INTERNATIONAL STANDARD

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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

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Contents

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Annexes

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.

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.

International Standard ISO 5151 was prepared by Technical Committee ISO/TC 86, *Refrigeration*, Subcommittee SC 6, *Factory-made air-conditioning and heat pump units*.

This first edition cancels and replaces ISO/R 859:1968.

Annexes A, B and C form an integral part of this International Standard. Annexes D, E, F and G are for information only.

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

1 Scope

1.1 This International Standard specifies the standard conditions on which the ratings of single-package and split-system non-ducted air conditioners employing air- and water-cooled condensers and heat pumps employing air-cooled condensers are based, and the test methods to be applied for determination of the various ratings. This International Standard is limited to systems utilizing a single refrigeration circuit and having one evaporator and one condenser.

NOTE 1 For the purposes of this International Standard, the term "equipment" will be used to mean "non-ducted air conditioners and/or non-ducted heat pumps".

1.2 This International Standard also specifies the test conditions and the corresponding test procedures for determining various performance characteristics of these non-ducted air conditioners and heat pumps.

1.3 It does not apply to the testing and rating of:

a) water-source heat pumps;

b) multiple split-system[1] air conditioners and heat pumps;

c) units designed for use with additional ducting; or

d) mobile (windowless) units having a condenser exhaust duct.

1.4 Clause 4 of this International Standard covers the rating and testing conditions for non-ducted air conditioners and heat pumps when used for cooling.

1.5 Clause 5 of this International Standard covers the rating and testing conditions for non-ducted air conditioners and heat pumps when used for heating. The means for heating may be the heat pump refrigeration cycle or electrical resistance.

1.6 Annex A establishes testing procedures. Annex B describes the test facilities for the calorimeter method. Annex C provides formulae for the calculation of heating and cooling capacities. Annex D describes instruments which can be used in making measurements, and annex E describes methods for measuring air-flow. Annex F describes the outdoor air-enthalpy test method. Annex G gives a list of symbols used in the annexes.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 817:—[2], *Refrigerants — Number designation.*

3 Definitions

For the purposes of this International Standard, the following definitions apply. Annex G lists the symbols used to identify the terms contained in this International Standard.

1) A unit having two or more indoor units connected to a single outdoor unit.

2) To be published. (Revision of ISO 817:1974)

3.1 non-ducted air conditioner: An encased assembly or assemblies designed as a unit, primarily for mounting in a window, or through a wall, or as a console. It is designed primarily to provide free delivery of conditioned air to an enclosed space, room or zone (conditioned space). It includes a prime source of refrigeration for cooling and dehumidification and may also include means for heating other than a heat pump, and means for the circulation and the cleaning of air. It may also include means for heating, humidifying, ventilating or exhausting air. Where such equipment is provided in more than one assembly, the separated assemblies (split-systems) are to be designed to be used together, and the requirements of rating outlined in this International Standard are based on the use of matched assemblies.

3.2 non-ducted heat pump: An encased assembly or assemblies designed as a unit, primarily for mounting in a window, or through a wall, or as a console. It is designed primarily to provide free delivery of conditioned air to an enclosed space, room or zone (conditioned space). It includes a prime source of refrigeration for heating which takes heat from a heat source. It may 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 may also include means for the circulation and the cleaning of air, humidifying, ventilating or exhausting air.

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.

NOTE 2 The definitions given in 3.4 to 3.13 relating to air-flow are illustrated in figure 1.

3.4 indoor discharge air-flow: Rate of flow of air from the indoor-side outlet of the equipment into the conditioned space.

3.5 indoor intake air-flow: Rate of flow of air into the equipment from the conditioned space.

3.6 ventilation air-flow: Rate of flow of air introduced to the conditioned space through the equipment from the outside.

3.7 outdoor discharge air-flow: Discharge rate of flow of air from the outdoor side of the equipment to the outdoors.

3.8 outdoor intake air-flow: Rate of flow of air into the equipment from the outdoor side.

3.9 exhaust air-flow: Rate of flow of air from the indoor side through the equipment to the outdoor side.

3.10 leakage air-flow: 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.

3.11 bypassed indoor air-flow: Flow of conditioned air directly from the indoor-side outlet to the indoor-side inlet of the equipment.

