of standard air;

f) outdoor exhaust airflow, l/s of standard air;

g) total power input to the equipment or individual power inputs to each of the electrical equipment components, in watts.

NOTE 1 For a), b) and d), standard ratings for capacities include the effects of the circulating fan heat.

NOTE 2 For determination of latent cooling capacity, see Annex D.

8.1.2 Adjustments

Test results shall be used to determine capacities without adjustment for permissible variations in test conditions. Air enthalpies, specific volumes and isobaric specific heat capacities shall be based on the measured barometric pressure.

8.1.3 Cooling capacity calculations

8.1.3.1 Average cooling capacity

An average cooling capacity shall be determined from the set of cooling capacities recorded over the data collection period.

8.1.3.2 Total electrical power input

The total electrical power input shall be determined from the set of electrical power inputs recorded over the data collection period or from the integrated electrical power for the same interval, for cases where an electrical energy meter is used.

8.1.4 Heating capacity calculations

8.1.4.1 Average heating capacity

An average heating capacity shall be determined from the set of heating capacities recorded over the data collection period.

8.1.4.2 Total electrical power input

Total electrical power input shall be determined from the set of electrical power inputs recorded over the data collection period or from the integrated electrical power for the same interval, for cases where an electrical energy meter is used.

8.2 Data to be recorded

The data to be recorded for the capacity tests are given in Tables 10 and 11. The tables identify the general information required, but are not intended to limit the data to be obtained. Electrical input values used for rating purposes shall be those measured during the capacity tests.

8.3 Test report

8.3.1 General information

As a minimum, the test report shall contain the following general information:

a) a reference to this document, i.e. ISO 18326;

b) the date;

c) the test institute;

d) the test location;

e) the test supervisor;

f) a description of test set-up, including equipment location;

g) the nameplate information (see 9.2);

h) photographs of the equipment installation (see A.2.7).

Table 10 — Data to be recorded for calorimeter cooling capacity tests

No.	Data
1	Date
2	Observers
3	Barometric pressure, in kPa
4	Fan speed settings
5	Applied voltage, in V
6	Frequency, in Hz
7	Total current input to equipment, in A
8	Total power input to equipment, in W
9	Control dry-bulb and wet-bulb temperatures of air (indoor-side calorimeter compartment)[a], in °C
10	Control dry-bulb and wet-bulb temperatures of air (outdoor-side calorimeter compartment)[a] in C
11	Average air temperature outside the calorimeter, if calibrated (see Figure D.1), in °C
12	Total power input to indoor-side compartment, ΣP_{ic}, in W
13	Total power input to outdoor-side compartment, ΣP_{oc}, in W
14	Quantity of water evaporated in humidifier, in kg
15	Temperature of humidifier water entering indoor-side and outdoor-side (if used) compartments or in humidifier tank, in degrees °C
16	Cooling water flow rate through outdoor-side compartment test chamber heat-rejection coil, in l/s
17	Temperature of cooling water entering outdoor-side test compartment, for heat-rejection coil, in °C
18	Temperature of cooling water leaving outdoor-side test compartment, for heat-rejection coil, in °C
19	Mass of water from equipment which is condensed in the reconditioning equipment[c], in kg
20	Temperature of condensed water leaving outdoor-side test chamber, in °C
21	Volume of outdoor exhaust airflow, in l/sec
22	Air-static pressure difference across the separating partition of calorimeter compartments, in Pa
23	Dry-bulb temperature of the air leaving the exhaust duct, recorded at the discharge centre-line
24	Quantity and temperature of water added to the equipment prior and during testing
25	Temperature of water added supplementary water tank, in °C
26	Supplementary water tank volume, in L
27	Supplementary water thank operating duration in standard rating conditions, in min

[a] See D.1.8.

[b] For equipment that evaporates condensate on the outdoor coil.

Table 11 — Data to be recorded for calorimeter heating capacity tests

No.	Data
1	Date
2	Observers
3	Barometric pressure, in kPa
4	Fan speed settings
5	Applied voltage, in V
6	Frequency, in Hz
7	Total current input to equipment, in A
8	Total power input to equipment, in W
9	Control dry-bulb and wet-bulb temperatures of air (indoor-side calorimeter compartment)[a], in °C
10	Control dry-bulb and wet-bulb temperatures of air (outdoor-side calorimeter compartment)[a], in °C
11	Average air temperature outside the calorimeter, if calibrated (see Figure D.1), in °C
12	Total power input to indoor-side compartment ΣP_{ic}, in W
13	Total power input to outdoor-side ΣP_{oc}, in W
14	Quantity of water evaporated in humidifier, in kg
15	Temperature of humidifier water entering indoor-side and outdoor-side (if used) compartments or in humidifier tank, in °C
16	Cooling water flow rate through indoor-side compartment heat-rejection coil, in °C
17	Temperature of cooling water entering indoor-side compartment, for heat-rejection coil, in °C
18	Temperature of cooling water leaving indoor-side compartment, for heat-rejection coil, in °C
19	Mass of water from equipment which is condensed in the reconditioning equipment [b], in kg
20	Temperature of condensed water leaving outdoor-side compartment, in °C
21	Volume of outdoor exhaust airflow, in L/sec
22	Air-static pressure difference across the separating partition of calorimeter compartments, in Pa
23	Dry-bulb temperature of the air leaving the exhaust duct, recorded at the discharge centre-line
24	Quantity and temperature of water added to the equipment prior to and during testing

a See D.1.8.

b For equipment that evaporates condensate on the outdoor heat exchanger.

