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R 859

TESTING AND RATING

ROOM AIR CONDITIONERS

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BRIEF HISTORY

The ISO Recommendation R 859, *Testing and rating room air conditioners,* was drawn up by Technical Committee ISO/TC 86, *Refrigeration,* the Secretariat of which is held by the British Standards Institution (BSI).

Work on this question led to the adoption of a Draft ISO Recommendation.

In April 1967, this Draft ISO Recommendation (No. 1190) was circulated to all the ISO Member Bodies for enquiry. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Australia	Hungary	Switzerland
Belgium	Israel	United Kingdom
Canada	Italy	U.S.A.
Chile	Korea, Rep. of	U.S.S.R.
Czechoslovakia	Poland	Yugoslavia
France	Spain	
Germany	Sweden	

One Member Body opposed the approval of the Draft :

Japan

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in October 1968, to accept it as an ISO RECOMMENDATION.

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TESTING AND RATING

ROOM AIR CONDITIONERS

INTRODUCTION

It was decided to study factory-assembled air-conditioning units within the framework of the activities of Technical Committee ISO/TC 86 Refrigeration – and it has been agreed that this scope is too broad to be covered in one ISO Recommendation. The initial study, therefore, and the resulting first ISO Recommendation of this series of ISO Recommendations, will cover only room air-conditioning units with air-cooled condensers. Other types and sizes of units will be covered in later ISO Recommendations. Where general values are involved, the equivalents have been rounded off.

1. GENERAL

1.1 Scope

1.1.1 This ISO Recommendation prescribes the standard conditions on which the ratings of room air conditioners employing air-cooled condensers are based, and the methods of testing to be applied for the determination of the various ratings.

1.1.2 This ISO Recommendation also prescribes the test conditions and the corresponding test procedures for determining various performance characteristics of room air conditioners.

1.1.3 This ISO Recommendation covers only room air conditioners when used for cooling and does not cover the performance of such room air conditioners when used for heating or humidification.

1.1.4 Room air conditioners employing water-cooled condensers are not covered by this ISO Recommendation.

1.2 Definitions

For the purposes of this ISO Recommendation, the following definitions apply.

1.2.1 *Room air conditioner.* An encased assembly designed as a unit, primarily for mounting in a window or through the 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 means for the circulation and the cleaning of air. It may also include means for heating, humidifying, ventilating or exhausting air.

1.2.2 *Standard barometric pressure.* Barometric pressure of 1.01325 bar (760 mmHg : 29.92 inHg).

1.2.3 *Wet-bulb temperature.* Temperature indicated when the temperature sensing element and wetted wick have reached a state of constant temperature (evaporative equilibrium) (see clause 4.1.5).

1.2.4 *Room discharge air-flow of a unit.* Rate of flow of air from the room-side outlet of the unit.

1.2.5 *Room intake air-flow of a unit.* Rate of flow of air into the unit from the conditioned space.

1.2.6 *Ventilation air-flow of a unit.* Rate of flow of air introduced to the conditioned space through the unit from the outside.

1.2.7 *Outdoor discharge air-flow of a unit.* Rate of flow of air from the outdoor side of the unit.

1.2.8 *Outdoor intake air-flow of a unit.* Rate of flow of air into the unit from the outdoor side.

1.2.9 *Exhaust air-flow of a unit.* Rate of flow of air from the room side through the unit to the outdoor side.

1.2.10 *Leakage air-flow.* Rate of flow of air interchanged between the room side and outdoor side through the unit as a result of its construction features and sealing techniques.

1.2.11 *Bypassed room air-flow of a unit.* Flow of conditioned air directly from the room-side outlet to the room-side inlet of the unit.

1.2.12 *Bypassed outdoor air-flow of a unit.* Flow of air directly from the outdoor-side outlet to the outdoor-side inlet of the unit.

1.2.13 *Equalizer opening air-flow.* Rate of flow of air through the equalizer opening in the partition wall of a calorimeter.

NOTE. – The definitions given in clauses 1.2.4 to 1.2.13 (inclusive) relating to air flow are illustrated in Annex A.

1.2.14 *Net total room cooling effect of a unit.* Total available capacity of the unit for removing sensible and latent heat from the space to be conditioned.

1.2.15 *Net room dehumidifying effect (latent cooling effect).* Total available capacity of the unit for removing latent heat from the space to be conditioned.

1.2.16 *Net room sensible cooling effect.* Available capacity of the unit for removing sensible heat from the space to be conditioned.

1.2.17 *Net room sensible heat ratio.* Ratio of the net room sensible cooling effect to the net total room cooling effect.

1.2.18 *Room calorimeter.* Test facility consisting of two contiguous calorimeters with a common partition. One is designated as the room-side compartment, and the other as the outdoor compartment. Each side is equipped with instrumented reconditioning equipment whose output may be measured and controlled to counterbalance the room-side dehumidifying and cooling effect and the outdoor-side humidifying and heating effect of the room air conditioner under test.

