BS ISO 13253:2017+A1:2020

BSI Standards Publication

Ducted air-conditioners and air-to-air heat pumps — Testing and rating for performance

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National foreword

This British Standard is the UK implementation of ISO 13253:2017+A1:2020. It supersedes BS ISO 13253:2017, which is withdrawn.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.

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Published by BSI Standards Limited 2020

ISBN 978 0 539 12545 0

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: Table E.1 amended

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INTERNATIONAL STANDARD

ISO 13253

Third edition
2017-07

Ducted air-conditioners and air-to-air heat pumps — Testing and rating for performance

Climatiseurs et pompes à chaleur air/air raccordés — Essais et détermination des caractéristiques de performance

Reference number
ISO 13253:2017(E)

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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 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 13253:2011), which has been technically revised.

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Ducted air-conditioners and air-to-air 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:

— ducted air-cooled air conditioners and ducted air to air heat pumps.

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, and

— 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 (see ISO 15042 for 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) non-ducted equipment (see ISO 5151 for testing of such equipment);

g) ducted air conditioners and/or ducted heat pumps, rated at less than 8 kW and intended to operate at external static pressures of less than 25 Pa, controlled by a single thermostat/controller (refer to ISO 5151).

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.

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

ISO 817, *Refrigerants — Designation and safety classification*

ISO 5151, *Non-ducted air conditioners and heat pumps — Testing and rating for performance*

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

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.

3.2
ducted heat pump
encased assembly or assemblies designed primarily to provide ducted delivery of conditioned air to an enclosed space, room or zone (conditioned space), including 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.

3.3
standard air
dry air at 20,0 °C and at a standard barometric pressure of 101,325 kPa, having a mass density of 1 204 kg/m^3

3.4
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.

3.5
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.

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3.6
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.

3.7
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.

3.8
sensible heat ratio
SHR
ratio of the *sensible cooling capacity* (3.7) to the *total cooling capacity* (3.4)

3.9
rated voltage
voltage shown on the nameplate of the equipment

3.10
rated frequency
frequency shown on the nameplate of the equipment

3.11
energy efficiency ratio
EER
ratio of the *total cooling capacity* (3.4) to the *effective power input* (3.14) 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/watts.

3.12
coefficient of performance
COP
ratio of the *heating capacity* (3.5) to the *effective power input* (3.14) 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/watts.

3.13
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.

3.14
effective power input
P_E
average electrical power input to the equipment, obtained from the following:

— the power input for operation of the compressor(s);

— the power input to electric heating devices used only for defrosting;

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— the power input to all control and safety devices of the equipment;

— the power input for operation of all fans, whether provided with the equipment or not

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

3.15
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 are functioning during full-load operations.

4 Symbols

Symbol	Description	Unit
A_l	coefficient, heat leakage	J/(s·K)
A_n	nozzle area	m^2
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)
C	airflow coefficient	$Pa/(m^3/s)^2$
C_d	nozzle discharge coefficient	—[a]
D_e	equivalent diameter	M
D_i	diameter of circular ducts, inlet	m
D_n	nozzle throat diameter	m
D_o	diameter of circular ducts, outlet	m
D_t	outside diameter of refrigerant tube	m
h_{a1}	specific enthalpy of air entering the indoor-side	J/kg[b]
h_{a2}	specific enthalpy of air leaving the indoor-side	J/kg[b]
h_{a3}	specific enthalpy of air entering the outdoor-side	J/kg[b]
h_{a4}	specific enthalpy of air leaving the 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 the indoor-side	J/kg
h_{r2}	specific enthalpy of refrigerant leaving the indoor-side	J/kg
h_{w1}	specific enthalpy of water or steam supplied to the indoor side test chamber	J/kg
h_{w2}	specific enthalpy of condensed moisture leaving the 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

[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.

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Symbol	Description	Unit
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
L	length of refrigerant line	m
L_d	length of duct	m
L_m	length to external static pressure measuring point	m
p_a	barometric pressure	kPa
p_c	test chamber equalization pressure	Pa
p_e	external static pressure (ESP)	Pa
p_{isc}	internal static pressure drop of the indoor coil cabinet assembly measured from the cooling capacity test	Pa
p_m	external static pressure (p_e during the blowing test)	Pa
p_n	absolute pressure at nozzle throat	Pa
p_v	velocity pressure at nozzle throat or static pressure difference across the nozzle	Pa
P_{fan}	estimated fan power to circulate indoor air	W
P_i	power input, indoor-side data	W
P_K	power input to the compressor	W
P_t	total power input to the 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, outdoor-side	m^3/s
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
R_e	Reynolds number	—[a]
SHR	Sensible heat ratio	—[a]
T	thickness of tubing insulation	m
t_a	temperature, ambient of compressor calorimeter	°C
t_{a1}	temperature of air entering the indoor-side, dry bulb	°C
t_{a2}	temperature of air leaving the indoor-side, dry bulb	°C
t_{a3}	temperature of air entering the outdoor-side, dry bulb	°C
t_{a4}	temperature of air leaving the 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

[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.