8.3.2 Capacity tests

The values reported shall be the mean of the values taken over the data collection period and shall be stated with an uncertainty of measurement at a confidence level of 95 %.

NOTE Guidance on the determination of uncertainty in measurements is given in ISO/IEC Guide 98-3.

9 Marking provisions

9.1 Nameplate requirements

Each air conditioner and heat pump system shall have a durable nameplate, firmly attached to it and in a location accessible for reading.

9.2 Nameplate information

The nameplate shall carry the following minimum information, in addition to the information required by International Standards on safety:

a) the manufacturer's name or trademark;

b) any distinctive type or model number and serial number;

c) the rated voltage(s);

d) the rated frequency(ies);

e) the refrigerant designation in accordance with ISO 817;

f) the refrigerant mass charge.

10 Publication of ratings

10.1 Standard ratings

10.1.1 General

Standard ratings shall be published for cooling capacities (sensible, latent and total), heating capacity, EER and COP, for all systems produced in conformance to this document. These ratings shall be based on data obtained at the established rating conditions in accordance with the provisions of this document.

10.1.2 Units

The values of the standard capacities shall be expressed in kilowatts or watts, rounded to three significant figures.

10.1.3 EER and COP

The values of EER and COP shall be rounded to three significant figures.

10.1.4 Capacity rating and test voltage

Each capacity rating shall be followed by the corresponding test voltage (see Column 2 of Table 2) and frequency rating.

10.2 Other ratings

Additional ratings may be published based on conditions other than those specified as standard rating conditions, if they are clearly specified and the relevant data are determined by the methods specified in this document or by analytical methods which are verifiable by the test methods specified in this document.

Annex A
(normative)

Test requirements

A.1 Test room requirement

Test room conditions shall be as specified in Annex D.

A.2 Equipment installation

A.2.1 General

The equipment to be tested shall be installed in accordance with the manufacturer's installation instructions using recommended installation procedures and the standard exhaust duct as supplied. The exhaust duct shall be configured to minimize pressure drops. No adaptors or accessories shall be fitted to the end of the duct except those supplied by the manufacturer for attaching the duct to the unit. No other alterations to the equipment shall be made except for the attachment of the required test apparatus and instruments in the prescribed manner.

A.2.2 Exhaust duct set-up

The exhaust duct shall extend from the equipment and discharge the exhaust air into the outdoor compartment through the partition separating the indoor and outdoor chambers. To ensure that the exhaust duct can be sealed and supported, it shall protrude into the partition that separates the chambers by 5 cm. The duct should also be supported in the middle of its length with a non-conducting support to maintain its straightness. See Figure A.1 for a visual representation of the duct set-up.

