

ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION

R 859

TESTING AND RATING
ROOM AIR CONDITIONERS

1st EDITION

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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	32 °C (90 °F)	32 °C (90 °F)
- wet-bulb	23 °C (73 °F)	23 °C (73 °F)
Outside air temperature		
- dry-bulb	43 °C (110 °F)	52 °C (125 °F)
- wet-bulb	26 °C (78 °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	21 °C (70 °F)*
- wet-bulb	16 °C (60 °F)
Outside air temperature	
- dry-bulb	21 °C (70 °F)
- wet-bulb	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	27 °C (80 °F)
- wet-bulb	24 °C (75 °F)
Outside air temperature	
- dry-bulb	27 °C (80 °F)
- wet-bulb	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 ($0.153 \text{ mmH}_2\text{O}$; $0.006 \text{ inH}_2\text{O}$).

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.

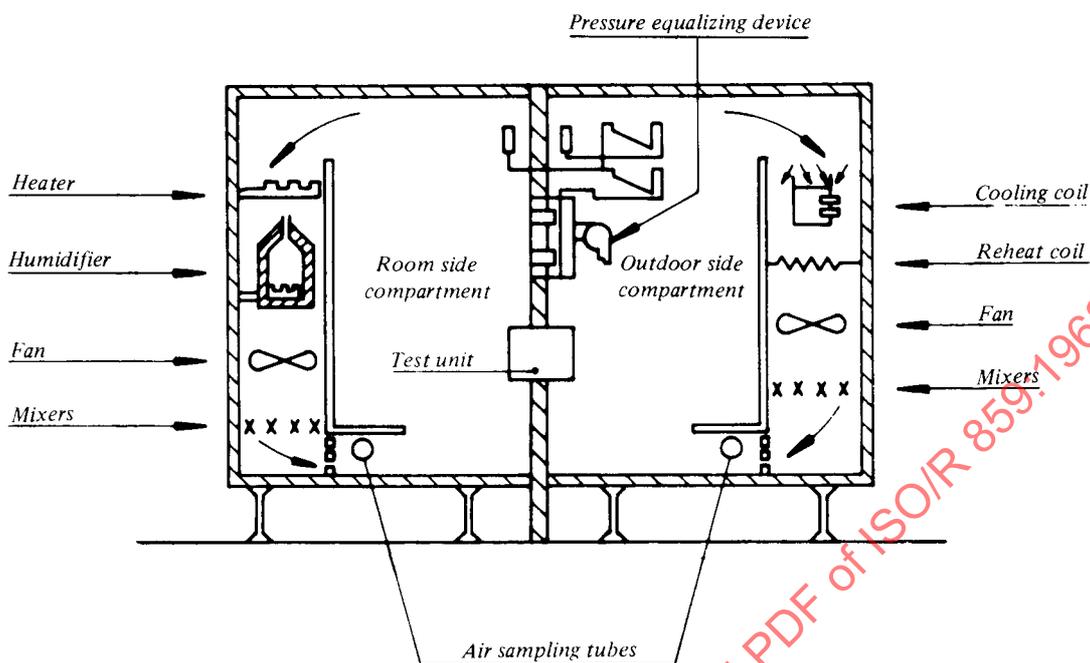


FIG. 1A - Calibrated room-type calorimeter

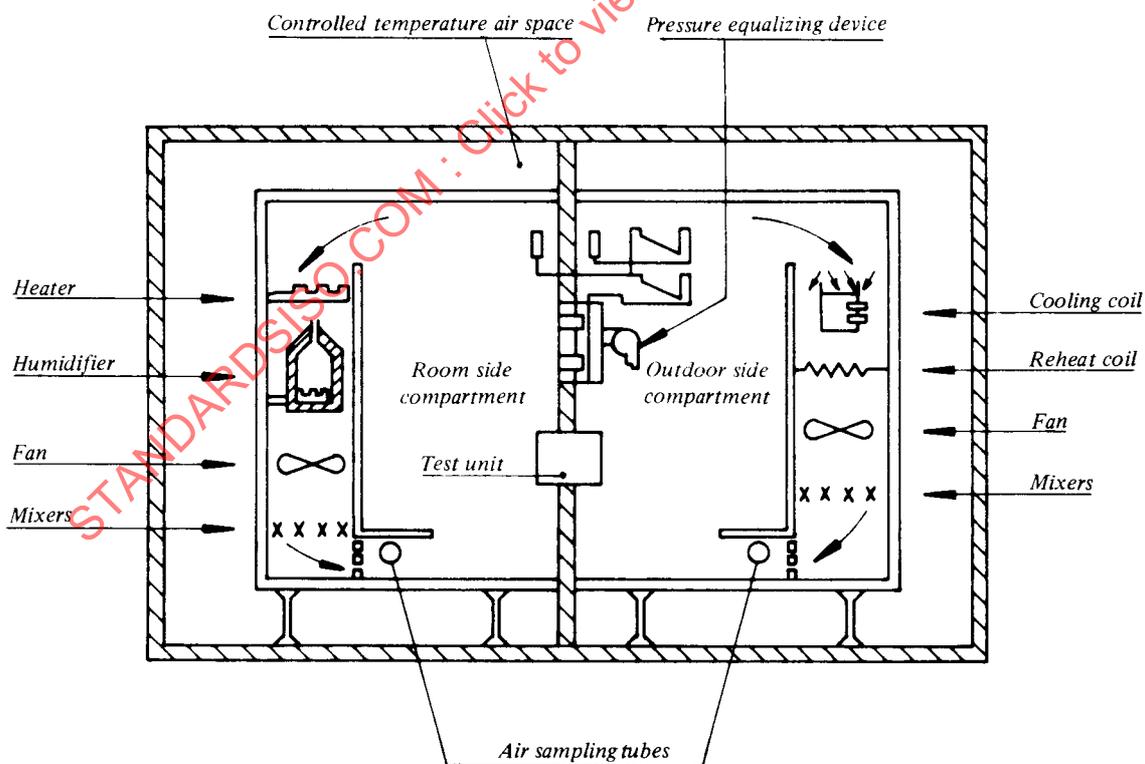


FIG. 1B - Balanced ambient room-type calorimeter

4. INSTRUMENTS

4.1 Temperature-measuring instruments

4.1.1 Temperature measurements should be carried out with one or more of the following instruments :

- (a) mercury-in-glass thermometers;
- (b) thermocouples;
- (c) electric resistance thermometers.

4.1.2 Instrument accuracy should be within the following limits :

- (a) wet- and dry-bulb temperatures of reconditioned air in room-side calorimeter compartment, ± 0.05 °C (± 0.1 °F)
- (b) water temperatures, outdoor-side compartment conditioning coil, ± 0.05 °C (± 0.1 °F);
- (c) all other temperatures, ± 0.3 °C (± 0.5 °F).