3.12 bypassed outdoor air-flow: Flow of air directly from the outdoor-side outlet to the outdoor-side inlet of the equipment.

3.13 equalizer opening air-flow: Rate of flow of air through the equalizer opening in the partition wall of a calorimeter.

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.

3.15 heating capacity: Amount of heat that the equipment can add to the conditioned space in a defined interval of time.

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.

3.17 sensible cooling capacity: Amount of sensible heat that the equipment can remove from the conditioned space in a defined interval of time.

3.18 sensible heat ratio: Ratio of the sensible cooling capacity to the total cooling capacity.

3.19 rated voltage(s): Voltage(s) shown on the nameplate of the equipment.

3.20 rated frequency(ies): Frequency(ies) shown on the nameplate of the equipment.

3.21 energy efficiency ratio (EER): Ratio of the total cooling capacity to the effective power input at any given set of rating conditions. (Where the EER is stated without an indication of units, it shall be understood that it is derived from watts/watt.)

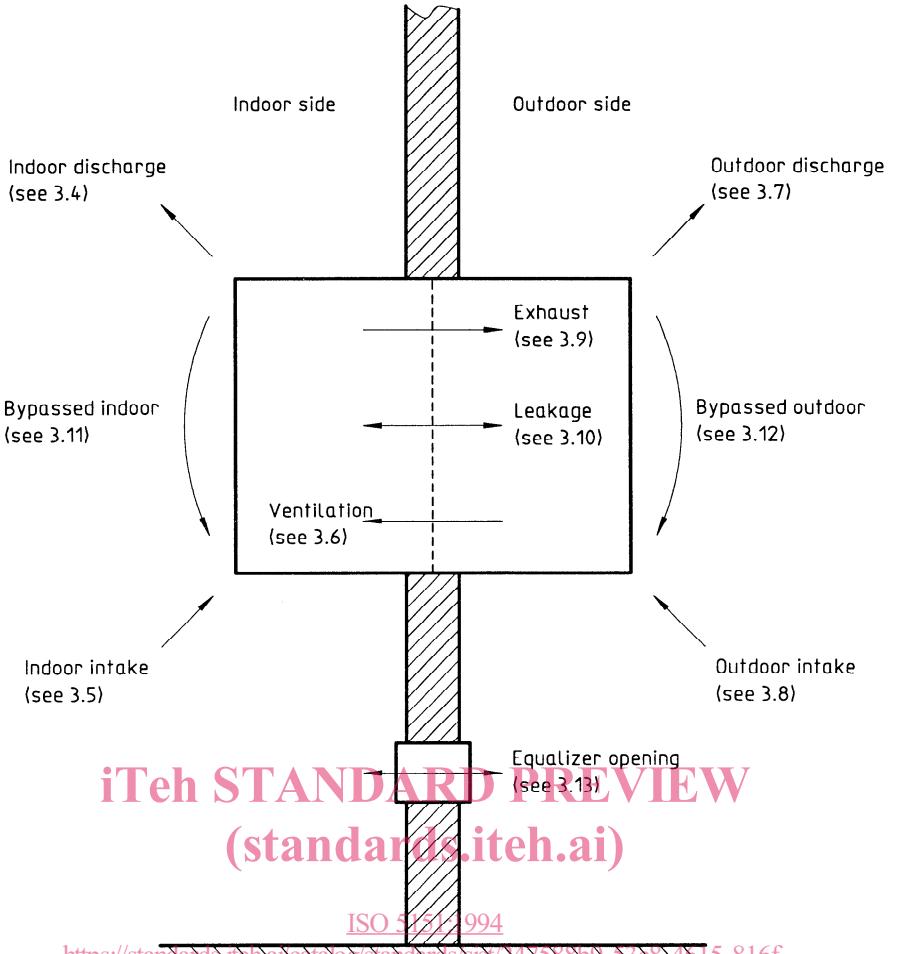

Figure 1 — Air-flow diagram illustrating definitions given in 3.4 to 3.13

3.22 coefficient of performance (COP): Ratio of the heating capacity to the effective power input of the device at any given set of rating conditions.

