



BSI Standards Publication

Non-ducted air conditioners and heat pumps — Testing and rating for performance

National foreword

This British Standard is the UK implementation of ISO 5151:2017+A1:2020. It supersedes [BS ISO 5151:2017](#), which is withdrawn.

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

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2020
Published by BSI Standards Limited 2020

ISBN 978 0 539 12544 3

ICS 23.120; 27.080

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 July 2017.

Amendments/corrigenda issued since publication

Date	Text affected
31 October 2020	Implementation of ISO amendment 1:2020: replacement of Table 15 and Table D.1

INTERNATIONAL STANDARD

ISO
5151

Third edition
2017-07-01

Non-ducted air conditioners and heat pumps — Testing and rating for performance

*Climatiseurs et pompes à chaleur non raccordés — Essais et
détermination des caractéristiques de performance*



Reference number
ISO 5151:2017(E)
Documents
Document Sharing Hub
© ISO 2017



COPYRIGHT PROTECTED DOCUMENT

© ISO 2017, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

Foreword	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 Symbols	6
5 Cooling tests	8
5.1 Cooling capacity test	8
5.1.1 General conditions	8
5.1.2 Temperature conditions	8
5.1.3 Airflow conditions	9
5.1.4 Test conditions	10
5.2 Maximum cooling performance test	11
5.2.1 General conditions	11
5.2.2 Temperature conditions	11
5.2.3 Airflow conditions	11
5.2.4 Test conditions	11
5.2.5 Performance requirements	12
5.3 Minimum cooling, freeze-up air blockage and freeze-up drip performance tests	13
5.3.1 General conditions	13
5.3.2 Temperature conditions	13
5.3.3 Airflow conditions	13
5.3.4 Test conditions	13
5.3.5 Performance requirements	13
5.4 Freeze-up drip performance test	14
5.4.1 General conditions	14
5.4.2 Temperature conditions	14
5.4.3 Airflow conditions	14
5.4.4 Performance requirements	15
5.5 Condensate control and enclosure sweat performance test	15
5.5.1 General conditions	15
5.5.2 Temperature conditions	15
5.5.3 Airflow conditions	15
5.5.4 Test conditions	15
5.5.5 Performance requirements	15
6 Heating tests	16
6.1 Heating capacity tests	16
6.1.1 General conditions	16
6.1.2 Temperature conditions	17
6.1.3 Airflow conditions	17
6.1.4 Defrost operation	18
6.1.5 Test procedure — General	18
6.1.6 Preconditioning period	18
6.1.7 Equilibrium period	18
6.1.8 Data collection period	18
6.1.9 Test procedure when a defrost cycle (whether automatically or manually initiated) ends the preconditioning period	19
6.1.10 Test procedure when a defrost cycle does not end the preconditioning period	19
6.1.11 Test procedure for transient tests	20
6.1.12 Heating capacity test results	21
6.2 Maximum heating performance test	21
6.2.1 General conditions	21

6.2.2	Temperature conditions	21
6.2.3	Airflow conditions	22
6.2.4	Test conditions	22
6.2.5	Performance requirements	22
6.3	Minimum heating performance test	22
6.3.1	General conditions	22
6.3.2	Temperature conditions	22
6.3.3	Airflow conditions	23
6.3.4	Test condition	23
6.3.5	Performance requirements	23
6.4	Automatic defrost performance test	23
6.4.1	General conditions	23
6.4.2	Temperature conditions	23
6.4.3	Airflow conditions	23
6.4.4	Test conditions	24
6.4.5	Performance requirements	24
7	Test methods and uncertainties of measurements	24
7.1	Test methods	24
7.1.1	General	24
7.1.2	Calorimeter test method	24
7.1.3	Indoor air enthalpy test method	24
7.1.4	Capacity tests	25
7.2	Uncertainties of measurement	25
7.3	Test tolerances for steady-state cooling and heating tests	26
7.4	Test tolerances for performance tests	27
8	Test results	27
8.1	Capacity results	27
8.1.1	General	27
8.1.2	Adjustments	27
8.1.3	Cooling capacity calculations	28
8.1.4	Heating capacity calculations	28
8.2	Data to be recorded	29
8.3	Test report	29
8.3.1	General information	29
8.3.2	Capacity tests	31
8.3.3	Performance tests	31
9	Marking provisions	32
9.1	Nameplate requirements	32
9.2	Nameplate information	32
9.3	Split systems	32
10	Publication of ratings	33
10.1	Standard ratings	33
10.2	Other ratings	33
	Annex A (normative) Test requirements	34
	Annex B (informative) Airflow measurement	36
	Annex C (normative) Calorimeter test method	42
	Annex D (normative) Indoor air enthalpy test method	50
	Annex E (informative) Refrigerant enthalpy test method	56
	Annex F (informative) Outdoor air enthalpy test method	58
	Annex G (informative) Indoor calorimeter confirmative test method	61
	Annex H (informative) Outdoor calorimeter confirmative test method	63
	Annex I (informative) Balanced-type calorimeter confirmative test method	65

Annex J (informative) Cooling condensate measurements	66
Annex K (informative) Pictorial examples of the heating capacity test procedures given in 6.1	67
Bibliography	74

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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*.