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Symbol	Description	Unit
v_n	specific volume of dry air portion of mixture at nozzle[b]	m^3/kg[b]
v'_n	specific volume of dry air portion of 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 the indoor-side[b]	kg/kg[b]
W_{i2}	specific humidity of air leaving the 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	pressure ratio	—[a]
α_a	Interconnecting tubing heat transfer coefficient	$W/(m^2 \cdot K)$
λ	thermal conductivity	W/(m·K)
ν	kinematic viscosity of air	m^2/s
$\eta_{fan,i}$	estimated indoor fan static efficiency	—[a]
$\eta_{mot,i}$	estimated indoor motor efficiency	—[a]
$\sum P_{ic}$	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
$\sum P_{oc}$	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 the 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
ϕ_{ho}	heating capacity, outdoor-side test chamber	W
ϕ_{li}	heat leakage into the indoor side test chamber through walls, floor and ceiling	W
ϕ_{lo}	heat leakage out of the outdoor side test chamber through walls, floor and ceiling	W
ϕ_{lp}	heat leakage into the indoor-side test chamber through the partition separating the indoor-side from the 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.

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5 Airflow setting

5.1 General

The airflow rate shall be specified by the manufacturer. This flow rate shall be for full-load cooling and be expressed in cubic metres per second (m^3/s) of standard air conditions, as defined in 3.3, and correspond with the compressor or compressors not operating.

P_{fan} is the estimated fan power required to circulate indoor air, in watts.

5.2 Indoor airflow setting

The airflow rate setting shall be made when only the fan is operating, at an ambient temperature between 20 °C to 30 °C and relative humidity between 30 % and 70 %. The airflow settings of the units shall be in accordance with Annex A for units supplied with a fan, and in accordance with Annex L for units supplied without a fan.

The rated airflow rate given by the manufacturer shall be set and the resulting external static pressure (ESP), p_e, measured. The measured ESP shall be not less than the ESP for rating, defined in Table 1. If the unit has an adjustable speed, it shall be adjusted to the lowest speed that provides the ESP for rating or greater.

5.3 ESP for rating

5.3.1 If the rated ESP specified by the manufacturer is greater than or equal to the minimum value given in Table 1, the specified rated ESP is used as the ESP for rating.

5.3.2 If the rated ESP specified by the manufacturer is less than the minimum value given in Table 1, and greater than or equal to 80 % of the maximum ESP, the specified rated ESP is used as the ESP for rating. The maximum ESP may either be specified by the manufacturer or be identified from fan curves provided by the manufacturer.

5.3.3 If the rated ESP specified by the manufacturer is less than the minimum value given in Table 1, and less than 80 % of the maximum ESP, the value of Table 1 or 80 % of the maximum ESP, whichever is less, is used as the ESP for rating.

5.3.4 If the rated ESP is not specified by the manufacturer, the value of Table 1 or 80 % of the maximum ESP, whichever is less, is used as the ESP for rating.

5.3.5 The process of selecting the ESP for rating is shown in Figure 1.

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5.3.6 In the case that the determined ESP for rating is less than 25 Pa, the unit can be considered as a non-ducted unit and be tested in accordance with ISO 5151.