3.23 effective power input (P_E)**:** Average electrical power input to the equipment within a defined interval of time, obtained from:

— the power input for operation of the compressor and any power input for defrosting, excluding additional electrical heating devices not used for defrosting;

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

— the power input of the conveying devices within the equipment for heat transport media (e.g. fan, pump).

3.24 total power input (P_t)**:** Power input to all components of the equipment as delivered.

4 Cooling tests

4.1 Cooling capacity ratings

4.1.1 General conditions

All equipment within the scope of this International Standard shall have the cooling capacities and energy efficiency ratios determined in accordance with the provisions of this International Standard and rated at the cooling conditions specified in table 1.

4.1.2 Temperature conditions

4.1.2.1 Test conditions stated in table 1, columns T1, T2 and T3, shall be considered standard rating conditions.

4.1.2.2 Equipment manufactured for use in a moderate climate similar to that specified in table 1, column T1 only, shall have a nameplate rating determined by tests conducted at these specified conditions and shall be designated type T1 units.

4.1.2.3 Equipment manufactured for use in a cool climate similar to that specified in table 1, column T2 only, shall have a nameplate rating determined by tests conducted at these specified conditions and shall be designated type T2 units.

4.1.2.4 Equipment manufactured for use in a hot climate similar to that specified in table 1, column T3 only, shall have a nameplate rating determined by tests conducted at these specified conditions and shall be designated type T3 units.

4.1.2.5 Equipment manufactured for use in more than one of the types of climate defined in table 1, columns T1, T2 and T3, shall have marked on the nameplate the designated type and rating determined by tests for each of the specified conditions for which they have been designated and tested.

4.1.3 Air-flow conditions

When determining air-flow quantities for rating purposes, tests shall be conducted at standard rating conditions (see table 1) with 0 Pa static maintained at the air discharge of the equipment and with the refrigeration means in operation and after condensate equilibrium has been obtained. All air quantities shall be expressed as metre cubed per second $\left(m^3/s\right)$ of standard air as defined in 3.3.

Table 1 — Test conditions for the determination of cooling capacity

Parameter	Standard test conditions		
	T1	T2	T3
Temperature of air entering indoor side (°C)			
dry-bulb	27	21	29
wet-bulb	19	15	19
Temperature of air entering outdoor side (°C)			
dry-bulb	35	27	46
wet-bulb[1]	24	19	24
Condenser water temperature[2] (°C)			
inlet	30	22	30
outlet	35	27	35
Test frequency	Rated frequency[3]		
Test voltage	Rated voltage[4]		

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

1) The wet-bulb temperature condition is not required when testing air-cooled condensers which do not evaporate the condensate.

2) Representative of equipment working with cooling towers. For equipment designed for other uses, the manufacturer shall designate the condenser water inlet and outlet temperatures or the water flowrates and the inlet water temperature in the ratings.

3) Equipment with dual-rated frequencies shall be tested at each frequency.

4) The test voltage on dual-rated voltage equipment shall be performed at both voltages or at the lower of the two voltages if only a single rating is published.

4.1.4 Test conditions

4.1.4.1 Preconditions

a) When using the calorimeter method, two simultaneous methods of determining capacities shall be used. One method determines the capacity on the indoor side, the other measures the capacity on the outdoor side. These two simultaneous determinations shall agree within 4 % of the value obtained on the indoor side for the test to be valid. In the case of non-ducted air conditioners with water-cooled condensers, the heat-flow rejected via the cooling water is measured instead of the measurement in the outdoor-side compartment.

b) The test capacity shall include the determination of the sensible, latent or total cooling capacity as determined in the indoor-side compartment.

c) 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).

d) Grille positions, damper positions, fan speeds, etc. shall be set to result in maximum cooling capacity unless this is contrary to the manufacturer's instructions. When tests are made at other settings, these shall be noted together with the cooling capacity ratings.

e) Test conditions shall be maintained for not less than 1 h before recording data for the capacity test.

4.1.4.2 Duration of test

The test shall then be run for 30 min, recording data every 5 min, providing seven sets of readings. Variations allowed in capacity test readings shall be in accordance with table 12.

4.2 Maximum cooling test

4.2.1 General conditions

The conditions which shall be used during the maximum cooling test are given in table 2.