This third edition cancels and replaces the second edition ([ISO 5151:2010](http://www.iso.org/iso/5151:2010)), which has been technically revised.

Non-ducted air conditioners and heat pumps — Testing and rating for performance

1 Scope

This document specifies performance testing, the standard conditions and the test methods for determining the capacity and efficiency ratings of air-cooled air conditioners and air-to-air heat pumps.

This document is applicable to the following equipment:

- non-ducted air-cooled air conditioners and non-ducted air-to-air heat pumps; or
- ducted air conditioners and/or ducted heat pumps rated at less than 8 kW and intended to operate at an external static pressure of less than 25 Pa.

This document is limited to:

- residential, commercial and industrial single-package and split-system air conditioners and heat pumps;
- factory-made, electrically driven and use mechanical compression;
- utilizing single, multiple and variable capacity components;
- multiple split-system utilizing one or more refrigeration systems, one outdoor unit and one or more indoor units, controlled by a single thermostat/controller.

The requirements of testing and rating contained in this document are based on the use of matched assemblies.

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

- a) water-source heat pumps or water cooled air conditioners;
- b) multi-split-system air conditioners and air-to-air heat pumps (follow [ISO 15042](#) for the testing of such equipment);
- c) mobile (windowless) units having a condenser exhaust duct;
- d) individual assemblies not constituting a complete refrigeration system;
- e) equipment using the absorption refrigeration cycle;
- f) ducted equipment except for those specified in this clause (follow [ISO 13253](#) for the testing of such equipment).

This document does not cover the determination of seasonal efficiencies, which can be required in some countries because they provide a better indication of efficiency under actual operating conditions.

NOTE Throughout this document, the terms “equipment” and “systems” mean “air conditioners” and/or “heat pumps”.

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*

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

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 <http://www.iso.org/obp>

3.1
non-ducted air conditioner
encased assembly or assemblies, designed primarily to provide free delivery of conditioned air to an enclosed space, room or zone

Note 1 to entry: It can be either single-package or split-system and comprises a primary source of refrigeration for cooling and dehumidification. It can also include means for heating other than a heat pump, as well as means for circulating, cleaning, humidifying, ventilating or exhausting air. Such equipment can be provided in more than one assembly, the separated assemblies (split-systems) of which are intended to be used together.

Note 2 to entry: An enclosed space, room or zone is known as a conditioned space.

3.2
non-ducted heat pump
encased assembly or assemblies 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

Note 1 to entry: It 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. It can also include means for circulating, cleaning, humidifying, ventilating or exhausting air. Such equipment can be provided in more than one assembly; the separated assemblies (split-systems) of which are intended to be used together.

Note 2 to entry: An enclosed space, room or zone is known as a conditioned space.

3.3
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/m³

3.4
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](#).

3.5
indoor intake airflow
rate of flow of air into the equipment from the conditioned space

Note 1 to entry: See [Figure 1](#).

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

Note 1 to entry: See [Figure 1](#).

3.7

outdoor discharge airflow

discharge rate of flow of air from the equipment

Note 1 to entry: See [Figure 1](#).

3.8

intake outdoor airflow

rate of flow of air into the equipment from the outdoor-side

Note 1 to entry: See [Figure 1](#).

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

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](#).

Note 2 to entry: This is not applicable for split system products.

3.11

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](#).

3.12

bypassed outdoor airflow

rate of flow of air directly from the outdoor-side outlet to the outdoor-side inlet of the equipment

Note 1 to entry: See [Figure 1](#).

3.13

equalizer opening airflow

rate of flow of air through the equalizer opening in the partition wall of a calorimeter

Note 1 to entry: See [Figure 1](#).

3.14

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.

3.15

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.

3.16

latent cooling capacity **room dehumidifying 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 and room dehumidifying capacity are expressed in units of watts.

3.17

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.

3.18

sensible heat ratio

SHR

ratio of the sensible cooling capacity to the total cooling capacity

3.19

rated voltage

voltage shown on the nameplate of the equipment

3.20

rated frequency

frequency shown on the nameplate of the equipment

3.21

energy efficiency ratio

EER

ratio of the total cooling capacity to the effective power input to the device at any given set of rating conditions

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

3.22

coefficient of performance

COP

ratio of the heating capacity to the effective 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.

3.23

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.