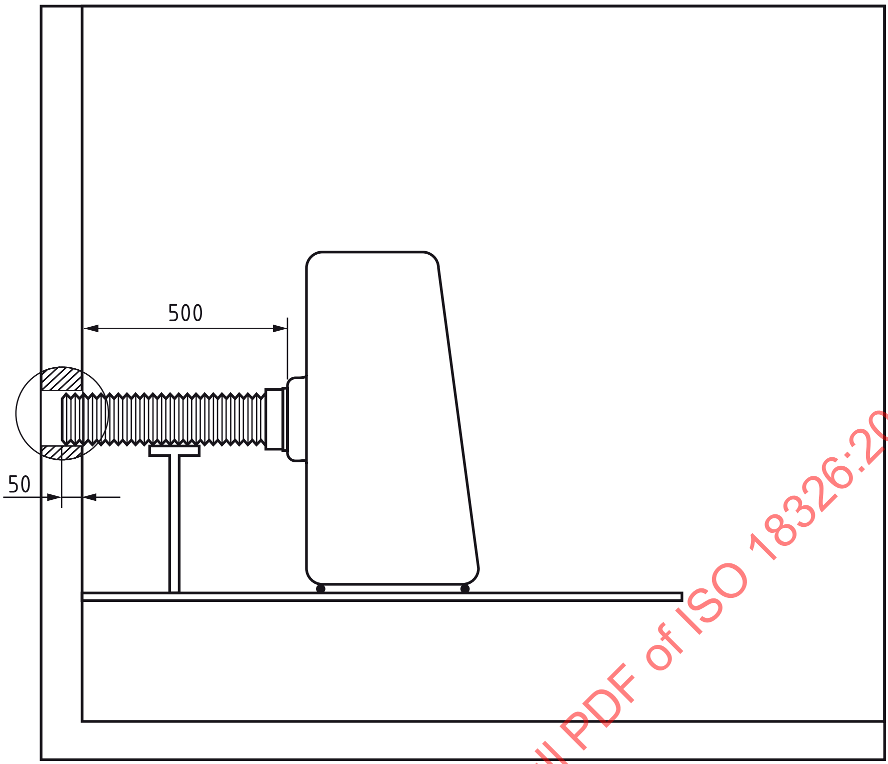
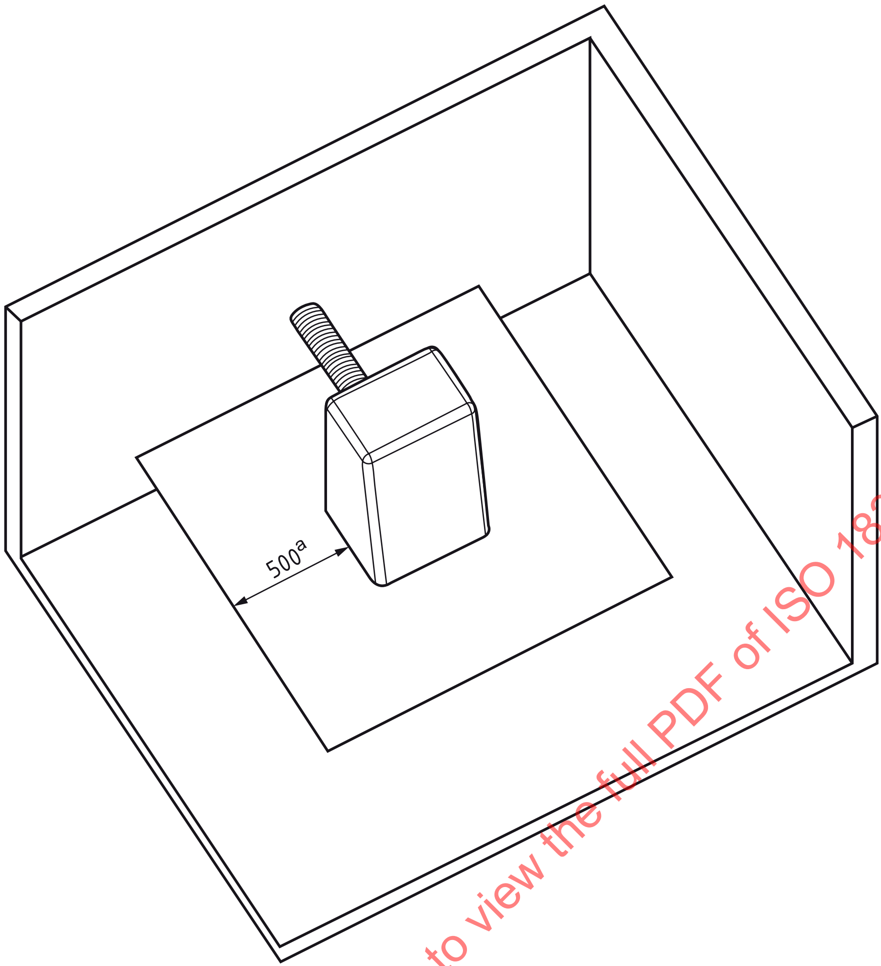


Figure A.1 — Typical duct set-up

A.2.3 Exhaust duct length and orientation

The equipment shall be placed either on the floor or on a raised, non-porous platform. The surface on which the unit sits shall be level (within 2°). The hole in the chamber partition wall shall allow the exhaust duct to extend from the equipment following the natural angle of the equipment's duct outlet. The length of the exhaust duct exposed to the indoor chamber shall be 50 cm ± 1 cm, measured along its centre-line from the fixed part of the unit's hose connector to the partition wall. This 50 cm includes any adaptors that attach the hose to the fixed part of the unit. See Figures A.1 and A.2 for visual representations of the set-up.

NOTE Keeping the test unit level is vital to ensure the proper functioning of the condensate collection and/or evaporation process.



Key

a Typical.

Figure A.2 — Using a raised platform to mount the unit off the floor

A.2.4 Orientation of unit

The equipment shall be placed so that clearance from the chamber walls meets the minimum recommendations of the manufacturer. If a platform is used to mount the unit above floor level, it shall extend out from the unit by a minimum of 50 cm on all sides. Installation shall only deviate from this if the 50 cm duct length requires the back of the unit to be closer to the wall than 50 cm.

NOTE Some units have their exhaust ducts mounted at an angle from the top of the unit's casing and are designed to have the duct connected to the room's outlet at an approximately 45 ° angle. To ensure only 50 cm of duct is exposed to the indoor chamber, the unit can be placed closer than 50 cm to the chamber dividing wall.

A.2.5 Miscellaneous equipment settings

Grille positions, damper positions and fan speeds shall be set in accordance with the manufacturer's instructions. For evaporatively cooled condenser units with supplementary water tanks, the tank may require filling as required by the test general conditions, and as per manufacturer's instructions. If so, they shall be filled in accordance with manufacturer's instructions. In the absence of manufacturer's instructions, the grilles, dampers and fan speeds shall be set to provide maximum capacity. When tests are carried out at other settings, these settings shall be noted together with the capacity ratings.

A.2.6 Temperature measuring equipment

A multiple point sampling technique shall be used for measuring the temperature of the pressure equalizing air from the outdoor chamber to the indoor chamber (where the open space pressure equalization method is used) and other air on temperature measurements.