4.2.2 Temperature conditions

Tests shall be carried out under the conditions given in column T1, T2 or T3 of table 2, based on the intended use, as determined in 4.1.2. Equipment intended for use under more than one set of operating conditions shall have the highest relevant set of the intended operating conditions applied for test purposes. If maximum operating temperature conditions for cooling are specified in the manufacturer's equipment specification sheets, they shall be used in lieu of those in table 2.

4.2.3 Air-flow conditions

The maximum cooling test shall be conducted with an indoor-side air volume flowrate as determined under 4.1.3.

4.2.4 Test conditions

4.2.4.1 Preconditions

The controls of the equipment shall be set for maximum cooling and all ventilating air dampers and exhaust air dampers shall be closed. The equipment shall be operated continuously for 1 h after the specified air temperatures and the equilibrium condensate level have been established.

4.2.4.2 Duration of test

All power to the equipment shall be cut off for 3 min and then restored for 1 h.

4.2.5 Performance requirements

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

4.2.5.2 The motors of the equipment shall operate continuously for the first hour of the test without tripping of the motor-overload protective devices.

4.2.5.3 The motor-overload 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 motor-overload protective device shall trip.

4.2.5.4 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.

Table 2 — Maximum cooling test conditions

Parameter	Standard test conditions		
	T1	T2	T3
Temperature of air entering indoor side (°C)			
dry-bulb	32	27	32
wet-bulb	23	19	23
Temperature of air entering outdoor side (°C)			
dry-bulb	43	35	52
wet-bulb[1)]	26	24	31
Condenser water temperature (°C)			
inlet[2)]	34	27	34
Test frequency	Rated frequency[3)]		
Test voltage	1) 90 % and 110 % of rated voltage with a single nameplate rating 2) 90 % of minimum voltage and 110 % of maximum voltage for units with a dual nameplate voltage		

1) The wet-bulb temperature condition is not required when testing air-cooled condensers which do not evaporate the condensate.

2) For equipment with water-cooled condensers, the water flowrate shall be the same as that used in cooling capacity test (minimum flowrate for equipment with multiple cooling capacity rating). For equipment incorporating a condenser water control valve, it shall be allowed to operate normally.

3) Equipment with dual-rated frequencies shall be tested at each frequency.

4.3 Minimum cooling test

4.3.1 General conditions

The conditions which shall be used during the minimum cooling test are given in table 3.

4.3.2 Temperature conditions

If minimum operating temperature conditions are specified in the manufacturer's equipment specification sheets, they shall be used in lieu of those given in table 3.

4.3.3 Air-flow conditions

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

4.3.4 Test conditions

4.3.4.1 Preconditions

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

4.3.4.2 Duration of test

After the operating conditions have stabilized, the equipment shall be operated for a period of 4 h.

4.3.5 Performance requirements

4.3.5.1 After the end of the starting period of 10 min, no safety element shall cut off during the 4 h of operation.

4.3.5.2 At the end of 4 h, any accumulation of ice or frost on the evaporator shall not cover more than 50 % of the indoor-side face area of the evaporator coil.

Table 3 — Minimum cooling test conditions

Parameter	Standard test conditions
Temperature of air entering indoor side (°C) dry-bulb wet-bulb	 21[1)] 15
Temperature of air entering outdoor side	Lowest limit recommended by manufacturer
Water temperature (°C) inlet	 10
Water flowrate	As specified by the manufacturer
Test frequency	Rated frequency[2)]
Test voltage	Rated voltage[3)]

1) 21 °C or the lowest temperature above 21 °C at which the regulating (control) device will allow the equipment to operate.

2) Equipment with dual-rated frequencies shall be tested at each frequency.

3) Equipment with dual-rated voltages shall be tested at the higher voltage.

4.4 Enclosure sweat and condensate disposal test

4.4.1 General conditions

Air-cooled equipment which rejects condensate to the condenser air shall meet the requirements of this test. The electrical conditions which shall be used during the enclosure sweat and condensate disposal test are given in table 4.

4.4.2 Temperature conditions

The temperature conditions which shall be used during this test are given in table 4.

4.4.3 Air-flow 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.

4.4.4 Test conditions

4.4.4.1 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.

4.4.4.2 Duration of test

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

4.4.5 Performance requirements

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

4.4.5.2 Equipment which rejects condensate to the condenser air shall dispose all condensate and there shall be no dripping or blowing-off of water from the equipment such that the building or surroundings become wet.