3.24

effective power input

P_E

average electrical power input to the equipment obtained from

- the power input from the compressor(s),
- the power input to electric heating devices used only for defrosting,
- the power input to all control and safety devices of the equipment, and

— the power input for operation of all fans

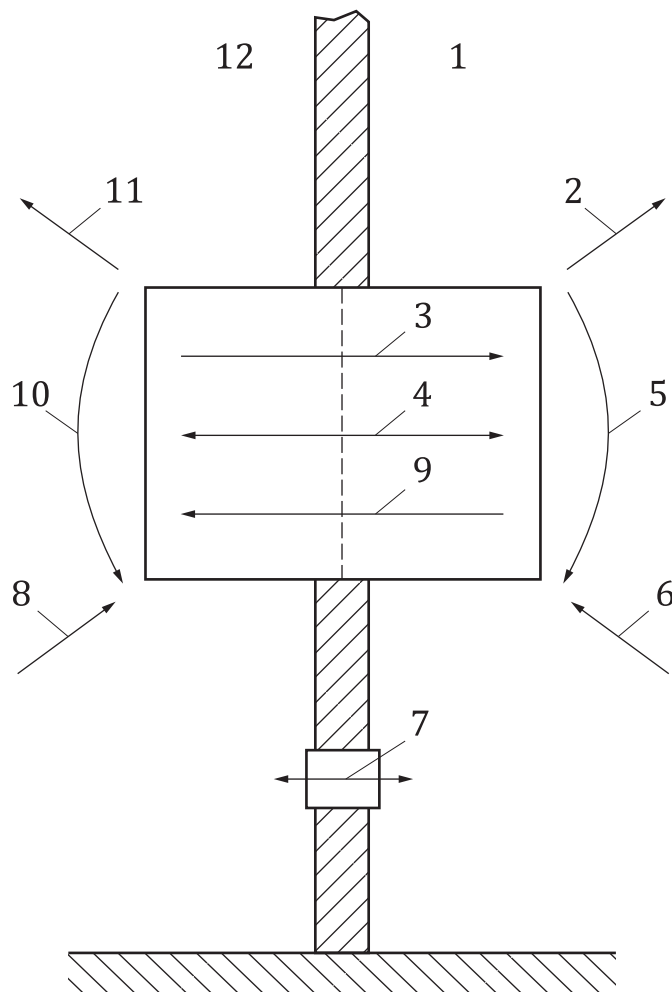
Note 1 to entry: Effective power input is expressed in units of watts.

3.25

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

Note 1 to entry: Unless otherwise regulated by the automatic controls of the equipment, all indoor units and compressors operate during full-load operations.



Key

1 outdoor-side	7 equalizer opening
2 outdoor discharge	8 indoor intake
3 exhaust	9 ventilation
4 leakage	10 bypassed indoor
5 bypassed outdoor	11 indoor discharge
6 outdoor intake	12 indoor-side

NOTE Airflow diagram illustrating the definitions given in 3.4 to 3.13

Figure 1 — Airflow diagram

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_{pa1}	specific heat of moist air entering indoor-side ^b	J/(kg ^b ·K)
c_{pa2}	specific heat of moist air leaving indoor-side ^b	J/(kg ^b ·K)
c_{pa3}	specific heat of moist air entering outdoor-side ^b	J/(kg ^b ·K)
c_{pa4}	specific heat of moist air leaving outdoor-side ^b	J/(kg ^b ·K)
c_{pw}	specific heat of water	J/(kg ^b ·K)
D_n	nozzle throat diameter	m
D_t	outside diameter of refrigerant tube	m
h_{a1}	specific enthalpy of air entering indoor-side	J/kg ^b
h_{a2}	specific enthalpy of air leaving indoor-side	J/kg ^b
h_{a3}	specific enthalpy of air entering outdoor-side	J/kg ^b
h_{a4}	specific enthalpy of air leaving outdoor-side	J/kg ^b
h_{f1}	specific enthalpy of refrigerant liquid entering expansion device	J/kg
h_{f2}	specific enthalpy of refrigerant liquid leaving condenser	J/kg
h_{g1}	specific enthalpy of refrigerant vapour entering compressor	J/kg
h_{g2}	specific enthalpy of refrigerant vapour leaving compressor	J/kg
h_{r1}	specific enthalpy of refrigerant entering indoor-side	J/kg
h_{r2}	specific enthalpy of refrigerant leaving indoor-side	J/kg
h_{w1}	specific enthalpy of water or steam supplied to indoor side test chamber	J/kg
h_{w2}	specific enthalpy of condensed moisture leaving indoor side test chamber	J/kg
h_{w3}	specific enthalpy of condensed moisture leaving outdoor-side test chamber	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 ($2\,460 \times 10^3$ J/kg at 15 °C)	J/kg
L	length of refrigerant line	m
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
P_i	power input, indoor-side data	W
P_K	power input to compressor	W
P_t	total power input to equipment	W
q_m	air mass flow rate	kg/s
q_r	refrigerant flow rate	kg/s
q_{ro}	refrigerant and oil mixture flow rate	kg/s
q_v	air volume flow rate	m ³ /s
q_{vi}	air volume flow rate, indoor-side	m ³ /s
^a Dimensionless value. ^b It means the mass of dry air; the mass, kg, of denominator in this unit is based on dry air (or DA). For units practically used in the air conditioning field, "kg (DA)" is very often used for 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.		

