INTERNATIONAL STANDARD

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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
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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 13253 was prepared by Technical Committee ISO/TC 86, *Refrigeration and air-conditioning*, Subcommittee SC 6, *Testing and rating of air-conditioners and heat pumps*.

This second edition cancels and replaces the first edition (ISO 13253:1995), which has been technically revised.

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

1 Scope

This International Standard specifies the standard conditions for capacity and efficiency ratings of ducted, air-cooled air-conditioners and ducted air-to-air heat pumps. This International Standard is applicable to the test methods for determining the capacity and efficiency ratings. Residential, commercial, and industrial single-package and split-system air-conditioners and heat pumps are included. The equipment (taken to mean ducted air-conditioners and/or ducted heat pumps) shall be factory-made and electrically driven, and shall use mechanical compression.

This International Standard is applicable to equipment utilizing one or more refrigeration systems, one outdoor unit and one or more indoor units controlled by a single thermostat/controller. This International Standard is applicable to equipment utilizing single-, multiple- and variable-capacity components.

This International Standard 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).

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

2 Normative references

The following referenced documents are indispensable for the application 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/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.

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 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 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 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 Heating capacity is expressed in units of watts.

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 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 Sensible cooling capacity is expressed in units of watts.

3.8
sensible heat ratio
SHR
ratio of the sensible cooling capacity to the total cooling capacity

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 to the effective power input to the device at any given set of rating conditions

NOTE 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 to the effective power input to the device at any given set of rating conditions

NOTE 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 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 power input for operation of 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, whether provided with the equipment or not

NOTE 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 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·°C
A_n	nozzle area	m^2
α	pressure ratio	—
C_d	nozzle discharge coefficient	—
c_o	concentration of oil	—
c_pa	specific heat of moist air	J/kg·°C
c_pa1	specific heat of moist air entering the indoor side	J/kg·°C
c_pa2	specific heat of moist air leaving the indoor side	J/kg·°C
c_pw	specific heat of water	J/kg·°C
D_e	equivalent diameter	mm
D_n	nozzle throat diameter	mm
D_i	diameter of circular ducts, inlet	mm
D_o	diameter of circular ducts, outlet	mm
D_t	outside diameter of refrigerant tube	mm
h_a1	specific enthalpy of air entering the indoor side	J/kg of dry air
h_a2	specific enthalpy of air leaving the indoor side	J/kg of dry air
h_a3	specific enthalpy of air entering the outdoor side	J/kg of dry air
h_a4	specific enthalpy of air leaving the outdoor side	J/kg of dry air
h_f1	specific enthalpy of refrigerant liquid entering the expansion device	J/kg
h_f2	specific enthalpy of refrigerant liquid leaving the condenser	J/kg
h_g1	specific enthalpy of refrigerant vapour entering the compressor	J/kg
h_g2	specific enthalpy of refrigerant vapour leaving the condenser	J/kg
h_k2	specific enthalpy of fluid leaving the calorimeter evaporator	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 compartment	J/kg
h_w2	specific enthalpy of condensed moisture leaving the indoor-side compartment	J/kg
h_w3	specific enthalpy of condensate removed by the air-treating coil in the outdoor-side compartment of the reconditioning equipment	J/kg
h_w4	specific enthalpy of the water supplied to the outdoor-side compartment	J/kg
h_w5	specific enthalpy of the condensed water (in the case of test condition high) and the frost, respectively (in the case of test conditions low or extra-low) in the test unit	J/kg
K_1	latent heat of vaporization of water (2 500,4 J/g at 0 °C)	J/g
L_d	length of duct	m
L_m	length to external static pressure measuring point	m