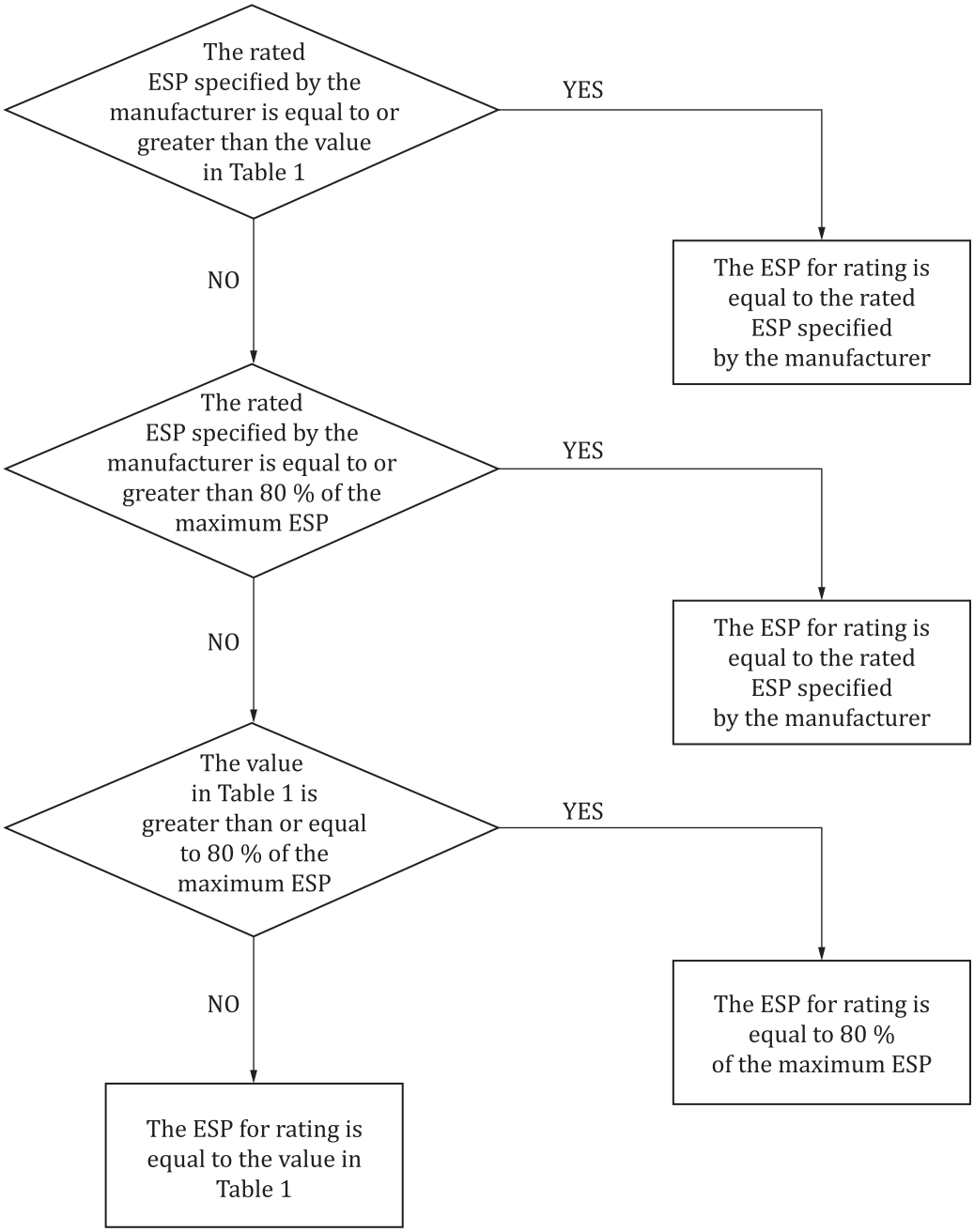

Figure 1 — Flowchart of selecting the ESP for rating

Table 1 — Pressure requirement for comfort air-conditioners

Standard capacity ratings kW	**Minimum external static pressure**[a] Pa
$0 < Q < 8$	25
$8 \leq Q < 12$	37
$12 \leq Q < 20$	50

[a] For equipment tested without an air filter installed, the minimum ESP, p_e, shall be increased by 10 Pa.

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Table 1 *(continued)*

Standard capacity ratings kW	Minimum external static pressure[a] Pa
$20 \leq Q < 30$	62
$30 \leq Q < 45$	75
$45 \leq Q < 82$	100
$82 \leq Q < 117$	125
$117 \leq Q < 147$	150
$Q > 147$	175

[a] For equipment tested without an air filter installed, the minimum ESP, p_e, shall be increased by 10 Pa.

5.4 Outdoor airflow

If the outdoor airflow is adjustable, all tests shall be conducted at the outdoor-side air quantity or 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 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 G.2.1).

5.5 Unit supplied without indoor fan

If no fan is supplied with the unit (i.e. coil only units), supplemental requirements given in Annex L also apply.

6 Cooling tests

6.1 Cooling capacity tests

6.1.1 General conditions

6.1.1.1 All equipment within the scope of this document shall have the cooling capacities and energy efficiency ratios (EERs) determined in accordance with the provisions of this document and rated at the cooling test conditions specified in Table 2. All tests shall be carried out in accordance with the requirements of Annex B and the test methods specified in Clause 8. All tests shall be conducted with the equipment functioning at full-load operation, as defined in 3.15. The electrical input values used for rating purposes shall be measured during the cooling capacity test.

6.1.1.2 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.

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6.1.2 Temperature conditions

6.1.2.1 The temperature conditions specified in Table 2 (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 2.

Table 2 — Cooling capacity rating conditions

Parameter	Standard rating conditions		
	T1	T2	T3
Temperature of air entering the indoor-side: — dry-bulb — wet-bulb	27 °C 19 °C	21 °C 15 °C	29 °C 19 °C
Temperature of air entering the outdoor-side: — dry-bulb — wet-bulb[a]	35 °C 24 °C	27 °C 19 °C	46 °C 24 °C
Test frequency[b]	Rated frequency		
Test voltage	See Table 3		

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 be required only when testing air-cooled condensers that evaporate the condensate.

