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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

[Revision of first edition (ISO 5151:1994)]

ICS 23.120; 27.080

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 TC 86, *Refrigeration and Air-conditioning*, SC 6, *Factory-made air-conditioning and heat pump units*.

The first edition cancelled and replaced ISO/R 859:1968.

The second edition of ISO 5151 was prepared by TC 86/SC 6/Working Group WG 1 between 1997, , and 2005.

Annex A forms an integral part of this International Standard. Annexes B – R are ”Informative”. It should be noted that Annexes B to K, while “Informative” contain the mandatory verb “shall” because once the test method is selected, all of the requirements stated in the Annex must be met..

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

1 Scope

1.1 This international Standard specifies the standard conditions for capacity and efficiency ratings of non-ducted air conditioners employing air- and water-cooled condensers and non-ducted air-to-air heat pumps. . This International Standard also applies to ducted units rated at less than 8kW and intended to operate at an external static pressure of less than 25 Pa. The International Standard also specifies 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 shall be factory-made, electrically-driven, and use mechanical compression. This International Standard covers 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 covers equipment utilizing single, multiple and variable capacity components.

NOTE For the purposes of this International Standard, the term “equipment” is used to mean “non-ducted air conditioners and/or non-ducted heat pumps” and “ducted air conditioners and heat pumps rated at less than 8 kW and intended to operate at external static pressures of less than 25 Pa.”

1.2 This International Standard also specifies standard performance test conditions and the corresponding test procedures for determining performance characteristics of air conditioners and heat pumps that are covered in 1.1.

1.3 This International Standard does not apply to the testing and rating of:

a) water-source heat pumps;

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

c) mobile (windowless) units having a condenser exhaust duct;

d) individual assemblies not constituting a complete refrigeration system; or

f) equipment using the absorption refrigeration cycle.

g) Ducted equipment except that specified in the note above. (such equipment shall be tested according to ISO 13253)

1.4 This international standard does not cover the determination of seasonal efficiencies which may be required in some countries because they provide a better indication of efficiency under actual operating conditions.

2 Normative reference

The following standard contains provisions, which through reference in this text, constitute provisions of this International Standard:

ISO 817, *Refrigerants — Number designation.*

ISO 917, *Testing of Refrigerant Compressors*

3 Definitions

For the purposes of this International Standard, the following definitions apply (see Annex Q for the symbols used to identify the terms contained in this International Standard):

3.1 non-ducted air conditioner

An encased assembly or assemblies that may be either a single-package or split system. 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

[1] Systems having a single outdoor unit and two or more indoor units, each indoor unit being independently controlled (see ISO 15042).

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

3.2 non-ducted heat pump

An encased assembly or assemblies that may be either a single-package or a split system. . 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. 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 circulating, cleaning, humidifying, ventilating or exhausting air. Such equipment may 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.

NOTE 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 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.

3.7 outdoor discharge air-flow

Discharge rate of flow of air from the equipment.

3.8 outdoor intake air-flow

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

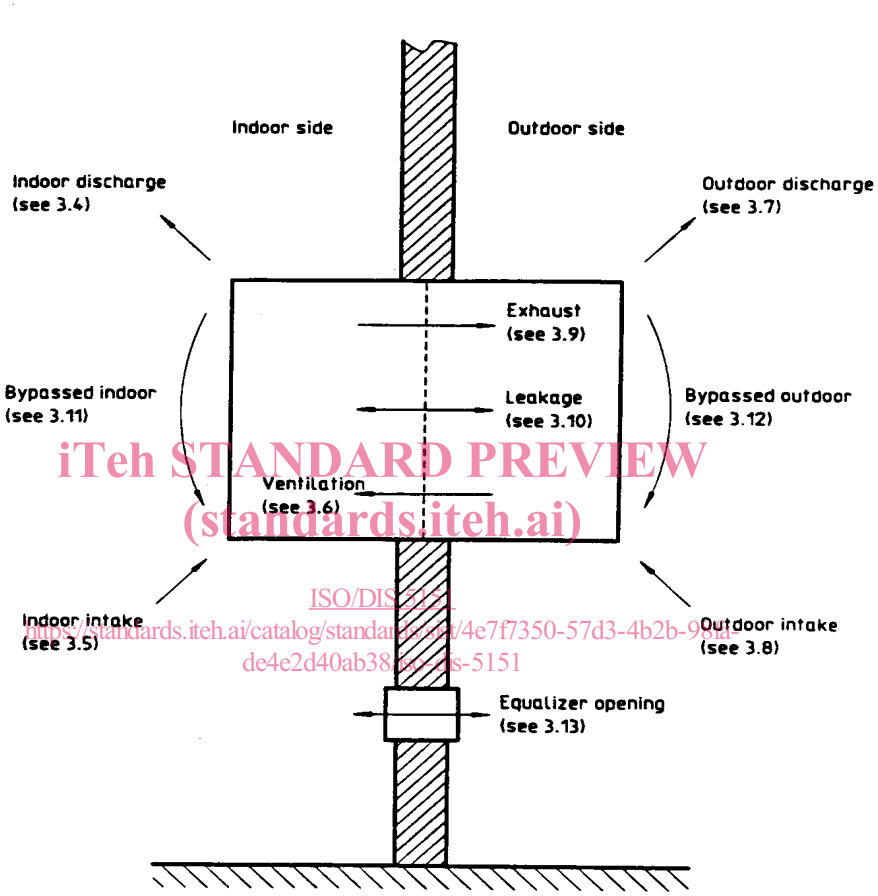

Figure 1 — Air-flow diagram illustrating definitions given in 3.4 to 3.13

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

Rate of flow of conditioned air directly from the indoor-side outlet to the indoor-side inlet of the equipment.