1.2.19 *Rated voltage.* Voltage shown on the nameplate of the unit.

1.2.20 *Rated frequency(ies).* Frequency(ies) shown on the nameplate of the unit.

2. RATING AND TEST CONDITIONS

2.1 Rating conditions for the determination of the cooling-capacity

2.1.1 Test conditions stated in Table 1, columns A and B, should be considered standard rating conditions.

2.1.2 Units manufactured for use in a climate similar to that specified in Table 1 column A only, should have a nameplate rating determined by tests conducted at these specified conditions and should be designated type A units.

2.1.3 Units manufactured for use in a climate similar to that specified in Table 1 column B only, should have a nameplate rating determined by tests conducted at these specified conditions and should be designated type B units.

2.1.4 Units manufactured for use in both types of climate defined in Table 1, columns A and B, should have two nameplate ratings determined by tests conducted at both these specified conditions and should be designated type AB units.

TABLE 1 – **Test conditions for the determination of the cooling-capacity**

Test conditions	A	B
Room air temperature		
– dry-bulb	27 °C (80 °F)	29 °C (85 °F)
– wet-bulb	19 °C (67 °F)	19 °C (67 °F)
Outside air temperature		
– dry-bulb	35 °C (95 °F)	46 °C (115 °F)
– wet-bulb	24 °C (75 °F)	24 °C (75 °F)
Test frequency	Rated frequency*	
Test voltage	Rated voltage**	

* Units with dual rated frequencies should be tested at each frequency.

** Units having dual rated voltages should be tested at the higher voltage.

2.1.5 Any capacity rating should be followed by the corresponding voltage and frequency rating.

2.2 Maximum operating test conditions

The conditions which should be used during tests for maximum operating conditions are given in Table 2. Tests should be carried out at conditions in column A or column B, based upon intended use as determined in clause 2.1. For type AB units, conditions in column B apply.

TABLE 2 – **Maximum operating conditions**

Operating conditions	A	B
Room air temperature – dry-bulb – wet-bulb	32 °C (90 °F) 23 °C (73 °F)	32 °C (90 °F) 23 °C (73 °F)
Outside air temperature – dry-bulb – wet-bulb	43 °C (110 °F) 26 °C (78 °F)	52 °C (125 °F) 31 °C (87 °F)
Test frequency	Rated frequency*	
Test voltage	(1) 90 % and 110 % for units with a single nameplate rating. (2) 95 % of minimum voltage and 110 % of maximum voltage for units with a dual nameplate voltage.	

* Units with dual rated frequencies should be tested at each frequency.

2.3 Freeze-up conditions

The conditions which should be used during freeze-up tests for all models are given in Table 3.

TABLE 3 – **Freeze-up test conditions**

Room air temperature – dry-bulb – wet-bulb	21 °C (70 °F)* 16 °C (60 °F)
Outside air temperature – dry-bulb – wet-bulb	21 °C (70 °F) 16 °C (60 °F)
Test frequency	Rated frequency**
Test voltage	Rated voltage***

* 21 °C (70 °F) or the lowest temperature above 21 °C (70 °F) at which the regulating device will allow the unit to operate.

** Units with dual rated frequencies should be tested at each frequency.

*** Units with dual rated voltages should be tested at the higher voltage.

2.4 Enclosure sweat test conditions

The conditions which should be used during enclosure sweat tests for all models are given in Table 4.

TABLE 4 – **Enclosure sweat test conditions**

Room air temperature – dry-bulb – wet-bulb	 27 °C (80 °F) 24 °C (75 °F)
Outside air temperature – dry-bulb – wet-bulb	 27 °C (80 °F) 24 °C (75 °F)
Test frequency	Rated frequency*
Test voltage	Rated voltage**

* Units with dual rated frequencies should be tested at each frequency.

** Units with dual rated voltages should be tested at the higher voltage.

2.5 Condensate disposal test conditions

Condensate disposal tests should be conducted at the same conditions as those specified for enclosure sweat tests (see clause 2.4).

2.6 Air-flow measuring conditions

Tests for determining air flow quantities for rating purposes should be conducted at standard rating conditions (see Table 1), with the refrigeration means in operation and after condensate equilibrium has been obtained.

3. CALORIMETERS

3.1 Calorimeters required for testing room air conditioners

Room air conditioners should be tested for cooling-capacity in a room calorimeter of either calibrated or balanced-ambient type (see clauses 3.3 and 3.4).

3.2 Calorimeters – General

3.2.1 The calorimeter provides a method for determining cooling-capacity simultaneously on both the room side and the outdoor side. The room side capacity determination is made by balancing the cooling and dehumidifying effects with measured heat and water inputs. The outdoor-side capacity provides a confirming test of the cooling and dehumidifying effect by balancing the heat and water rejection on the condenser side with a measured amount of cooling medium.