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

6.1.2.2 Equipment manufactured for use only in a moderate climate similar to that specified in Table 2, Column T1, shall have ratings determined by tests conducted at T1 conditions and shall be designated type T1 equipment.

6.1.2.3 Equipment manufactured for use only in a cool climate similar to that specified in Table 2, Column T2, shall have ratings determined by tests conducted at T2 conditions and shall be designated type T2 equipment.

6.1.2.4 Equipment manufactured for use only in a hot climate similar to that specified in Table 2, Column T3, shall have ratings determined by tests conducted at T3 conditions and shall be designated type T3 equipment.

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6.1.2.5 Equipment manufactured for use in more than one of the climates defined in Table 2 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 2.

Table 3 — Voltages for capacity and performance tests (except the maximum cooling and the maximum heating performance tests)

Rated (nameplate) voltages[a] V	Test voltage[b] 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 220 V and 440 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.

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

6.1.3 Test conditions

6.1.3.1 Preconditions

The test room reconditioning apparatus and the equipment under test shall be operated until equilibrium conditions, as required by 8.3, are attained. Equilibrium conditions shall be maintained for not less than 1 h before capacity test data are recorded.

6.1.3.2 Duration of test

The data shall be recorded at equal intervals as required by 8.3.3. The recording of the data shall continue for at least a 30-min period during which the tolerances specified in 8.3 shall be met.

6.2 Maximum cooling performance test

6.2.1 General conditions

The test shall be conducted with the equipment functioning at full-load operation, as defined in 3.15. The test voltages in Table 4 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 6.2.4.2. The determination of cooling capacity and electrical power input is not required for this performance test.

6.2.2 Temperature conditions

Tests shall be carried out under the conditions given in Columns T1, T2 or T3 of Table 4, based on the intended use, as determined in 6.1.2. For equipment rated for use under more than one set of operating conditions, the most stringent set of the intended operating conditions shall be applied for test purposes.

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Table 4 — Maximum cooling performance test conditions

Parameter	Standard rating conditions		
	T1	T2	T3
Temperature of air entering the indoor-side: — dry-bulb — wet-bulb	32 °C 23 °C	27 °C 19 °C	32 °C 23 °C
Temperature of air entering the outdoor-side: — dry-bulb — wet-bulb[a]	43 °C 26 °C	35 °C 24 °C	52 °C 31 °C
Test frequency[b]	Rated frequency		
Test voltage	a) 90 % and 110 % of rated voltage with a single nameplate voltage rating. b) 90 % of the lower rated voltage and 110 % of the higher rated voltage for equipment with a dual or extended nameplate voltage.		

[a] The wet-bulb temperature condition shall be required only when testing air-cooled condensers that evaporate the condensate.

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

6.2.3 Airflow conditions

The maximum cooling performance test shall be conducted with an indoor-side fan speed setting as determined in 5.2.

6.2.4 Test conditions

6.2.4.1 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.

6.2.4.2 Duration of test

The equipment shall be operated continuously for 1 h after the specified air temperatures in Table 4 have been established in accordance with tolerance in Table 13. 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.

6.2.5 Performance requirements

6.2.5.1 Air-conditioners and heat pumps shall meet the following requirements when operating under the conditions specified in Table 4:

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 the motor-overload protective devices;

c) after the interruption of power, the equipment shall resume operation within 30 min and run continuously for 1 h except as specified in 6.2.5.2 and 6.2.5.3. See Figure 2.

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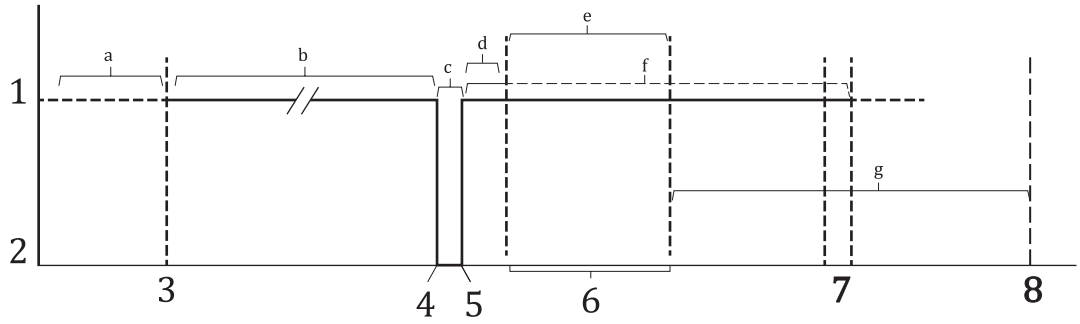

Key

1 power supply to equipment unit is on

2 power supply to equipment is off

3 official test period begins

4 power supply to equipment is turned off

5 power supply to equipment is 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, 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

6.2.5.2 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. The equipment shall be permitted to start and stop under the control of an automatic limit device, if provided.