3.12 bypassed outdoor air-flow

Rate of 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, expressed in watts.

3.15 heating capacity

Amount of heat that the equipment can add to the conditioned space (but not including supplementary heat) in a defined interval of time, expressed in watts.

3.16 latent cooling capacity; room dehumidifying capacity

Amount of latent heat that the equipment can remove from the conditioned space in a defined interval of time, expressed in watts. Latent cooling is derived from the volume of water extracted by the air conditioner: 1kg/second = 2460 kilowatts

3.17 sensible cooling capacity

Amount of sensible heat that the equipment can remove from the conditioned space in a defined interval of time, expressed in watts. Sensible cooling effect is derived from the temperature drop of the air and thermal mass of air.

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 to the device 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/watts.)

3.22 coefficient of performance (COP)

Ratio of the heating capacity to the effective power input to the device at any given set of rating conditions. (Where the COP is stated without an indication of units, it shall be understood that it is derived from watts/watts.)

3.23 total power input (P_t)

The average electrical power input to the equipment as measured during the test, expressed in watts.

3.24 effective power input (P_E)

Average electrical power input to the equipment expressed in watts and obtained from:

- the power input for operation of the compressor;
- 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 and, if applicable, any water-cooled condenser pump(s).

3.25 full-load operation

Operation with the equipment and controls configured for the maximum continuous duty refrigeration capacity specified by the manufacturer and allowed by the unit controls. Unless otherwise regulated by the automatic controls of the equipment, all indoor units and compressors shall be functioning during full-load operations.

4 Cooling tests

4.1 Cooling capacity tests and ratings

4.1.1 General conditions

4.1.1.1 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 test conditions specified in Table 1. All tests shall be carried out in accordance with the requirements of Annex A and the test methods specified in Clause 6. All tests shall be conducted with the equipment functioning at full-load operation, as defined by 3.25. The electrical input values used for rating purposes shall be measured during the cooling capacity test.

4.1.1.2 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, then the equipment shall be operated with its thermostat or controller set to its minimum allowable temperature setting.

4.1.2 Temperature conditions

4.1.2.1 The temperature conditions stated in Table 1- Columns T1, T2 and T3 - shall be considered standard rating conditions for the determination of cooling capacity. For

equipment intended for space cooling, testing shall be conducted at one or more of the standard rating conditions specified in Table 1.

4.1.2.2 Equipment manufactured only for use in a **moderate** climate similar to that specified in Table 1, Column T1, shall have ratings determined by tests conducted at Table 1 – T1 conditions and shall be designated type T1 equipment.

4.1.2.3 Equipment manufactured only for use in a **cool** climate similar to that specified in Table 1, Column T2, shall have ratings determined by tests conducted at Table 1 – T2 conditions and shall be designated type T2 equipment.

4.1.2.4 Equipment manufactured only for use in a **hot** climate similar to that specified in Table 1, Column T3, shall have ratings determined by tests conducted at Table 1 - T3 conditions and shall be designated type T3 equipment.

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

4.1.3 Air-flow conditions

4.1.3.1 Indoor-side air quantity – air enthalpy test method

4.1.3.1.1 Tests shall be conducted at standard rating conditions (see Table 1) with 0 Pa static pressure maintained at the air discharge of the equipment and with the refrigeration means in operation. All air quantities shall be expressed as m^3/s of standard air as defined in 3.3.

4.1.3.1.2 Air flow measurements should be made in accordance with the provisions specified in Annex B, as appropriate, as well as the provisions established in other appropriate annexes of this standard. (NOTE: Additional guidance for making airflow

measurements can be found in ISO 3966, *Measurement of fluid flow in closed conduits — Velocity area method using pitot static tubes*, ISO 5167, *Air distribution and air diffusion — Rules for methods of measuring air flow rate in an air handling duct,* and ISO 5221, *Measurement of fluid flow by means of pressure differential devices — Part 1: Orifice plates, nozzles and Venturi tubes inserted in circular cross-section conduits running full).*

Table 1 — Cooling capacity rating conditions

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

T1 = Standard cooling capacity rating conditions for **moderate** climates.

T2 = Standard cooling capacity rating conditions **cool** climates

T3 = Standard cooling capacity rating conditions for **hot** climates

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

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

Table 2 — Voltages for capacity and performance tests

(except the maximum cooling and the maximum heating tests)

Rated (nameplate) voltages [1)]	Test voltage
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

1) For equipment with dual-rated voltages such as 115/230 and 220/440, the test voltages would be 115 and 230 volts in the first example, and 230 and 460 volts in the second example. For equipment with an extended voltage range, such as 110-120 volts or 220-240 volts, the test voltage would be 115 volts or 230 volts, 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 200-220 volts, the test voltage would be 230 volts, based on the mean voltage of 210 volts.)

4.1.3.2 Outdoor-side air quantity

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

4.1.4 Test conditions

4.1.4.1 Preconditions

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

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

4.1.4.1.3 The test room reconditioning apparatus and the equipment under test shall be operated until equilibrium conditions, as required by 6.3, are attained. Equilibrium conditions shall be maintained for not less than one hour before capacity test data are recorded.

4.1.4.2 Testing requirements

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

4.1.4.3 Duration of test

The data shall be recorded at equal intervals that span five minutes or less except as required by 6.3.3. The recording of the data shall continue for at least a 30-minute period during which the tolerances specified in 6.3 shall be met.

4.2 Maximum cooling test