Symbol	Description	Unit
ln	natural logarithm	—
m_1	mass of cylinder and bleeder assembly, empty	g
m_3	mass of cylinder and bleeder assembly, with sample	g
m_5	mass of cylinder and bleeder assembly, with oil from sample	g
$\eta_{fan,i}$	estimated indoor fan static efficiency	—
$\eta_{mot,i}$	estimated indoor motor efficiency	—
p_a	barometric pressure	kPa
p_c	compartment equalization pressure	kPa
p_e	external static pressure (ESP)	kPa
p_{isc}	internal static pressure drop of the indoor coil cabinet assembly measured from the cooling capacity test	Pa
p_m	measured external static pressure	kPa
p_n	pressure at the nozzle throat	kPa abs
p_v	velocity pressure at nozzle throat or static pressure difference across the nozzle	Pa
Re	Reynolds number	—
ϕ_{ci}	heat removed from the indoor-side compartment	W
ϕ_c	heat removed by the cooling coil in the outdoor-side compartment	W
ϕ_{lp}	heat leakage into the indoor-side compartment through the partition separating the indoor side from the outdoor side	W
ϕ_{li}	heat leakage into the indoor-side compartment through walls, floor and ceiling	W
ϕ_{lo}	heat leakage out of the outdoor-side compartment through walls, floor and ceiling	W
ϕ_L	line heat loss in interconnecting tubing	W
ϕ_e	heat input to the calorimeter evaporator	W
ϕ_{sc}	sensible cooling capacity	W
ϕ_{sci}	sensible cooling capacity (indoor-side data)	W
ϕ_d	latent cooling capacity (dehumidifying)	W
ϕ_{hi}	heating capacity (indoor-side compartment)	W
ϕ_{ho}	heating capacity (outdoor-side compartment)	W
ϕ_{lci}	latent cooling capacity (indoor-side data)	W
ϕ_{tci}	total cooling capacity (indoor-side data)	W
ϕ_{tco}	total cooling capacity (outdoor-side data)	W
ϕ_{thi}	total heating capacity (indoor-side data)	W
ϕ_{tho}	total heating capacity (outdoor-side data)	W
P_{fan}	estimated fan power to circulate indoor air	W
P_i	power input, indoor-side data	W
$\sum P_{ic}$	other power input to the indoor-side compartment (e.g. illumination, electrical and thermal power input to the compensating device, heat balance of the humidification device)	W

Symbol	Description	Unit
$\sum P_{oc}$	sum of all total power input to the outdoor-side compartment, not including power to the equipment under test	W
P_E	effective power input to the equipment	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
$q_{V,i}$	indoor air volume flow rate	m^3/s
$q_{V,o}$	measured outdoor air volume flow rate	m^3/s
q_w	condenser water flow rate	kg/s
q_{wc}	rate at which water vapour is condensed by the equipment	g/s
$q_{m,w}$	water mass flow supplied to the outside compartment for maintaining the test conditions	kg/s
t_a	temperature, ambient	°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 the surface of the calorimeter condenser	°C
t_{w1}	temperature of water entering the calorimeter	°C
t_{w2}	temperature of water leaving the calorimeter	°C
v	kinematic viscosity of air	m^2/s
v_n	velocity of air, at nozzle	m/s
V_n	specific volume of dry air portion of mixture at nozzle	m^3/kg
V'_n	specific volume of air at nozzle	m^3/kg of air-water vapour mixture
W_{i1}	specific humidity of air entering the indoor side	kg/kg of dry air
W_{i2}	specific humidity of air leaving the indoor side	kg/kg of dry air
W_n	specific humidity at nozzle inlet	kg/kg of dry air
W_r	water vapour (rate) condensed by the equipment	g/s
X_r	mass ratio, refrigerant to refrigerant-oil mixture	—
Y	expansion factor	—

5 Airflow

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 terms of standard air conditions 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.

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.

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.