6.2.5.3 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.

6.3 Minimum cooling performance test

6.3.1 General conditions

The test and operating conditions specified in Table 5 shall be used when conducting the minimum cooling performance test. The test shall be conducted with the equipment functioning at full-load operation, as defined in 3.15, except as required in 6.3.3. The determination of cooling capacity and electrical power input is not required for this performance test.

6.3.2 Temperature conditions

Tests shall be carried out under the temperature conditions established in Table 5.

6.3.3 Airflow conditions

The controls, fan speeds, dampers and grilles of the equipment shall be set to maximize the tendency for frost or ice to form on the evaporator, provided such settings are not contrary to the manufacturer's operating instructions. The test apparatus shall remain in the configuration established in 5.2 and in Annex A.

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6.3.4 Test conditions

6.3.4.1 Preconditions

The equipment shall be started and operated until the operating conditions have stabilized according to Tables 5 and 13.

6.3.4.2 Duration of test

After the operating conditions given in Table 5 have stabilized, in accordance with the test tolerance in Table 13, 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 5 — Minimum cooling performance test conditions

Parameter	Standard test conditions	
	T1 and T3	T2
Temperature of air entering the indoor-side: — dry-bulb — wet-bulb	21 °C 15 °C	21 °C 15 °C
Temperature of air entering the outdoor-side: — dry-bulb — wet-bulb[a]	21 °C —	10 °C —
Test frequency[b]	Rated frequency	
Test voltage	See Table 3	

[a] The wet-bulb temperature condition shall be required only when testing air-cooled condensers that evaporate the condensate.

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

6.3.5 Performance requirements

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

6.3.5.2 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 coil or reduce the airflow rate by more than 25 % of the initial airflow rate. If the equipment does not allow visual observation of the indoor coil and if the indoor air volume rate is not measured, then the requirements of 6.3.5.3 shall be met.

6.3.5.3 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 not cycle OFF on automatic controls during the test, and

— if coil circuit temperature(s) are measured, the temperature(s) shall not remain more than 2 K below the corresponding initial value for each circuit for more than 20 consecutive minutes, 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 minutes.

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b) If the compressor(s) cycle ON/OFF on automatic controls during the test, and

— if coil circuit temperature(s) are measured, the individual circuit temperature(s) 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.

If the indoor fan is stopped by the automatic controls during the test, the airflow through the indoor coil shall be reduced to zero.

6.4 Condensate control and enclosure sweat performance test

6.4.1 General conditions

The conditions which shall be used during the condensate control and enclosure sweat test are given in Table 6. The test shall be conducted with the equipment functioning at full-load operation, as defined in 3.15, except as required in 6.4.3. The determination of cooling capacity and electrical power input is not required for this performance test.

6.4.2 Temperature conditions

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

6.4.3 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.

6.4.4 Test conditions

6.4.4.1 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.

6.4.4.2 Duration of test

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

6.4.5 Performance requirements

6.4.5.1 When operating under the test conditions specified in Table 6, no condensed water shall drip, run or blow from the equipment.

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6.4.5.2 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.

Table 6 — Condensate control test conditions

Parameter	Standard test conditions
Temperature of air entering the indoor-side: — dry-bulb — wet-bulb	27 °C 24 °C
Temperature of air entering the outdoor-side: — dry-bulb — wet-bulb[a]	27 °C 24 °C
Test frequency[b]	Rated frequency
Test voltage	See Table 3

[a] The wet-bulb temperature condition shall be required only when testing air-cooled condensers that evaporate the condensate.

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

7 Heating tests

7.1 Heating capacity tests

7.1.1 General conditions

7.1.1.1 For all heating capacity tests, the requirements specified in Annex B shall apply. Testing shall be conducted using the method(s) and instrumentation that meet the requirements of 8.1 and 8.2.

7.1.1.2 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.

7.1.1.3 The test setup 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 D.

7.1.1.4 Standard rating conditions for heating capacity tests are specified in Table 7.

7.1.1.5 All Clause 7 heating capacity tests shall be conducted with the heat pump functioning at full-load operation, as defined in 3.15.

7.1.1.6 The manufacturer shall specify, for inverter-controlled compressors, the specific frequency that is needed to give full-load operation. The heat pump shall be maintained at this frequency for all heating capacity tests. If the manufacturer of a heat pump having a variable-speed compressor fails to provide information on the full-load operating frequency and how to achieve it during heating capacity tests,

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then the heat pump shall be operated with its thermostat or controller set to its maximum allowable temperature setting.