4.1.3 In no case should the smallest scale division of the temperature-measuring instrument exceed twice the specified accuracy. For example, for the specified accuracy of ± 0.05 °C (± 0.1 °F), the smallest scale division should not exceed 0.1 °C (0.2 °F).

4.1.4 Where an instrument accuracy of ± 0.05 °C (± 0.1 °F) is specified, the instrument should be calibrated by comparison with a thermometer certified by a recognized authority, such as a national standards authority.

4.1.5 In all measurements of wet-bulb temperature, sufficient wetting should be provided and sufficient time should be allowed for the state of evaporative equilibrium to be attained. For mercury-in-glass thermometers having a bulb diameter not over 6.5 mm (0.250 in), temperatures should be read under conditions which ensure a minimum air velocity of 3 m/s (590 ft/min).

For any other instrument, a sufficient air velocity should be provided to give the same equilibrium conditions as those defined above.

4.1.6 Wherever possible, temperature-measuring instruments used to measure the change in temperature should be arranged so that they can be readily interchanged between inlet and outlet positions to improve accuracy.

4.1.7 Temperature of fluids within conduits should be measured by inserting the temperature-measuring instrument directly within the fluid, or within a well inserted into the fluid. If a glass thermometer is to be inserted directly into the fluid, it should be calibrated for the effect of pressure.

4.1.8 Temperature-measuring instruments should be adequately shielded from radiation from any adjacent heat sources.

4.2 Pressure-measuring instruments

4.2.1 Accuracy of pressure-measuring instruments, not including barometers, should permit measurements within ± 1 N/m²; 0.01 mbar (0.1 mmH₂O; 0.004 inH₂O).