NOTE An example of suitable apparatus for this can be found in Annex F.

A.2.7 Photographs

Photographs of the installation shall be taken from above, front on and side on. The photographs shall show capacity or performance tests and the airflow measurement setup if a pressure equalization device is not used and pressure is measured separately. These shall be supplied with the test report.

Annex B
(normative)

Units with a supplementary water-tank — Determining the duration of supplementary water evaporation feature

B.1 General

Units with a supplementary water evaporation feature shall have the duration of the tank determined under cooling capacity rating conditions (see Table 1).

B.2 Preparation and pre-conditioning period

After the cooling capacity test without using the supplementary water evaporation feature is performed, the supplementary water tank shall be filled with water at 35 °C ± 1 K. The equipment shall be operated under the conditions and period specified in pre-conditioning in 5.1.6.2. During this period, it is permissible to refill the tank.

B.3 Recording period

The recording period immediately follows the pre-conditioning period. The tank shall be refilled for the commencement of the 1 h recording period.

At the end of the recording period, the volume of water consumed shall be recorded, as shall the total capacity of the supplementary water tank. The water tank operating time shall be calculated from these measurements.

B.4 Performance requirements

To be able to claim performance and cooling capacity ratings for a supplementary water evaporation feature, the supplementary water evaporation feature shall be able to operate continuously without refilling the tank for 4 h or more at standard cooling capacity rating conditions.

If the unit achieves an operating time of 4 h or more, all other cooling tests shall be performed with the supplementary water feature in operation. If the unit automatically reverts to cooling without the aid of supplementary water cooling once it detects that the supplementary water tank has insufficient water, it shall also have all other cooling tests performed with the tank empty.

A summary of the testing, performance and rating requirements is presented in Table B.1.

Table B.1 — Summary of testing, performance and rating requirements

Supplementary water tank	Unit operates without supplementary water	Required cooling capacity tests	Calculated tank run time	Allowable ratings
No	N/A	Test without supplementary water	N/A	Single rating without supplementary water
Yes	No	Test with supplementary water and measure water usage to calculate tank run time	Shall be ≥4 h	Single rating with supplementary water
Yes	Yes	Test without supplementary water, then test with supplementary water and measure water usage to calculate tank run time	<4 h	Single rating without supplementary water
			≥4 h	Dual rating with and without supplementary water

Annex C
(informative)

Airflow measurement

C.1 Airflow determination

C.1.1 General

Airflow should be measured using the apparatus and testing procedures given in this Annex.

C.1.2 Quantities

Airflow quantities are determined as mass flow rates. If airflow quantities are to be expressed for rating purposes in volume flow rates, such ratings should state the conditions (pressure, temperature and humidity) at which the specific volume is determined.

C.2 Airflow and static pressure

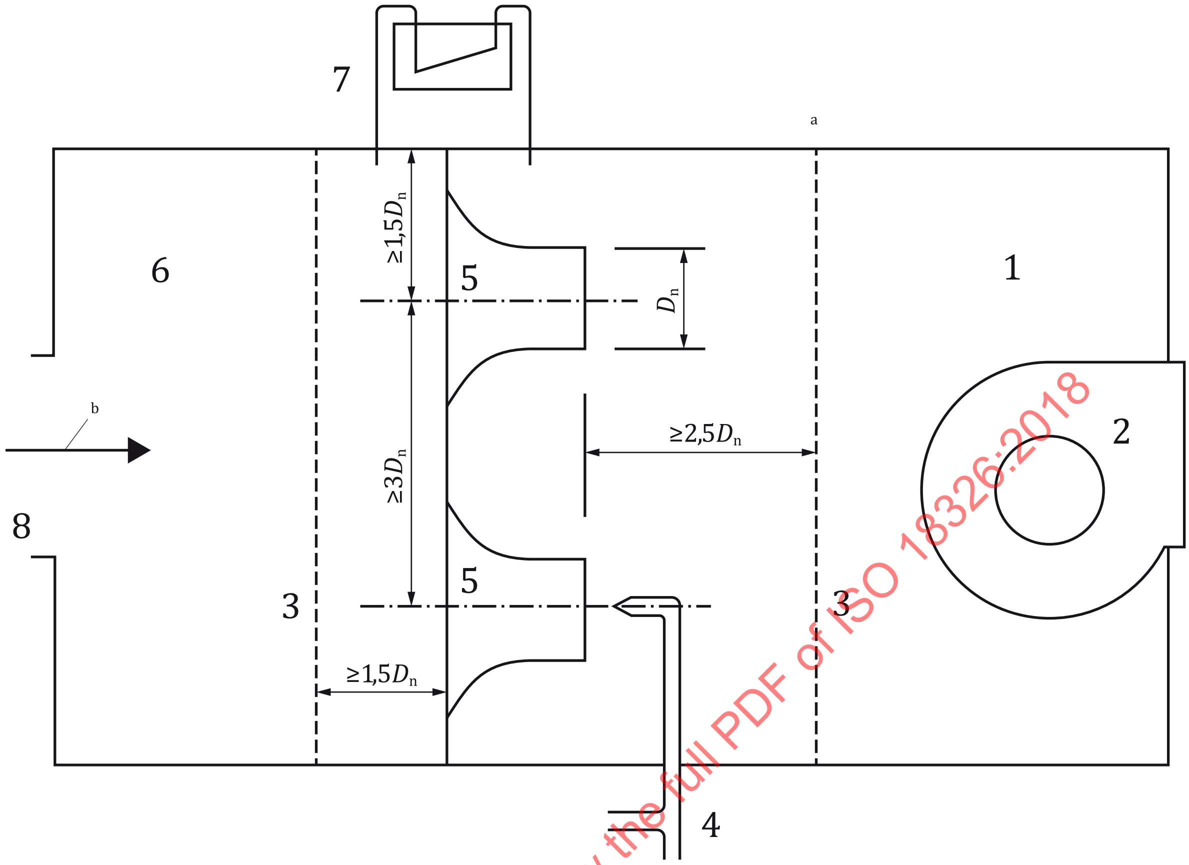
The area of a nozzle, A_n, should be determined by measuring its diameter to an accuracy of ±0,2 % in four locations approximately 45° apart around the nozzle in each of two places through the nozzle throat, one at the outlet and the other in the straight section near the radius.