Symbol	Description	Unit
q_{vo}	air volume flow rate, outdoor-side	m ³ /s
q_w	condenser water flow rate	kg/s
q_{wc}	rate at which water vapour is condensed by the equipment	kg/s
q_{wo}	water mass flow supplied to the outside test chamber for maintaining the test conditions	kg/s
Re	Reynolds number	a
T	thickness of tubing insulation	m
t_a	temperature, ambient of compressor calorimeter	°C
t_{a1}	temperature of air entering indoor-side, dry bulb	°C
t_{a2}	temperature of air leaving indoor-side, dry bulb	°C
t_{a3}	temperature of air entering outdoor-side, dry bulb	°C
t_{a4}	temperature of air leaving outdoor-side, dry bulb	°C
t_c	temperature of surface of condenser of the compressor calorimeter	°C
t_e	temperature of surface of evaporator of the compressor calorimeter	°C
t_{w1}	temperature of water entering condenser of the compressor calorimeter	°C
t_{w2}	temperature of water leaving condenser of the compressor calorimeter	°C
v_a	velocity of air, at nozzle	m/s
v_n	specific volume of dry air portion of mixture at nozzle ^b	m ³ /kg ^b
v'_n	specific volume of air-water vapour mixture at nozzle	m ³ /kg
W_1	mass of cylinder and bleeder assembly, empty	g
W_3	mass of cylinder and bleeder assembly, with sample	g
W_5	mass of cylinder and bleeder assembly, with oil from sample	g
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
W_n	specific humidity at nozzle inlet ^b	kg/kg ^b
W_r	water vapour (rate) condensed	kg/s
X_o	concentration of oil to refrigerant-oil mixture	a
X_r	mass ratio, refrigerant to refrigerant-oil mixture	a
Y	expansion factor	a
α_a	Interconnecting tubing heat transfer coefficient	W/(m ² ·K)
λ	thermal conductivity	W/(m·K)
ν	kinematic viscosity of air	m ² /s
ΣP_{ic}	other power input to the indoor-side test chamber (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 test chamber, not including power to the equipment under test	W
ϕ_c	heat removed by cooling coil in the outdoor-side test chamber	W
ϕ_{ci}	heat removed by cooling coil in the indoor side test chamber	W
ϕ_d	latent cooling capacity (dehumidifying)	W
ϕ_e	heat input to evaporator of compressor calorimeter	W
ϕ_{hi}	heating capacity, indoor-side test chamber	W

^a Dimensionless value.

^b It means the mass of dry air; the mass, kg, of denominator in this unit is based on dry air (or DA). For units practically used in the air conditioning field, "kg (DA)" is very often used for denominator. Example: J/kg(DA), m³/kg (DA), kg/kg (DA)

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

Symbol	Description	Unit
ϕ_{ho}	heating capacity, outdoor-side test chamber	W
ϕ_{li}	heat leakage into indoor side test chamber through walls, floor and ceiling	W
ϕ_{lo}	heat leakage out of outdoor side test chamber through walls, floor and ceiling	W
ϕ_{lp}	heat leakage into indoor-side test chamber through partition separating indoor-side from outdoor-side	W
ϕ_L	line heat loss in interconnecting tubing	W
ϕ_{sci}	sensible cooling capacity, indoor side	W
ϕ_{tc}	refrigerating capacity of a refrigerant compressor	W
ϕ_{tci}	total cooling capacity, indoor-side	W
ϕ_{tco}	total cooling capacity, outdoor-side	W
ϕ_{thi}	total heating capacity, indoor-side	W
ϕ_{tho}	total heating capacity, outdoor-side	W
^a Dimensionless value. ^b It means the mass of dry air; the mass, kg, of denominator in this unit is based on dry air (or DA). For units practically used in the air conditioning field, "kg (DA)" is very often used for 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 [3.25](#). The electrical input values used for rating purposes shall be measured during the cooling capacity test.

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

5.1.2 Temperature conditions

5.1.2.1 The temperature conditions stated in [Table 1](#) (columns T1, T2 and T3) shall be considered standard rating conditions for the determination of cooling capacity. For equipment intended for space cooling, testing shall be conducted at one or more of the standard rating conditions specified in [Table 1](#).

5.1.2.2 Equipment manufactured only for use in a moderate climate similar to that specified in [Table 1](#), column T1, shall have ratings determined by tests conducted at T1 conditions and shall be designated as type T1 equipment.