Table 7 — Heating capacity rating conditions

Parameter	Standard rating conditions		
	H1[a]–moderate cold condition	H2[a]–cold condition	H3[a]–very cold condition
Temperature of air entering the indoor-side: — dry-bulb — wet-bulb (maximum)	20 °C 15 °C		
Temperature of air entering the outdoor-side: — dry-bulb — wet-bulb	7 °C 6 °C	2 °C 1 °C	−7 °C −8 °C
Test frequency[b]	Rated frequency		
Test voltage	See Table 3		

[a] If a defrosting cycle occurs during the H1, H2 or H3 heating capacity tests, testing under these conditions shall be accomplished using either the calorimeter or the indoor air enthalpy method (see Annexes D and E).

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

7.1.2 Temperature conditions

7.1.2.1 Three different outdoor-side temperature conditions, designated as H1-moderate cold condition, H2-cold condition, and H3-very cold condition, are specified in Table 7.

7.1.2.2 Table 7 temperature conditions for the air entering the indoor-side of the equipment shall be used for all heating capacity tests.

7.1.2.3 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.

7.1.2.4 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 7 (and Table 3) shall be used to determine if additional heating capacity tests are required.

7.1.3 Airflow conditions

7.1.3.1 General conditions

7.1.3.1.1 Measurement of the indoor-side air volume rate is required in all cases, regardless of whether the calorimeter test method or the indoor air enthalpy test method is used to provide the primary measurement of heating capacity.

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

NOTE All airflow rates are expressed in units of m^3/s of standard air. In the heating capacity calculations described in Annex E, the indoor-side airflow rate is expressed in units of m^3/s of the air-water vapour mixture.

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7.1.3.1.3 When tests are conducted at settings other than those prescribed in 7.1.3.1.1 and 7.1.3.1.2, these alternative settings shall be noted together with the heating capacity ratings.

7.1.3.2 Requirements when testing heat pumps that provide both cooling and heating

7.1.3.2.1 Equipment settings, on both the indoor and the outdoor-sides, shall be the same as those established during the cooling capacity tests. The heating capacity tests shall be conducted at the outdoor-side airflow rate that is inherent with the outdoor-side air circuit, with the exception of any adjustments allowed if using the outdoor air enthalpy test method (see Annex G).

7.1.3.2.2 Heating capacity tests shall be conducted with the same setting of the damper or exhaust fan as for the cooling capacity test. If cooling capacity tests are conducted for more than one climatic condition (T1, T2, T3), with different flow rates, then the setting giving the highest flow rate shall be used to conduct the heating capacity tests.

7.1.3.3 Requirements when testing heating-only heat pumps

7.1.3.3.1 On the outdoor-side of the heat pump, all resistance elements associated with inlets, louvers, and any ductwork and attachments considered by the manufacturer as normal installation practice shall be installed. If the outdoor airflow is adjustable, all tests shall be conducted at the outdoor-side fan control setting that is specified by the manufacturer. 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 Annex G).

7.1.3.3.2 On the indoor-side of the heat pump, damper positions, fan speeds, etc. shall be set in accordance with the manufacturer's published installation instructions that are provided with the equipment. In the absence of such installation instructions, damper positions, fan speeds, etc. shall be set to provide the maximum heating capacity when testing at the H1 temperature conditions.

7.1.3.3.3 The heat pump setup used for the H1 test shall be used during the H2 and/or H3 tests, if conducted. There is no minimum required ESP, p_e, when testing at the H2 and H3 test conditions.

7.1.4 Defrost operation

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

7.1.4.2 Any defrost cycle, whether automatically or manually initiated, that occurs while preparing for or conducting a heating capacity test shall always be automatically terminated by the heat pump defrost controls.

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

7.1.5 Test procedure — General

7.1.5.1 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 upon 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 7.1.11.5) is different to the data collection period required if using the calorimeter method (see 7.1.11.6).

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7.1.5.2 Annex M represents pictorially most of the different test sequences that are possible when conducting a heating capacity test.

7.1.6 Preconditioning period

7.1.6.1 The test room preconditioning apparatus and the heat pump under test shall be operated until the test tolerances specified in 8.3 are attained for at least 10 min.

7.1.6.2 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.