3.2.2 The two calorimeter compartments, room-side and outdoor-side, are separated by an insulated partition having an opening into which the room air conditioner is mounted. The air conditioner should be installed using supporting members and filler pieces in a manner similar to a normal installation. No effort should be made to seal the internal construction of the air conditioner to prevent air leakage from the condenser side to the evaporator side or vice versa. No connections or alterations should be made to the conditioner which might in any way alter its normal operation.

3.2.3 A pressure-equalizing device should be provided in the partition wall between the room-side and the outdoor-side compartments to maintain a balanced pressure between these compartments and also the permit measurement of leakage, exhaust, and ventilation air. This device consists of one or more nozzles of the type shown in Figure 3, page 21, a discharge chamber equipped with an exhaust fan, and manometers for measuring compartment and air-flow pressures. A suggested arrangement of components is shown in Figure 2, page 21.

Since the air flow from one compartment to the other may be in either direction, two such devices, mounted in opposite directions, or a reversible device, should be used.

The manometer pressure pick-up tubes should be so located as to be unaffected by air discharged from the air conditioner on test or by the exhaust from the pressure-equalizing device. The fan or blower which exhausts air from the discharge chamber should permit variation of its air flow by any suitable means, such as a variable-speed drive, or a damper as shown in Figure 2. The exhaust from this fan or blower should be such that it will not affect the inlet air to the air conditioner on test.

The equalizing device should be adjusted during calorimeter tests or air-flow measurements so that the static pressure difference between the room-side and outdoor-side compartments is not greater than 1.5 N/m^2; 0.015 mbar (0.153 mmH_2O; 0.006 inH_2O).

Construction details and calculations are specified in section 6.

3.2.4 The size of the calorimeter should be sufficient to avoid any restriction to intake or discharge openings of the air conditioner. Perforated plates or other suitable grilles should be provided at the discharge openings from the reconditioning equipment to avoid face velocities exceeding 0.5 m/s (98.3 ft/min). Sufficient space should be allowed in front of any inlet or discharge grilles of the air conditioner to avoid interference with the air flow. Minimum distance from the air conditioner to side walls or ceiling of the compartment(s) should be 1 m (3 ft), except for the back of a console-type room air conditioner, which should be in normal relation to the wall. Table 5 gives the suggested dimensions for the calorimeter.

TABLE 5 – **Sizes of calorimeter**

Maximum rated cooling capacity of unit*	Suggested minimum inside dimensions of each room of calorimeter		
	Width	Height	Depth
3 000 W (2 500 kcal/h) (10 000 Btu/h)	2.4 m (8 ft)	2.1 m (7 ft)	1.8 m (6 ft)
6 000 W (5 000 kcal/h) (20 000 Btu/h)	2.4 m (8 ft)	2.1 m (7 ft)	2.4 m (8 ft)
9 000 W (7 500 kcal/h) (30 000 Btu/h)	2.7 m (9 ft)	2.4 m (8 ft)	3.0 m (10 ft)
12 000 W (10 000 kcal/h) (40 000 Btu/h)	3.0 m (10 ft)	2.4 m (8 ft)	3.7 m (12 ft)

* All figures are round numbers.

3.2.5 Each compartment should be provided with reconditioning equipment to maintain specified air flow and prescribed conditions. Reconditioning equipment for the room-side compartment should consist of heaters to supply sensible heat and a humidifier to supply moisture. The energy supply may be electric, steam, or any other than can be controlled and measured. Reconditioning equipment for the outdoor-side compartment should provide cooling and dehumidification. A cooling coil equipped with by-pass dampers to control the dry-bulb temperature and supplied with variable temperature water or variable water quantity to control the wet-bulb temperature may be used. If desired, dehumidifying apparatus or reheating apparatus, or both may be used in combination with the cooling coil. Reconditioning equipment for both compartments should be provided with fans of sufficient capacity to overcome the resistance of the reconditioning equipment and to circulate not less than twice the quantity of air discharged by the air conditioner to the room side or to the outdoor side as the case may be. In no case should the reconditioning equipment discharge less than one compartment air change per minute.

3.2.6 Remote reading thermometers, instruments, or air-sampling tubes should be used to measure the specified wet- and dry-bulb temperatures in both calorimeter compartments. Air sampling should comply with clause 4.1.5. The air-sampling tube may be brought outside of the calorimeter walls for ease in reading the thermometers, but should be sealed and insulated to avoid air leakage and heat leakage. The sampling tube fans and fan motors should be installed completely within the calorimeter compartments and their electrical input included in the load measurement. The fan motor should be located so that its heat will not cause stratification of the air passing into the air conditioner. The fan should draw the air over the thermometers and return the air to the same compartment in a manner that will not affect air temperature measurements or inlet or discharge air flow of the air conditioner.