5.1.2.3 Equipment manufactured only for use in a cool climate similar to that specified in [Table 1](#), column T2, shall have ratings determined by tests conducted at T2 conditions and shall be designated as type T2 equipment.

5.1.2.4 Equipment manufactured only for use in a hot climate similar to that specified in [Table 1](#), column T3, shall have ratings determined by tests conducted at T3 conditions and shall be designated as type T3 equipment.

5.1.2.5 Equipment manufactured for use in more than one of the climates defined in [Table 1](#) shall have marked on the nameplate the designated type (T1, T2 and/or T3). The corresponding ratings shall be determined by the standard rating conditions specified in [Table 1](#).

5.1.3 Airflow conditions

5.1.3.1 Indoor-side air quantity — Air enthalpy test method

5.1.3.1.1 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. All air quantities shall be expressed as cubic metre per second (m³/s) of standard air, as defined in [3.3](#).

When the fan speed is adjustable, the difference of the mass airflow rate from the standard air due to low barometric pressure should be adjusted by the fan speed.

5.1.3.1.2 Airflow measurements should be made in accordance with the provisions specified in [Annex B](#), as appropriate, as well as the provisions established in other appropriate annexes of this document.

NOTE Additional guidance for making airflow measurements can be found in [ISO 3966](#) and [ISO 5167-1](#).

Table 1 — Cooling capacity rating conditions

Parameter	Standard rating conditions		
	T1	T2	T3
Temperature of air entering indoor-side:			
— dry-bulb	27 °C	21 °C	29 °C
— wet-bulb	19 °C	15 °C	19 °C
Temperature of air entering outdoor-side:			
— dry-bulb	35 °C	27 °C	46 °C
— wet-bulb ^a	24 °C	19 °C	24 °C
Test frequency ^b	Rated frequency		
Test voltage	See Table 2		
NOTE			
T1 Standard cooling capacity rating conditions for moderate climates.			
T2 Standard cooling capacity rating conditions for cool climates.			
T3 Standard cooling capacity rating conditions for hot climates.			
^a The wet-bulb temperature condition shall only be required when testing air-cooled condensers which evaporate the condensate.			
^b Equipment with dual-rated frequencies shall be tested at each frequency.			

Table 2 — Voltages for capacity and performance tests

Rated (nameplate) voltage^a	Test voltage^b
V	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 this 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.

^b The voltages in this table are for capacity and performance tests other than the maximum cooling and the maximum heating performance tests.

5.1.3.2 Outdoor-side air quantity

If the outdoor airflow is adjustable, all tests shall be conducted at the outdoor-side air quantity or at the fan control setting that is specified by the manufacturer. Where the fan is non-adjustable, all tests shall be conducted at the outdoor-side air volume flow rate inherent in the equipment when operated with the following in place: all of the resistance elements associated with inlets, louvers and any ductwork and attachments considered by the manufacturer as normal installation practice. Once established, the outdoor-side air circuit of the equipment shall remain unchanged throughout all tests prescribed in this document, except to adjust for any change caused by the attachment of the airflow measuring device when using the outdoor air enthalpy test method (see F.2.1).

5.1.4 Test conditions

5.1.4.1 Preconditions

5.1.4.1.1 Tests shall be conducted under the selected conditions with no changes made in fan speed or system resistance to correct for variations from the standard barometric pressure (see 3.3).

5.1.4.1.2 Grille positions, damper positions, fan speeds, etc. shall be set in accordance with the manufacturer's instructions. In the absence of manufacturer's instructions, the grilles, dampers, fan speeds, etc. shall be set to provide maximum cooling capacity. When tests are carried out at other settings, these settings shall be noted together with the cooling capacity ratings.

5.1.4.1.3 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.

5.1.4.2 Testing requirements

The test shall provide for the determination of the sensible, latent and total cooling capacities as determined in the indoor-side test chamber.

5.1.4.3 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.

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 [3.25](#). The test voltages in [Table 3](#) 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.

5.2.2 Temperature conditions

The conditions, which shall be used during the maximum cooling, are given in [Table 3](#).

Table 3 — Maximum cooling performance test conditions

Parameter	Standard rating conditions		
	T1	T2	T3
Temperature of air entering indoor-side:			
— dry-bulb	32 °C	27 °C	32 °C
— wet-bulb	23 °C	19 °C	23 °C
Temperature of air entering outdoor-side:			
— dry-bulb	43 °C	35 °C	52 °C
— wet-bulb ^a	26 °C	24 °C	31 °C
Test frequency ^b	Rated frequency		
Test voltage	a) 90 % and 110 % of rated voltage with a single nameplate rating; b) 90 % of the lower rated voltage and 110 % of the higher rated voltage for units with a dual or extended nameplate voltage.		
^a The wet-bulb temperature condition shall only be required when testing air-cooled condensers that evaporate the condensate.			
^b Equipment with dual-rated frequencies shall be tested at each frequency.			