4.2.2 In no case should the smallest scale division of the pressure-measuring instrument exceed twice the specified accuracy.

4.2.3 Barometric pressure should be measured by a barometer having scale markings permitting readings with an accuracy within ± 0.1 %.

4.3 Electrical instruments

4.3.1 Electrical measurements should be made with either of the following instruments :

- (a) indicating;
- (b) integrating.

4.3.2 Accuracy should be within the following limits :

Instruments used for measuring all electrical inputs to the calorimeter compartments should be accurate to $\pm 0.5\%$ of the quantity measured.

4.4 Water-flow measuring instruments

4.4.1 Volume measurements should be made with either of the following instruments having an accuracy of $\pm 1\%$ of the quantity measured :

- (a) liquid quantity meter, measuring either mass or volume;
- (b) liquid flow rate meter.

4.4.2 The liquid quantity meter should employ a tank having a capacity sufficient to accumulate the flow for at least 2 minutes.

4.5 Other instruments

4.5.1 Time interval measurements should be made with instruments whose accuracy is $\pm 0.2\%$ of the quantity measured.

4.5.2 Mass measurement should be made with apparatus whose accuracy is $\pm 1\%$ of the quantity measured.

5. COOLING-CAPACITY TEST

5.1 Requirements for the test (see Table 6)

5.1.1 Cooling-capacity test should be conducted at the test conditions established in clause 2.1, as required by the intended application of the unit.

5.1.2 Two simultaneous methods of determining capacities should be used. One method determines the capacity on the room side, the other measures the capacity on the outdoor side. These two simultaneous determinations should agree within 4% of the value obtained on the room-side for the test to be valid.

5.1.3 The test capacity should be the sensible, latent, or total heat capacity determined on the room-side compartment.

5.1.4 Tests should be conducted at the selected conditions with no changes in fan speed or system resistance made to correct for variations from the standard barometric pressure (see clause 1.2.2).

TABLE 6 - Variations allowed in capacity test readings

Reading	Variation of arithmetical average from rating conditions	Maximum variation of individual 10-minute readings from rating conditions
All entering air temperatures		
- dry-bulb	0.3 °C (0.5 °F)	0.5 °C (1.0 °F)
- wet-bulb	0.2 °C (0.3 °F)	0.3 °C (0.5 °F)
Air temperature surrounding balanced ambient calorimeter		
- dry-bulb	0.5 °C (1.0 °F)	1.0 °C (2.0 °F)
- wet-bulb	0.3 °C (0.5 °F)	0.5 °C (1.0 °F)
Voltage (at unit connection)	1 %	2 %

5.1.5 Test conditions should be maintained until equilibrium has been reached, and maintained for not less than 1 hour, before recording data for the capacity test. The test should then be run for 1 hour recording data every 10 minutes, giving seven sets of readings.

5.1.6 Data to be recorded for cooling-capacity tests is given in Table 7. The table shows the general information required, but is not intended to limit the data to be obtained.

5.1.7 Grille positions, damper position, fan speeds, and the like should be set to result in maximum cooling capacity unless contrary to the manufacturer's instructions. When tests are made at other settings, they should be noted along with the cooling-capacity ratings.

5.2 Cooling-capacity calculations

5.2.1 Net total room cooling effect on the room side, as tested in either the calibrated or balanced-ambient room-type calorimeter (see Fig. 1A and 1B), is calculated as follows:

$$q_{t_r} = K_1 \Sigma E_r + (h_{w_1} - h_{w_2}) w_r + q_{1_p} + q_{1_r} \quad (1)$$

where

q_{t_r} is the net total room-cooling effect as determined on room-side compartment;

$K_1 = 1$ (= 0.860 kcal/Wh; = 3.413 Btu/Wh);