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

7.1.7 Equilibrium period

7.1.7.1 The equilibrium period immediately follows the preconditioning period.

7.1.7.2 A complete equilibrium period is 1 h in duration.

7.1.7.3 Except as specified in 7.1.11.3, the heat pump shall operate while meeting the test tolerances in 8.3.

7.1.8 Data collection period

7.1.8.1 The data collection period immediately follows the equilibrium period.

7.1.8.2 Data shall be collected as specified in 8.1 for the chosen test method(s). If using the calorimeter method, heating capacity shall be calculated as specified in Annex D. If using the indoor air enthalpy method, the heating capacity shall be calculated as specified in Annex E. For cases where one of the confirmative test methods from 8.1.3 is used, heating capacity shall be calculated as specified in the appropriate annex.

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

7.1.8.4 Except as specified in 7.1.8.3 and 7.1.8.5, data shall be sampled at equal intervals that span 30 s or less.

7.1.8.5 During defrost cycles, plus the first 10 min following defrost termination, certain data used in evaluating the integrated heating capacity of the heat pump shall be sampled at equal intervals that span 10 s or less. When using the indoor air enthalpy method, these more frequently sampled data include the change in indoor-side dry-bulb temperature. When using the calorimeter method, these more frequently sampled data include all measurements required to determine the indoor-side capacity.

7.1.8.6 For heat pumps that automatically cycle off the indoor fan during a defrost, the contribution of the net heating delivered and/or the change in indoor-side dry-bulb temperature shall be assigned the value of zero when the indoor fan is off, if using the indoor air enthalpy method. If using the calorimeter test method, the integration of capacity shall continue while the indoor fan is off.

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7.1.8.7 For both the indoor air enthalpy and the calorimeter test methods, the difference between the dry-bulb temperature of the air leaving and entering the indoor coil shall be measured. For each 5-min interval during the data collection period, an average temperature difference shall be calculated, $\Delta t_i(\tau)$. The average temperature difference for the first 5 min of the data collection period, $\Delta t_i(\tau=0)$, shall be saved for the purpose of calculating the change, Δt, expressed as a percentage, as given in Formula (1):

$$\%\Delta t = \left(\frac{\Delta t_{i(\tau=0)} - \Delta t_{i(\tau)}}{\Delta t_{i(\tau=0)}} \right) \times 100 \quad (1)$$

7.1.9 Test procedure when a defrost cycle (whether automatically or manually initiated) ends the preconditioning period

7.1.9.1 If the quantity $\%\Delta t$ exceeds 2,5 % during the first 35 min of the data collection period, the heating capacity test shall be designated a transient test (see 7.1.11). Likewise, if the heat pump initiates a defrost cycle during the equilibrium period or during the first 35 min of the data collection period, the heating capacity test shall be designated a transient test.

7.1.9.2 If the conditions specified in 7.1.9.1 do not occur and the test tolerances given in 8.3 are satisfied during both the equilibrium period and the first 35 min of the data collection period, then the heat capacity test shall be designated a steady-state test. Steady-state tests shall be terminated after 35 min of data collection.

7.1.10 Test procedure when a defrost cycle does not end the preconditioning period

7.1.10.1 If the heat pump initiates a defrost cycle during the equilibrium period or during the first 35 min of the data collection period, the heating capacity test shall be restarted as specified in 7.1.10.3.

7.1.10.2 If the quantity $\%\Delta t$ exceeds 2,5 % at any time during the first 35 min of the data collection period, the heating capacity test shall be restarted as specified in 7.1.10.3. Prior to the restart, a defrost cycle shall occur. This defrost cycle may be manually initiated or delayed until the heat pump initiates an automatic defrost.

7.1.10.3 If either 7.1.10.1 or 7.1.10.2 apply, then the restart shall begin 10 min after the defrost cycle terminates with a new, hour-long equilibrium period. This second attempt shall follow the requirements of 7.1.7 and 7.1.8 and the test procedure of 7.1.9.

7.1.10.4 If the conditions specified in 7.1.10.1 or 7.1.10.2 do not occur and the test tolerances given in 8.3 are satisfied during both the equilibrium period and the first 35 min of the data collection period, then the heating capacity test shall be designated a steady-state test. Steady-state tests shall be terminated after at least 35 min of data collection.

7.1.11 Test procedure for transient tests

7.1.11.1 When, in accordance with 7.1.9.1, a heating capacity test is designated a transient test, the adjustments specified in 7.1.11.2 to 7.1.11.6 shall apply.

7.1.11.2 The outdoor air enthalpy test method shall not be used and its associated outdoor-side measurement apparatus shall be disconnected from the heat pump. In all cases, the normal outdoor-side airflow of the heat pump shall not be disturbed. Use of other confirming test methods is not required.

7.1.11.3 To constitute a valid transient heating capacity test, the test tolerances specified in Table 8 shall be achieved during both the equilibrium period and the data collection period. As noted in Table 8, the test tolerances are specified for two sub-intervals. Interval H consists of data collected during each

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heating interval, with the exception of the first 10 min after defrost termination. Interval D consists of data collected during each defrost cycle plus the first 10 min of the subsequent heating interval.