5.2.3 Airflow conditions

The maximum cooling performance test shall be conducted with an indoor-side fan speed setting as determined under [5.1.4.1.2](#).

5.2.4 Test conditions

5.2.4.1 Preconditions

The controls of the equipment shall be set for maximum cooling and, if provided, all ventilating air dampers and exhaust air dampers shall be closed.

5.2.4.2 Duration of test

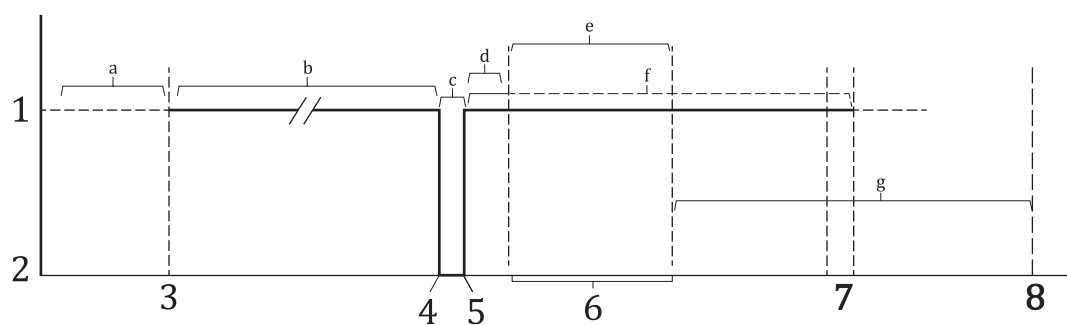
The equipment shall be operated continuously for 1 h after the specified air temperatures in [Table 3](#) have been established in accordance with the tolerances in [Table 12](#). Thereafter, all tolerances shall

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.

5.2.5 Performance requirements

5.2.5.1 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 [5.2.5.2](#) and [5.2.5.3](#).



Key

- 1 power supply to equipment unit on
- 2 power supply to equipment off
- 3 official test period begins
- 4 power supply to equipment turned off
- 5 power supply to equipment turned back on
- 6 maximum time before equipment resumes continuous operation
- 7 end of test, if equipment restarted upon re-energization of power
- 8 end of test, if equipment utilized full 30 min for protective device to reset
- a 30 min, steady-state operation.
- b 60 min, continuous operation running at reduced or increased supply voltage.
- c 3 min, power off.
- d 5 min, in which a protective device may trip.
- e 30 min.
- f, g 60 min of continuous operation after equipment restarts.

Figure 2 — Maximum performance test operation

5.2.5.2 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.

5.2.5.3 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 Minimum cooling, freeze-up air blockage and freeze-up drip performance tests

5.3.1 General conditions

The test conditions specified in [Table 4](#) shall be used when conducting the minimum cooling, freeze-up air blockage and freeze-up drip performance tests. The tests shall be conducted with the equipment functioning at full-load operation, as defined in [3.25](#), except as required in [5.3.3](#). The determination of cooling capacity and electrical power input is not required for these performance tests.

5.3.2 Temperature conditions

Tests shall be carried out under the temperature conditions established in [Table 4](#).

5.3.3 Airflow conditions

The controls, fan speeds, dampers and grilles of the equipment shall be set to maximize the tendency to produce frost or ice on the evaporator, provided such settings are not contrary to the manufacturer's operating instructions.

5.3.4 Test conditions

5.3.4.1 Preconditions

The equipment shall be started and operated until the operating conditions have stabilized.

5.3.4.2 Duration of test

After the operating conditions given in [Table 4](#) have stabilized in accordance with the tolerances in [Table 12](#), the equipment shall be operated for a period of 4 h. The equipment shall be permitted to stop and start under the control of an automatic limit device, if provided.

Table 4 — Minimum cooling, freeze-up air blockage and freeze-up drip performance test conditions

Parameter	Standard test conditions	
	T1 and T3	T2
Temperature of air entering indoor-side: — dry-bulb — wet-bulb	21 °C 15 °C	21 °C 15 °C
Temperature of air entering outdoor-side: — dry-bulb — wet-bulb	21 °C —	10 °C —
Test frequency ^a	Rated frequency	
Test voltage	See Table 2	
^a Equipment with dual-rated frequencies shall be tested at each frequency.		

5.3.5 Performance requirements

5.3.5.1 The equipment shall operate under the conditions specified without any indication of damage.

5.3.5.2 At the end of the 4-h test, any accumulation of frost or ice on the indoor coil shall not cover more than 50 % of the indoor-side face area of the indoor coil or reduce the airflow rate by more than 25 % of the initial airflow rate. [If measuring indoor air volume rate using a test apparatus that includes an exhaust fan (as in [Figure B.1](#)), the operating speed of the exhaust fan and/or the position of an in-line

flow damper shall be controlled to maintain zero static pressure during the 4-h test.] If the equipment and test apparatus do not allow for visual observation of the indoor coil and if the indoor air volume rate is not measured, then the requirements of [5.3.5.3](#) shall be met.