4.5 Freeze-up test

4.5.1 General conditions

The freeze-up tests (air blockage test and drip test) may be conducted simultaneously with the minimum cooling test. The electrical conditions shall be those specified in table 5.

4.5.2 Temperature conditions

The temperature conditions for the freeze-up tests are given in table 5.

Table 4 — Enclosure sweat and condensate disposal test conditions

Parameter	Standard test conditions
Temperature of air entering indoor side (°C) dry-bulb wet-bulb	 27 24
Temperature of air entering outdoor side (°C) dry-bulb wet-bulb[1)]	 27 24
Condenser water temperature (°C) outlet	 27
Test frequency	Rated frequency[2)]
Test voltage	Rated voltage[3)]

1) The wet-bulb temperature condition is not required when testing air-cooled condensers which do not evaporate the condensate.

2) Equipment with dual-rated frequencies shall be tested at each frequency.

3) Equipment with dual-rated voltages shall be tested at the higher voltage.

Table 5 — Freeze-up test conditions

Parameter	Standard test conditions	
	T1 and T3	T2
Temperature of air entering indoor side (°C) dry-bulb wet-bulb	 21[1)] 15	 21[1)] 15
Temperature of air entering outdoor side (°C) dry-bulb wet-bulb	 21 —	 10 —
Condenser water temperature (°C) outlet[2)]	 21	 10
Water flowrate	As specified by the manufacturer	
Test frequency	Rated frequency[3)]	
Test voltage	Rated voltage[4)]	

1) 21 °C or the lowest temperature above 21 °C at which the regulating (control) device will allow the equipment to operate.

2) For equipment with water-cooled condensers, the condenser water flowrate shall be maintained at that established in table 1 except that, if more than one rating is provided, then the highest flowrate shall be used.

3) Equipment with dual-rated frequencies shall be tested at each frequency.

4) Equipment with dual-rated voltages shall be tested at the higher voltage.

4.5.3 Air-flow conditions

4.5.3.1 Air blockage test

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

4.5.3.2 Drip test

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

4.5.4 Test conditions

4.5.4.1 Air blockage test

The test shall be continuous, with the equipment operating on the cooling cycle for 4 h after establishment of the specified temperature conditions.

4.5.4.2 Drip test

The equipment shall be operated for 6 h after which the equipment shall be stopped and the air-inlet covering removed until the accumulation of ice or frost has melted. The equipment shall then be turned on again, with the fans operating at the highest speed, for 5 min.

4.5.5 Performance requirements

4.5.5.1 Air blockage test

At the end of 4 h of operation, any accumulation of ice or frost on the evaporator shall not cover more than 50 % of the indoor-side face area of the evaporator coil.

4.5.5.2 Drip test

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 Heating tests

5.1 Heating capacity ratings

5.1.1 General conditions

All equipment within the scope of this International Standard shall have the heating capacities and coefficients of performance determined in accordance with the provisions of this International Standard and rated at the conditions specified in table 6. The electrical input values used for rating purposes shall be measured during the heating capacity test.

5.1.2 Temperature conditions

5.1.2.1 Test conditions stated in table 6 shall be considered standard rating conditions.

5.1.2.2 If a manufacturer specifies that the equipment is not suitable for operation under the extra-low temperature test conditions, tests shall be made only at the high and low temperatures specified in table 6.

5.1.3 Air-flow conditions

5.1.3.1 Heating-only equipment shall use the air-flow quantity specified by the manufacturer.

5.1.3.2 For equipment which provides both heating and cooling, the test shall be conducted at the same air-flowrate as for the cooling capacity rating test.

5.1.3.3 When determining air-flow quantities for rating purposes, tests shall be conducted under standard rating conditions (see table 6) with the heating means in operation with 0 Pa static maintained in the air discharge of the equipment.

5.1.4 Test conditions

5.1.4.1 Preconditions

5.1.4.1.1 When using the calorimeter method, two simultaneous methods of determining capacities shall be used. One method determines the capacity on the indoor side, the other measures the capacity on the outdoor side. These two simultaneous determinations shall agree within 4 % of the value obtained on the indoor side for the test to be valid.