7.1.11.4 The test tolerance parameters in Table 8 shall be determined throughout the equilibrium and data collection periods. All data collected during each interval, H or D, shall be used to evaluate compliance with the Table 8 test tolerances. Data from two or more H intervals or two or more D intervals shall not be combined and then used in evaluating Table 8 compliance. Compliance shall be based on evaluating data from each interval separately.

7.1.11.5 If using the indoor air enthalpy method, the data collection period shall be continued until 3 h have elapsed or until the heat pump completes three complete cycles during the period, whichever occurs first. If at an elapsed time of 3 h, the heat pump is conducting a defrost cycle, the cycle shall be completed before terminating the collection of data. A complete cycle consists of a heating period and a defrost period, from defrost termination to defrost termination.

7.1.11.6 If using the calorimeter method, the data collection period shall be continued until 6 h have elapsed or until the heat pump completes six complete cycles during the period, whichever occurs first. If at an elapsed time of 6 h, the heat pump is conducting a defrost cycle, the cycle shall be completed before terminating the collection of data. A complete cycle consists of a heating period and a defrost period, from defrost termination to defrost termination.

NOTE Consecutive cycles are repeated with similar frost and defrost intervals before data is selected for use in calculating the integrated capacity and power.

7.1.11.7 Because of the confirming test method requirement of 8.1.3, the outdoor air enthalpy test apparatus may have to be disconnected from the heat pump, as specified in 7.1.11.2, during a heating capacity test. If removal during a test is required, the changeover interval shall not be counted as part of the elapsed time of the equilibrium or data collection periods. The changeover interval shall be defined as starting at the instant the heating capacity test is designated a transient test and ending when the test tolerances from Table 8 are first re-established after the outdoor air enthalpy apparatus is disconnected from the heat pump.

Table 8 — Variations allowed in heating capacity tests when using the transient (T) test procedure

Reading	Variation of arithmetical mean values from specified test conditions		Variation of individual readings from specified test conditions	
	Interval H[a]	Interval D[b]	Interval H[a]	Interval D[b]
Temperature of air entering the indoor-side:				
— dry-bulb	±0,6 K	±1,5 K	±1,0 K	±2,5 K
— wet-bulb	—	—	—	—
Temperature of air entering the outdoor-side:				
— dry-bulb	±0,6 K	±1,5 K	±1,0 K	±5,0 K
— wet-bulb	±0,3 K	±1,0 K	±0,6 K	—
Voltage	—	—	±2 %	±2 %
External resistance to airflow	±5 Pa	—	±5 Pa	—

[a] Applies when the heat pump is in the heating mode, except for the first 10 min after termination of a defrost cycle.

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

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7.1.12 Heating capacity test results

7.1.12.1 The electrical energy supplied to the heat pump during the test shall be recorded, along with the corresponding elapsed time, at the termination of each defrost cycle during the data collection period, if applicable, and at the termination of the data collection period.

7.1.12.2 Average heating capacity and average electrical power input shall be calculated in accordance with 9.1.4. For transient tests, the quantities shall be calculated using data from the total number of complete cycles that are achieved before the data collection period is terminated. In the event that a complete cycle does not occur during the data collection period of a transient test, the entire data set shall be used for the calculations (see 9.1.4.2).

7.2 Maximum heating performance test

7.2.1 General conditions

The conditions given in Table 9 shall be used during the maximum heating performance test. The test shall be conducted with the equipment functioning at full-load operation, as defined in 3.15.

The test voltages in Table 9 shall be maintained at the specified percentages under running conditions.

The determination of heating capacity and electrical power input is not required for this performance test.

7.2.2 Temperature conditions

The temperature conditions given in Table 9 shall be used during these tests unless the manufacturer specifies higher temperature conditions in the manufacturer's equipment specification sheets.

Table 9 — Maximum heating performance test conditions

Parameter	Standard test conditions
Temperature of air entering the indoor-side: — dry-bulb	27 °C
Temperature of air entering the outdoor-side: — dry-bulb — wet-bulb	24 °C 18 °C
Test frequency[a]	Rated frequency
Test voltage	a) 90 % and 110 % of rated voltage for equipment with a single nameplate voltage rating b) 90 % of the lower rated voltage and 110 % of the higher rated voltage for equipment with a dual or extended nameplate voltage
[a] Equipment with dual-rated frequencies shall be tested at each frequency.	

7.2.3 Airflow conditions

The maximum heating performance test shall be conducted with an indoor-side fan speed setting as determined in 5.2 and Annex A, except as required in 7.2.4.1. For heating-only heat pumps, the indoor-side fan speed shall be set as specified in 7.1.3.3, except as required in 7.2.4.1.

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