5.3.5.3 During the 4-h test period, the midpoint temperature of every indoor coil circuit or the refrigerant suction pressure shall be measured at equal intervals that span 1 min or less. The measurement(s) carried out 10 min after beginning the 4-h test shall be defined as the initial value(s). If the suction pressure is measured, it shall be used to calculate the saturated suction temperature.

- a) If the compressor(s) do(es) not cycle OFF on automatic controls during the test, and
 - if coil circuit temperatures are measured, the temperatures shall not remain more than 2 K below the corresponding initial value for each circuit for more than 20 consecutive min, or
 - if suction pressure is measured, the saturated suction temperature shall not remain more than 2 K below the initial value for more than 20 consecutive min.
- b) If the compressor(s) cycle(s) ON/OFF on automatic controls during the test, and
 - if coil circuit temperatures are measured, the individual circuit temperatures measured 10 min after the beginning of any ON cycle during the test shall not be more than 2 K below the corresponding initial circuit temperature(s), or
 - if suction pressure is measured, the saturated suction temperature measured 10 min after the beginning of any ON cycle during the test shall not be more than 2 K below the initial saturated suction temperature.

5.4 Freeze-up drip performance test

5.4.1 General conditions

The freeze-up drip performance test shall be run immediately after completion of the minimum cooling and freeze-up air blockage performance tests and at the conditions specified in [Table 4](#). The test shall be conducted with the equipment functioning at full-load operation, as defined in [3.25](#), except as required in [5.4.3](#). The determination of capacity and electrical power is not required for this performance test.

5.4.2 Temperature conditions

The temperature conditions for the freeze-up drip performance test are given in [Table 4](#).

5.4.3 Airflow conditions

The air inlet to the indoor coil shall be covered to completely block the passage of air, so as to attempt to achieve complete blockage of the evaporator by frost or ice.

5.4.3.1 Preconditions

The equipment shall be started and operated until the operating conditions given in [Table 4](#) have stabilized in accordance with the tolerances in [Table 12](#).

5.4.3.2 Duration of test

After the operating conditions have stabilized, the equipment shall be operated for a period of 4 h. The equipment shall be permitted to stop and start under the control of an automatic limit device, if provided. At the end of the 4-h test, the equipment shall be stopped and the air inlet covering removed until the accumulation of frost or ice has melted. The equipment shall then be turned on with the fan(s) operating at the highest speed for 5 min.

5.4.4 Performance requirements

During the test, no ice shall drip from the coil and no water shall drip or blow off the equipment on the indoor-side.

5.5 Condensate control and enclosure sweat performance test

5.5.1 General conditions

The conditions which shall be used during the condensate control and enclosure sweat test are given in [Table 5](#). The test shall be conducted with the equipment functioning at full-load operation, as defined in [3.25](#), except as required in [5.5.3](#). The determination of cooling capacity and electrical power input is not required for this performance test.

5.5.2 Temperature conditions

The temperature conditions which shall be used during this test are given in [Table 5](#).

Table 5 — Condensate control and enclosure sweat performance test conditions

Parameter	Standard test conditions
Temperature of air entering indoor-side:	
— dry-bulb	27 °C
— wet-bulb	24 °C
Temperature of air entering outdoor-side:	
— dry-bulb	27 °C
— wet-bulb ^a	24 °C
Test frequency ^b	Rated frequency
Test voltage	See Table 2
^a The wet-bulb temperature condition shall only be required when testing air-cooled condensers that evaporate the condensate.	
^b Equipment with dual-rated frequencies shall be tested at each frequency.	

5.5.3 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.

5.5.4 Test conditions

5.5.4.1 Preconditions

After establishment of the specified temperature conditions, the equipment shall be started with its condensate collection pan filled to the overflowing point and the equipment shall be run until the condensate flow has become uniform.

5.5.4.2 Duration of test

The equipment shall be operated for a period of 4 h.

5.5.5 Performance requirements

5.5.5.1 When operating under the test conditions specified in [Table 5](#), no condensed water shall drip, run or blow from the equipment.

5.5.5.2 Equipment which rejects condensate to the condenser air shall dispose of all condensate 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 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](#).

6.1.1.2 Selectable resistive elements used for heating indoor air shall be prevented from operating during all heating capacity tests, except those used only during a defrost cycle.

6.1.1.3 The test set-up shall include instrumentation to allow measurement of the temperature change across the indoor coil. If using the indoor air enthalpy method, the same dry-bulb temperature sensors as used to measure capacity may be used. If using the calorimeter test method, the temperature change shall be determined using the sensors specified in [Annex C](#).