ΣE_r is the sum of all power input to room-side compartment;

h_{w_1} is the enthalpy of water or steam supplied to maintain humidity. If no water is introduced during the test, h_{w_1} is taken at the temperature of the water in the humidifier tank of the reconditioning equipment;

h_{w_2} is the enthalpy of condensed moisture leaving the room-side compartment. Since transfer of condensed moisture from the room-side to the outdoor-side compartment usually takes place within the air conditioner, with consequent difficulty in measuring its temperature, the temperature of the condensate may be assumed to be at the measured, or estimated, wet-bulb temperature of the air leaving the air conditioner;

w_r is the water vapour (rate) condensed by air conditioner. This is measured by reconditioning equipment as the amount of water evaporated into the room-side compartment to maintain required humidity;

q_{1_p} is the heat leakage rate into room-side compartment through separating partition between room-side and outdoor-side compartments, as determined from calibrating test (or may be based on calculation in case of balanced-ambient room-type calorimeter);

q_{1_r} is the heat-leakage rate into room-side compartment through walls, floor, and ceiling (but not including the separating partition) as determined from calibrating test.

5.2.2 Net total room-cooling effect on the outdoor side, as tested in either the calibrated or balanced-ambient room-type calorimeter (see Fig. 1A and 1B), is calculated as follows :

$$q_{t_o} = q_c - K_1 \Sigma E_o - K_1 E + (h_{w_3} - h_{w_2}) w_r + q_{1_p} + q_{1_o} \quad (2)$$

where

q_{t_o} is the net total room-cooling effect as determined on outdoor side;

q_c is the heat removed by cooling coil in outdoor-side compartment;

$K_1 = 1$ (= 0.860 kcal/Wh; = 3.413 Btu/Wh);

ΣE_o is the sum of all power input to any equipment, such as reheaters, circulating fans, etc., in outdoor-side compartment;

E is the total power input to air conditioner;

h_{w_2} is the enthalpy of condensed moisture leaving the room-side compartment, as defined in clause 5.2.1;

h_{w_3} is the enthalpy of condensate removed by air-treating coil in outdoor-side compartment reconditioning equipment taken at the temperature at which the condensate leaves the compartment;

w_r is the water vapour condensed by air conditioner, as defined in clause 5.2.1;

q_{1_p} is the heat leakage out of outdoor-side compartment through separating partition between room-side and outdoor-side compartments, as determined from calibrating test (or may be based on calculation in case of balanced-ambient room-type calorimeter);

NOTE. - This quantity will be numerically equal to q_{1_p} used in equation (1) (see clause 5.2.1) if, but only if, the area of separating partition exposed to outdoor-side is equal to the area exposed to the room-side compartment.

q_{1_o} is the heat leakage out of outdoor-side (but not including the separating partition), as determined from the calibrating test.

5.2.3 Net room dehumidifying effect is calculated as follows :

$$q_d = K_2 w_r \quad (3)$$

where

$K_2 = 2460$ kJ/kg (= 588 kcal/kg; = 1060 Btu/lb);

q_d is the net room dehumidifying effect;

w_r is the water vapour condensed by air conditioner, as defined in clause 5.2.1;

5.2.4 Net room sensible cooling effect is calculated as follows :

$$q_s = q_{t_r} - q_d \quad (4)$$

where

q_s is the net room sensible cooling effect;

q_{t_r} : (see equation (1), clause 5.2.1);

q_d : (see equation (3), clause 5.2.3).

5.2.5 Net room sensible heat ratio is calculated as follows :

$$SHR = \frac{q_s}{q_{t_r}} \quad (5)$$

where

SHR is the net room sensible heat ratio,

q_s : (see equation (4), clause 5.2.4);

q_{t_r} : (see equation (1), clause 5.2.1).

TABLE 7 - Data to be recorded for cooling-capacity tests

No.	Data
1.	Date
2.	Observers
3.	Barometric pressure
4.	Speed of test unit cooling fan(s), where such speed is adjustable or variable
5.	Applied voltage for each test unit motor
6.	Frequency of applied voltage for each test unit motor
7.	Total power input to unit*
8.	Total current input to unit
9.	Control dry-bulb and wet-bulb temperature of air (room-side calorimeter compartment)**
10.	Control dry-bulb and wet-bulb temperature of air (outdoor-side calorimeter compartment)**
11.	Average air temperature outside the calorimeter (calibrated room-type - see Fig. 1A)
12.	Total power input to room-side and outdoor-side compartments
13.	Water quantity evaporated in humidifier
14.	Temperature of humidifier water entering room-side compartment, or in humidifier tank
15.	Cooling water-flow rate through outdoor-side compartment heat rejection coil
16.	Temperature of cooling water entering outdoor-side compartment, for heat-rejection coil
17.	Temperature of cooling water leaving outdoor-side compartment, from heat-rejection coil
18.	Water condensed in outdoor-side compartment
19.	Temperature of condensed water leaving outdoor-side compartment
20.	Volume of air flow through measuring nozzle of separating partition flow-meter
21.	Air-static pressure difference across separating partition of calorimeter compartments

* Total power input to unit, except if more than one external power connection is provided on unit; record input to each connection separately.