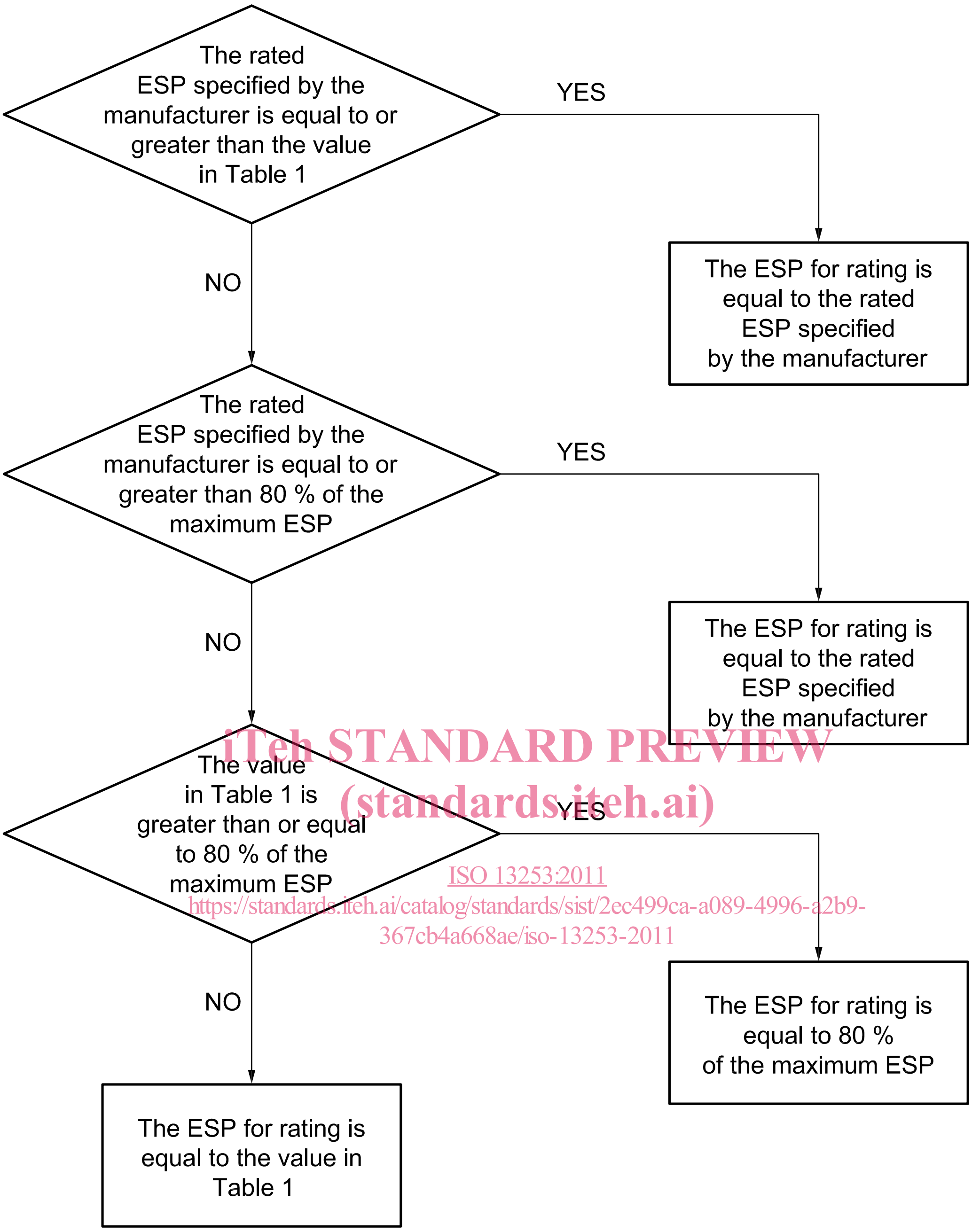

Figure 1 — Flowchart of selecting the ESP for rating

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
$20 \leq Q < 30$	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 this International Standard, except to adjust for any change caused by the attachment of the airflow measuring device when using the outdoor air enthalpy test method (see H.2.1).

5.5 Unit supplied without indoor fan

If no fan is supplied with the unit (i.e. coil only units), the requirements in Annex A and the supplemental requirements given in Annex M 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 International Standard shall have the cooling capacities and energy efficiency ratios (EERs) determined in accordance with the provisions of this International Standard 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.