C.3 Nozzle apparatus

Nozzle apparatus, consisting of a receiving chamber and a discharge chamber separated by a partition in which one or more nozzles are located (see Figure C.1). Air from the equipment under test is conveyed via a duct to the receiving chamber, passes through the nozzle(s) and is then exhausted to the test room or channelled back to the equipment's inlet.

The nozzle apparatus and its connections to the equipment's inlet should be sealed such that air leakage does not exceed 1,0 % of the airflow rate being measured.

The centre-to-centre distance between nozzles in use should not be less than three times the throat diameter of the larger nozzle and the distance from the centre of any nozzle to the nearest discharge or receiving chamber side wall should not be less than 1,5 times its throat diameter.



Key

1 discharge chamber
2 exhaust fan
3 diffusion baffle
4 Pitot tube (optional)
5 nozzle
6 receiving chamber
7 apparatus for differential pressure measurement
8 adapter duct (see C.9)
a Diffusion baffles should have uniform perforations, with approximately 40 % of free area.
b Airflow.

Figure C.1 — Airflow measuring apparatus

C.4 Diffusers

Installed in the receiving chamber (at a distance at least 1,5 times the largest nozzle throat diameter, D_n) upstream of the partition wall and in the discharge chamber (at a distance at least 2,5 times the largest nozzle throat diameter, D_n) downstream of the exit plane of the largest nozzle.

C.5 Exhaust fan

Capable of providing the desired static pressure at the equipment's outlet, installed in one wall of the discharge chamber and provided with a means of varying its capacity.

C.6 Manometers

For measuring the static pressure drop across the nozzle(s). One end of the manometer should be connected to a static pressure tap located flush with the inner wall of the receiving chamber and the other end to a static pressure tap located flush with the inner wall of the discharge chamber, or preferably, several taps in each chamber should be connected to several manometers in parallel or manifolded to a single manometer. Static pressure connections should be located so as not to be affected by airflow. Alternatively, the velocity head of the air stream leaving the nozzle(s) may be measured by a Pitot tube as shown in Figure C.1, but when more than one nozzle is in use, the Pitot tube reading should be determined for each nozzle.

C.7 Means of determining nozzle discharge coefficient

C.7.1 Throat velocity

The throat velocity of any nozzle in use should be not less than 15 m/s or more than 35 m/s.

C.7.2 Nozzle construction

Nozzles should be constructed in accordance with Figure C.2 and applied in accordance with the provisions of C.7.3 and C.7.4.

C.7.3 Nozzle discharge coefficient

The nozzle discharge coefficient, C_d, for the construction shown in Figure C.2, which has a throat length to throat diameter ratio of 0,6, may be determined using Formula (C.1):

$$C_d = 0{,}986 - \frac{7\,000}{\sqrt{R_e}} + \frac{134{,}6}{R_e} \quad \text{(C.1)}$$

for Reynolds numbers, R_e, of 12 000 and above.

The Reynolds number is defined as Formula (C.2):

$$R_e = \frac{v_a D_n}{v} \quad \text{(C.2)}$$

where

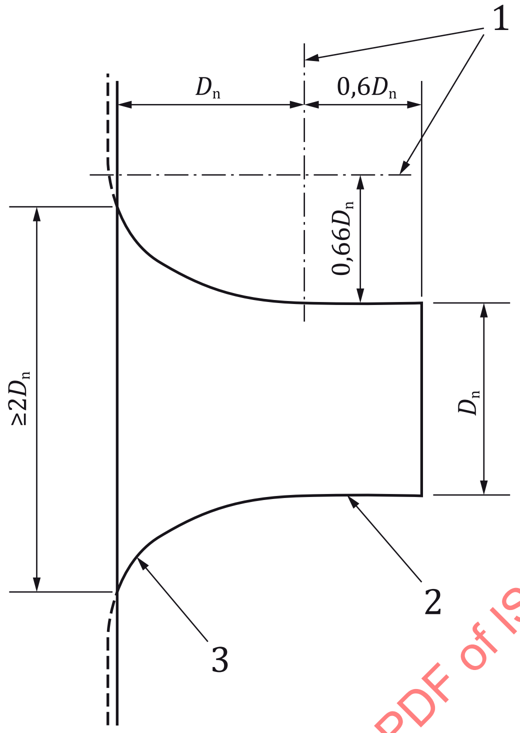
v_a is the mean airflow velocity at the throat of the nozzle;

D_n is the diameter of the throat of the nozzle;

v is the kinematic viscosity of air.