** See clause 3.2.7.

6. AIR-FLOW MEASUREMENT

6.1 Air-flow determination

6.1.1 The following air quantities may be measured using the apparatus and testing procedures given in this ISO Recommendation (see clause 2.6 for test conditions) :

- (a) room discharge air flow,
- (b) ventilation air flow if room air conditioner is equipped to provide same,
- (c) exhaust air flow if room air conditioner is equipped to provide same,
- (d) leakage air flow.

6.1.2 Air-flow quantities are determined as mass flow rates. If air-flow quantities are to be expressed for rating purposes in volume flow rates, such ratings should state the conditions (pressure, temperature, and humidity) at which the specific volume is determined.

6.2 Nozzles

6.2.1 Nozzles should be constructed in accordance with Figure 3, and installed in accordance with the provisions of succeeding clauses.

6.2.2 Nozzles discharge coefficients for the construction shown in Figure 3 may be determined by use of the alignment chart (see Annex B).

6.2.3 Nozzles may also be constructed in accordance with appropriate national standards, provided they can be used in the apparatus described in Figures 2 and 4 and result in equivalent accuracy.

6.3 Apparatus for room discharge air-flow measurements

6.3.1 Room discharge air-flow measurements should be made with apparatus similar to that shown in Figures 2, 3 and 4.

6.3.2 One or more nozzles constructed in accordance with Figure 3 should be fitted into one wall of the receiving chamber, discharging into the discharge chamber, and should be of such a size that the throat velocity is not less than 15 m/s (3000 ft/min). Centre distances between nozzles in use should not be less than three throat diameters, and the distance from the centre of any nozzle to any of the four adjacent side walls should be not less than 1.5 throat diameters. If the nozzles are of different diameters, the distance between axes should be based upon the average diameter. Size and arrangements of the receiving chamber should be sufficient to provide uniform approach velocity to the nozzle(s) or have suitable diffusion baffles to accomplish this purpose. Nozzles so installed may be considered to have a negligible correction for approach velocity.

6.3.3 To establish a zero static pressure, with respect to the test room, at the discharge of the room air conditioner in the receiving chamber, a manometer should have one side connected to one or more static pressure connections located flush with the inner wall of the receiving chamber.

6.3.4 Size and arrangement of the discharge chamber should be such that the distance from the centre of any nozzle to the adjacent side wall is not less than 1.5 throat diameters and not less than five throat diameters to the next obstruction, unless suitable diffusion baffles are used.

6.3.5 An exhaust fan should be connected to the discharge chamber to overcome the resistance of chamber, nozzle(s), and diffusion baffles.

6.3.6 The manometer(s) used to measure the pressure drop across the nozzle(s) should have one side connected to one or more static pressure connections located flush with the inner wall of the receiving chamber. The other side of the manometer(s) is connected in a similar manner to one or more static pressure connections in the wall of the discharge chamber. Static pressure connections should be located so as not to be affected by air flow. If desired, the velocity head of the air stream leaving the nozzle(s) may be measured by a Pitot tube, but when more than one nozzle is in use, the Pitot tube reading is determined for each nozzle. Temperature readings at the nozzle(s) should be used only for determining air density.

6.4 Room discharge air-flow measurement

6.4.1 Room discharge air-flow should be measured with apparatus similar to that illustrated in Figure 4.

6.4.2 The outlet or outlets of the room air conditioner should be connected to the receiving chamber by adapter ducting of negligible air resistance.

6.4.3 The exhaust fan should be adjusted to give zero static pressure at the discharge of the room air conditioner in the receiving chamber.

6.4.4 The following readings should be taken :

- (a) barometric pressure,
- (b) nozzle dry- and wet-bulb temperatures,
- (c) nozzle velocity pressure.