6.1.1.4 Standard rating conditions for heating capacity tests are specified in [Table 6](#).

6.1.1.5 All [Clause 6](#) heating capacity tests shall be conducted with the heat pump at full-load operation, as defined in [3.25](#).

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

Table 6 — Heating capacity rating conditions

Parameter	Standard rating conditions
Temperature of air entering indoor-side: — dry-bulb — wet-bulb (maximum)	20 °C 15 °C
Temperature of air entering outdoor-side, H1: moderate cold condition — dry-bulb — wet-bulb	7 °C 6 °C
Temperature of air entering outdoor-side, H2: cold condition — dry-bulb — wet-bulb	2 °C 1 °C
Temperature of air entering outdoor-side, H3: very cold condition — dry-bulb — wet-bulb	–7 °C –8 °C
Test frequency ^a	Rated frequency
Test voltage	See Table 2
NOTE If a defrosting cycle occurs during the H1, H2 or H3 heating capacity tests, testing under these conditions are accomplished using either the calorimeter or the indoor air enthalpy method (see Annexes C and D). Refer to Clause 7 .	
^a Equipment with dual-rated frequencies is tested at each frequency.	

6.1.2 Temperature conditions

6.1.2.1 Three different outdoor-side temperature conditions, designated as H1-moderate cold condition, H2-cold condition and H3-very cold condition, are specified in [Table 6](#).

6.1.2.2 The [Table 6](#) temperature conditions for the air entering the indoor-side of the equipment shall be used for all heating capacity tests.

6.1.2.3 All heat pumps shall be rated based on testing at the H1-moderate cold condition temperature conditions. Heating capacity tests shall also be conducted at the H2-cold condition and/or H3-very cold condition temperature, if the manufacturer rates the equipment for operation at one or both of these temperature conditions.

6.1.2.4 If the heat pump is rated for operation at two frequencies or, in some cases, if the equipment has a dual-rated voltage, then more than one heating capacity test shall be conducted at each applicable outdoor-side temperature condition. [Table 6](#) (and [Table 2](#)) shall be used to determine if additional heating capacity tests are required.

6.1.3 Airflow conditions

6.1.3.1 Heat pump set-up requirements

On the outdoor-side of the heat pump, all resistance elements associated with inlets, louvres and any ductwork and attachments considered by the manufacturer as normal installation practice shall be installed. On the indoor-side of the heat pump, grille positions, damper positions, fan speeds, etc. shall be set in accordance with the manufacturer's published installation instructions, which are normally provided with the equipment. In the absence of such installation instructions, grille positions, damper positions, fan speeds, etc. shall be set to provide the maximum heating capacity when testing at the H1 temperature conditions. The heat pump set-up used for the H1 test shall be used during the H2 and/or H3 tests, if conducted. When tests are carried out at other settings, these settings shall be noted together with the heating capacity ratings.

6.1.3.2 Requirements when using the indoor air enthalpy method

Each heating capacity test shall be conducted with the external static pressure at each indoor unit maintained at 0 Pa. For the heating capacity calculations described in [Annex D](#), the indoor-side air volume flow rate shall be expressed in units of cubic metres per second (m³/s) of the air-water vapour mixture. For reporting purposes, the indoor-side air volume flow rate shall be expressed in units of cubic metres per second of standard air.

NOTE 1 Airflow measurements are carried out according to the specifications in [Annex B](#), as appropriate, as well as the provisions established in other appropriate annexes of this document.

NOTE 2 Additional guidance for making airflow measurements can be found in [ISO 3966](#) and [ISO 5167-1](#).

6.1.4 Defrost operation

6.1.4.1 Overriding of automatic defrost controls shall be prohibited. The controls may only be overridden when manually initiating a defrost cycle during preconditioning.

6.1.4.2 If the heat pump turns the indoor fan off during the defrost cycle, airflow through the indoor coil shall cease.

6.1.5 Test procedure — General

6.1.5.1 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. In the case of transient operation, in addition, the data collection period specified when using the indoor air enthalpy method (see [6.1.11.5](#)) is different from the data collection period required if using the calorimeter method (see [6.1.11.6](#)).

6.1.5.2 [Annex K](#) pictorially represents most of the different test sequences which are possible when conducting a heating capacity test.

6.1.6 Preconditioning period

6.1.6.1 The test room reconditioning apparatus and the heat pump under test shall be operated until the test tolerances specified in [7.3](#) are attained for at least 10 min.

6.1.6.2 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.

6.1.6.3 It is recommended that the preconditioning period end with an automatic or manually-initiated defrost cycle when testing at the H2 and H3 temperature conditions.

6.1.7 Equilibrium period

6.1.7.1 A complete equilibrium period is 1 h in duration.

6.1.7.2 Except as specified in [6.1.11.3](#), the heat pump shall operate while meeting the [7.3](#) test tolerances.

6.1.8 Data collection period

6.1.8.1 The data collection period immediately follows the equilibrium period.