C.7.4 Appropriate nozzle construction

Nozzles may also be constructed in accordance with appropriate national standards, provided they can be used in the apparatus described in Figure C.1 and result in equivalent accuracy.



Key

1 axes of ellipse

2 throat section

3 elliptical approach

D_n diameter of nozzle throat, in metres

Figure C.2 — Airflow measuring nozzle

C.8 Static pressure measurements

The pressure taps should consist of 6,25 ± 0,25 mm diameter nipples soldered to the outer plenum surfaces and centred over 1 mm diameter holes through the plenum. The edges of these holes should be free of burrs and other surface irregularities.

The plenum and duct section should be sealed to prevent air leakage, particularly at the connections to the equipment and the air measuring device, and should be insulated to prevent heat leakage between the equipment outlet and the temperature measuring instruments.

C.9 Discharge airflow measurements

The outlet or outlets of the equipment under test should be connected to the receiving chamber by adaptor ducting of negligible air resistance, as shown in Figure C.1.

To establish zero static pressure with respect to the test room at the discharge of the air conditioner or heat pump in the receiving chamber, a manometer should have one side connected to one or more static pressure connections located flush with the inner wall of the receiving chamber.

C.10 Indoor-side airflow measurements

C.10.1 Readings

The following readings should be taken:

a) barometric pressure;

b) nozzle dry- and wet-bulb temperatures or dewpoint temperatures;

c) static pressure difference at the nozzle(s) or optionally, nozzle velocity pressure.

C.10.2 Calculating air-mass flow rate

Air mass flow rate, q_m, through a single nozzle is determined using Formula (C.3):

$$q_m = Y \times C_d \times A_n \sqrt{\frac{2p_v}{v'_n}} \tag{C.3}$$

where A_n is the area of the nozzle throat, in square metres.

The expansion factor, Y, is obtained from Formula (C.4):

$$Y = 0{,}452 + 0{,}548\,\alpha \tag{C.4}$$

The pressure ratio, α, is obtained from Formula (C.5):

$$\alpha = 1 - \frac{p_v}{p_n} \tag{C.5}$$

Air volume flow rate, q_V, through a single nozzle is determined using Formula (C.6):

$$q_V = Y \times C_d \times A_n \sqrt{2p_v V'_n} \tag{C.6}$$

where V'_n is calculated using Formula (C.7):

$$V'_n = \frac{v_n}{1 + W_n} \tag{C.7}$$

and W_n is the specific humidity at the nozzle inlet.

C.10.3 Calculating airflow through multiple nozzles

Airflow through multiple nozzles may be calculated in accordance with C.10.2, except that the total flow rate is then the sum of the q_m or q_V values for each nozzle used.

C.11 Ventilation, exhaust and leakage airflow measurements — Calorimeter test method

Ventilation, exhaust and leakage airflows should be measured using a device similar to that illustrated in Figure C.3, with the refrigeration system in operation and after condensate equilibrium has been obtained.

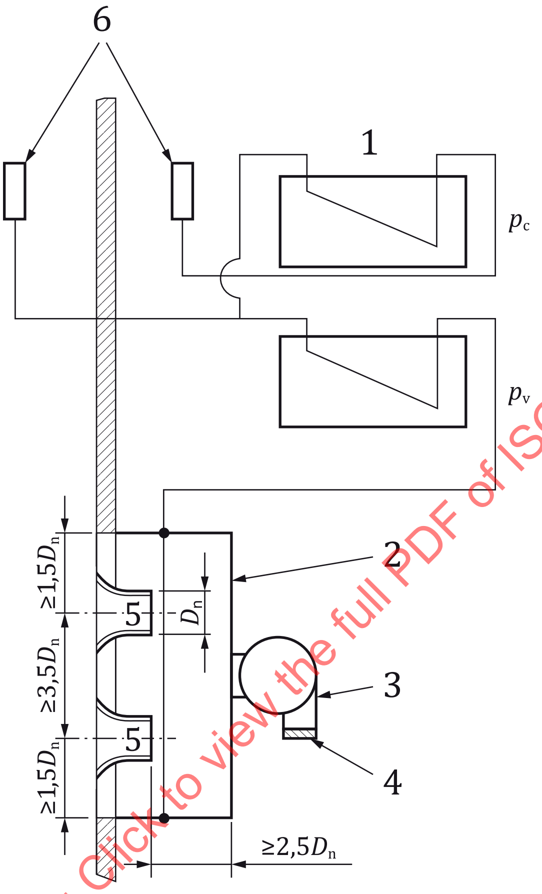
With the equalizing device adjusted for a maximum static pressure differential between the indoor-side and outdoor-side compartments of 1 Pa, the following readings should be taken:

a) barometric pressure;

b) nozzle wet- and dry-bulb temperatures;

c) nozzle velocity pressure.