3.2.7 It is recognized that in both the room-side and outdoor-side compartments, temperature gradients and air-flow patterns result from the interaction of the reconditioning equipment and the room air conditioner being tested. Therefore, the resultant conditions are peculiar to, and dependent upon, a given combination of compartment size, arrangement and size of reconditioning equipment, and the air conditioners air-discharge characteristics. Accordingly, no single location for the measurement of dry- and wet-bulb temperatures can be specified which will be acceptable for all combinations of calorimeter facilities and room air conditioners which may be tested.

It is intended that the specified test temperatures surrounding the unit being tested should simulate as nearly as possible a normal installation of such a unit operating at ambient air conditions identical with these specified test temperatures.

The point of measurement of specified test temperatures, both wet- and dry-bulb, should be such that the following conditions are fulfilled :

(*a*) The measured temperatures should be representative of the temperature surrounding the unit, and simulate the conditions encountered in an actual application for both room and outdoor sides as indicated above.

(*b*) At the point of measurement, the temperature of air should not be affected by air discharged from the test unit. This makes it mandatory that the temperatures are measured upstream of any recirculation produced by the test unit.

NOTE. – An illustration of the aim of this ISO Recommendation is given by the following :

(*a*) If the conditions of air movement and air-flow patterns in the calorimeter compartment are favourable, the temperatures may be measured at the outlet of the reconditioning equipment.

(*b*) If it has been established that the unit being tested does not produce any bypassed air from discharge to intake opening, the specified temperatures may be measured immediately upstream of such intake opening. In this case, care should be taken to ensure that the temperature-measuring equipment does not help or penalize the air conditioner in any way.

3.2.8 Interior surfaces of the calorimeter compartments should be of non-porous material with all joints sealed against air and moisture leakage. Access doors should be tightly sealed against air and moisture leakage by use of gaskets or other suitable means.

3.3 Calibrated room-type calorimeter

3.3.1 The calibrated room-type calorimeter is shown in Figure 1A. Each calorimeter, including the separating partition, should be insulated to prevent heat leakage (including radiation) in excess of 5 % of the air conditioner capacity. It is recommended that an air space permitting free circulation be provided under the calorimeter floor.

3.3.2 Heat leakage may be determined in either the room-side or outdoor-side compartment by the following method.

All openings should be closed. Either compartment may be heated by electric heaters to a temperature of at least 11 °C (20 °F) above the surrounding ambient temperature. The ambient temperature should be maintained constant within ± 1 °C (± 2 °F) outside all six enveloping surfaces of the compartment including the separating partition. If the construction of the partition is identical with that of the other walls, the heat leakage through the partition may be determined on a proportional area basis.

3.3.3 For calibrating the heat leakage through the separating partition alone, the following procedure may be used.

A test is carried out as described above. Then the temperature of the adjoining area on the other side of the separating partition is raised to equal the temperature in the heated compartment, thus eliminating heat leakage through the partition, while the 11 °C (20 °F) differential is maintained between the heated compartment and the ambient surrounding the other five enveloping surfaces. The difference in heat between the first test and second test will permit determination of the leakage through the partition alone.

3.3.4 For the outdoor-side compartment equipped with means for cooling, an alternative means of calibration may be to cool the compartment to a temperature at least 11 °C (20 °F) below the ambient temperature (on six sides) and carry out a similar analysis.

3.4 Balanced ambient room-type calorimeter

3.4.1 The balanced ambient room-type calorimeter is shown in Figure 1B and is based on the principle of maintaining the dry-bulb temperatures surrounding the particular compartment equal to the dry-bulb temperatures maintained within that compartment. If the ambient wet-bulb temperature is also maintained equal to that within the compartment, the vapour-proofing provisions of clause 3.2.8 are not required.

3.4.2 The floor, ceiling and walls of the calorimeter compartments should be spaced a sufficient distance away from the floor, ceiling and walls of the controlled areas in which the compartments are located in order to provide uniform air temperature in the intervening space. It is recommended that this distance be at least 0.3 m (12 in). Means should be provided to circulate the air within the surrounding space to prevent stratification.

3.4.3 Heat leakage through the separating partition should be introduced into the heat balance calculation and may be calibrated in accordance with clause 3.3, or may be calculated.

3.4.4 It is recommended that the floor, ceiling and walls of the calorimeter compartments be insulated so as to limit heat leakage (including radiation) to not more than 10 % of the air conditioner capacity, with a 11 °C (20 °F) temperature difference, or 300 W (250 kcal/h; 1000 Btu/h) for the same temperature difference, whichever is greater, as tested using the procedure given in clause 3.3.2.