Airflow values should be calculated in accordance with C.10.



Key

1 pressure manometers
2 discharge chamber
3 exhaust fan
4 damper
5 nozzle
6 pick-up tube
p_c compartment equalization pressure
p_v nozzle velocity pressure

Figure C.3 — Pressure-equalizing device

Annex D
(normative)

Calorimeter test method

D.1 General

D.1.1 Determining capacity

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

D.1.2 Installation of equipment

The two calorimeter compartments, indoor side and outdoor side, are separated by an insulated partition. The equipment should be installed in a manner similar to a normal installation. No effort should be made to seal the internal construction of the equipment to prevent air leakage from the condenser side to the evaporator side or vice versa. No connections or alterations should be made to the equipment which might in any way alter its normal operation.

D.1.3 Pressure equalizing devices

A pressure equalizing device, as illustrated in Figure D.3, should be provided in the partition wall between the indoor-side and the outdoor-side compartments to maintain a balanced pressure between these compartments and also to permit measurement of leakage, exhaust and ventilation air. This device consists of one or more nozzles of the type shown in Figure D.2, a discharge chamber equipped with an exhaust fan and manometers for measuring compartment and airflow pressures.

The manometer pressure pick-up tubes should be located so as to be unaffected by air discharged from the equipment or by the exhaust from the pressure equalizing device. The fan or blower, which exhausts air from the discharge chamber, should permit variation of its airflow by any suitable means, such as a variable speed drive or a damper as shown in Figure D.3. The exhaust from this fan or blower should be such that it does not affect the inlet air to the equipment.

The pressure equalizing device should be adjusted during calorimeter tests or airflow measurements so that the static pressure difference between the indoor-side and outdoor-side compartments is not greater than 1,25 Pa. The energy input to the fan motor of the pressure equalizing device shall be included in the heat input to the compartment in which it is located during capacity testing.

D.1.4 Size of calorimeter

The size of the calorimeter should be sufficient to avoid any restriction to the intake or discharge openings of the equipment. Perforated plates or other suitable grilles should be provided at the discharge opening from the reconditioning equipment to avoid face velocities exceeding 0,5 m/s. Sufficient space should be allowed in front of any inlet or discharge grille of the equipment to avoid interference with the airflow. The calorimeter shall be of such dimensions that the distance from any room surface to any equipment surface from which air is discharged is not less than 1,8 m. The minimum distance from the equipment to the side walls or ceiling of the compartment(s) should be 1 m, except for the back of the equipment, which should be in normal relation to the wall. Ceiling-mounted equipment should be installed at a minimum distance of 1,8 m from the floor. Table D.1 gives the suggested dimensions for the calorimeter. To accommodate peculiar sizes of equipment, it may be necessary to alter the suggested dimensions to comply with the space requirements.

D.1.5 Baffles

Since, in the indoor and outdoor compartments of a calorimeter, airflow patterns result from the interaction of the reconditioning apparatus and test equipment, it may be necessary to take measures, such as the addition of baffles, to prevent the recirculation of conditioned air, where this recirculation would not normally take place in a normal, non-test environment.

D.1.6 Pressure equilibrium — Indoor and outdoor compartments

Pressure equilibrium between indoor and outdoor compartments shall be obtained by introducing, into the indoor compartment, air at the same rating temperature conditions from the outdoor compartment. The pressure difference between the two compartments of the calorimeter room shall not be greater than 1,25 Pa. This pressure equilibrium can be achieved by using an equalizing device (see D.1.3) or by creating an open space area in the separation partition wall, the dimensions of which shall be calculated for the maximum airflow of the unit to be tested (see D.1.7). If an open space is created in the partition wall, an air-sampling device or several temperature sensors shall be used to measure the temperature of the air from the outdoor compartment to the indoor compartment.

It should be ensured that exhaust air from the test unit mixes with the outdoor chamber air properly before it can be drawn back to the indoor chamber. It may be necessary to take measures, such as the addition of baffles, to ensure this occurs.

D.1.7 Pressure equilibrium — Open space

When using an open space area to achieve pressure equilibrium between indoor and outdoor compartments, the minimum area, A (in cm^2), of the open space should be calculated by measuring the condenser exhaust airflow, Q (in L/s), and using Formula (D.1). The open space should not be more than 10 % larger than necessary to ensure the chambers' air flows do not interfere with one another.

$$A \geq \frac{Q}{0{,}6\sqrt{2 \times 0{,}5 \times 0{,}9007}} \qquad \text{(D.1)}$$

or

$$A \approx 20 \times Q$$

Table D.1 — Sizes of calorimeter

Rated cooling capacity of equipment[a] W	Suggested minimum inside dimensions of each room of the calorimeter m		
	Width	Height	Length
3 000	2,4	2,1	1,8
6 000	2,4	2,1	2,4
9 000	2,7	2,4	3,0
12 000[b]	3,0	2,4	3,7

[a] All figures are round numbers.

[b] Larger capacity equipment requires larger calorimeters.

D.1.8 Reconditioning equipment

Each compartment should be provided with reconditioning equipment to maintain specified airflow and prescribed conditions. The reconditioning equipment for the indoor-side compartment should consist of heaters to supply sensible heat and a humidifier to supply moisture. The reconditioning equipment for the outdoor-side compartment should provide cooling, dehumidification and humidification. The energy supply should be controlled and measured.

D.1.9 Heating, humidifying and cooling

When calorimeters are used for heat pumps, they should have heating, humidifying and cooling capabilities for both rooms (see Figures D.1 and D.2): other means, such as rotating the equipment, may be used as long as the rating conditions are maintained.

D.1.10 Fans

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

D.1.11 Air interactions

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

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

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

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

c) Air sampling tubes should be positioned on the intake side of the equipment under test.

D.1.12 Temperature of air leaving indoor heat exchanger

During a heating capacity test, the temperature of the air leaving the indoor heat exchanger of the heat pump shall be monitored to determine if its heating performance is being affected by a build-up of ice on the outdoor heat exchanger. A single temperature measuring device, placed at the centre of the indoor heat exchanger air outlet, is sufficient to indicate any change in the indoor heat exchanger air discharge temperature caused by a build-up of ice on the outdoor heat exchanger.

D.1.13 Interior surfaces

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

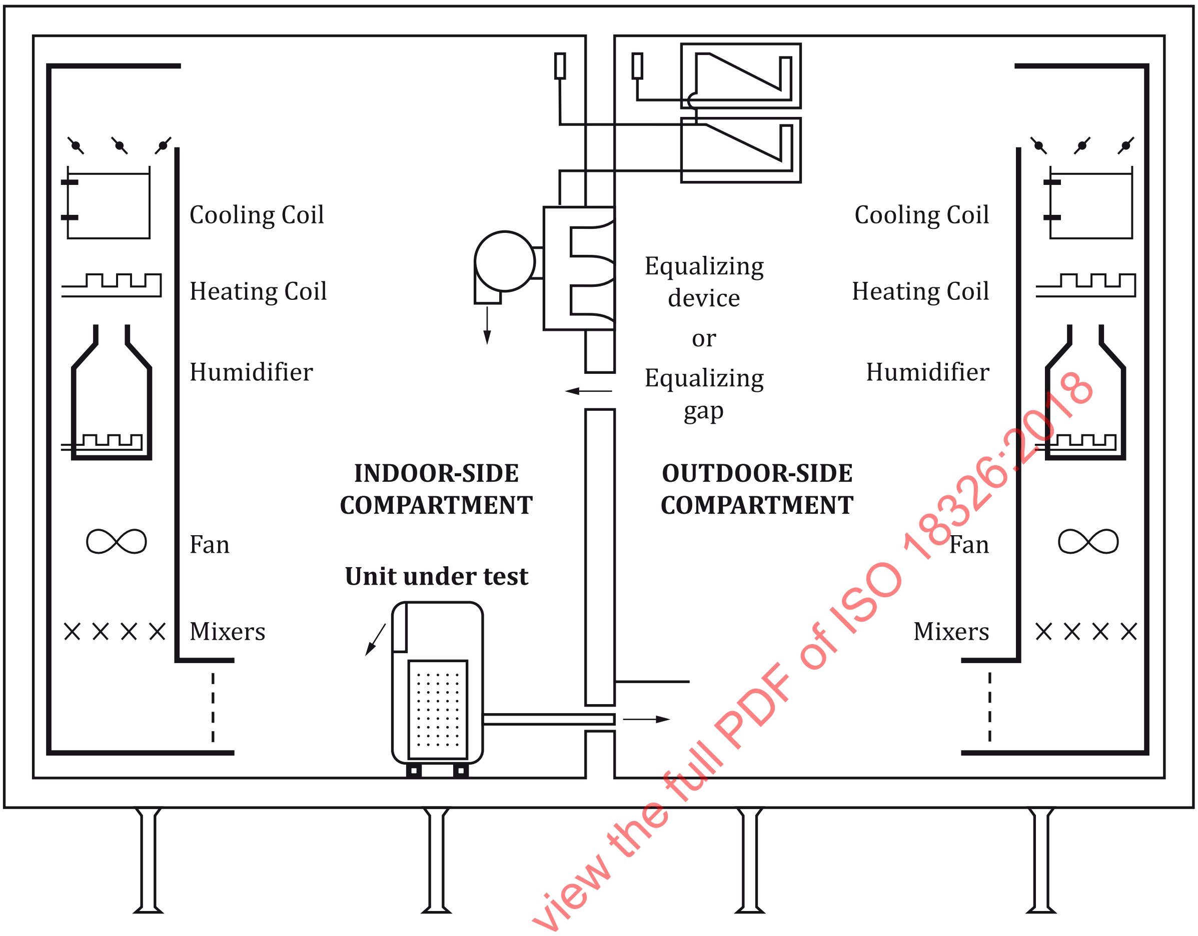


Figure D.1 — Typical calibrated room-type calorimeter