6.4.5 Air mass flow rate through a single nozzle is determined as follows :

$$Q_m = K_3 C_d A \sqrt{\frac{h_p}{v'_n}} \quad (6)$$

Air volume flow rate through a single nozzle is determined as follows :

$$Q_v = K_3 C_d A \sqrt{h_p \cdot v'_n} \quad (7)$$

$$v'_n = \frac{P_o}{P} = \frac{v_n}{1+x} \quad (8)$$

where

- K_3 = 1.41 for international system (SI) units,
= 15950 for metric units,
= 1096 for non-metric units,

C_d is the nozzle coefficient (see clause 6.2),

A is the nozzle area,

h_p is the static pressure difference across nozzle, or velocity pressure of nozzle throat, the approach velocity being considered negligible,

v'_n is the specific volume of humid air at nozzle inlet,

P_o is the standard barometric pressure = 1.01325 bar (760 mmHg; 29.92 inHg),

P is the barometric pressure at nozzle inlet,

x is the specific humidity at nozzle inlet,

v_n is the specific volume of humid air at dry-and wet-bulb temperature conditions existing at nozzle inlet but at standard barometric pressure.

NOTE. – Where the barometric pressure deviates from the standard barometric pressure by not more than 0.03 bar (22.5 mmHg; 0.886 inHg), v'_n may, for simplicity, be considered equal to v_n .

6.4.6 Air-flow through multiple nozzles should be calculated in accordance with clause 6.4.5, except that total flow rate will be the sum of the Q_m for each nozzle used.

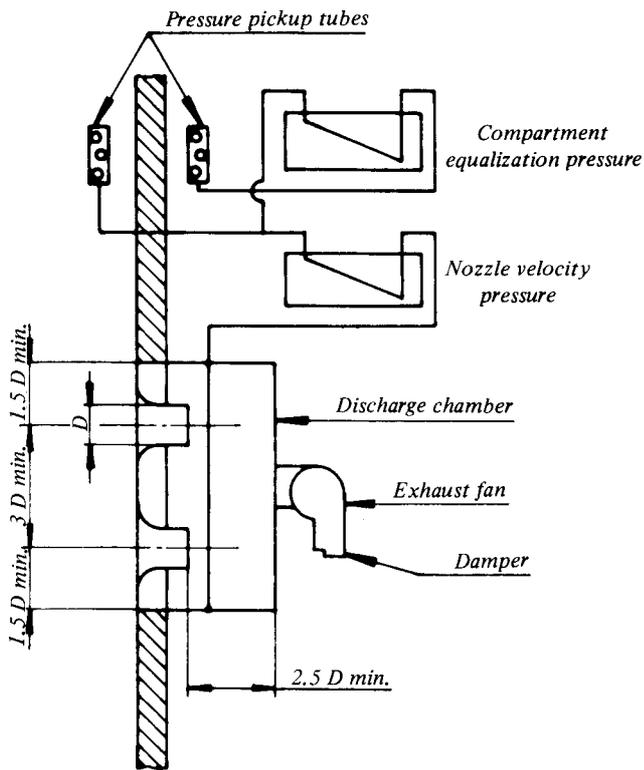


FIG. 2 - Pressure equalizing device

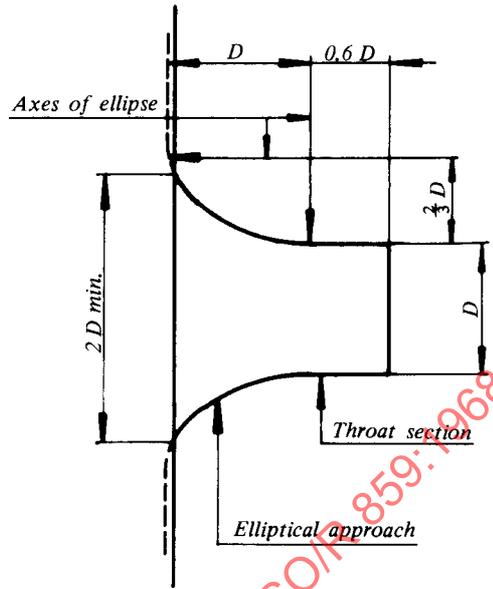


FIG. 3 - Air-flow measuring nozzle

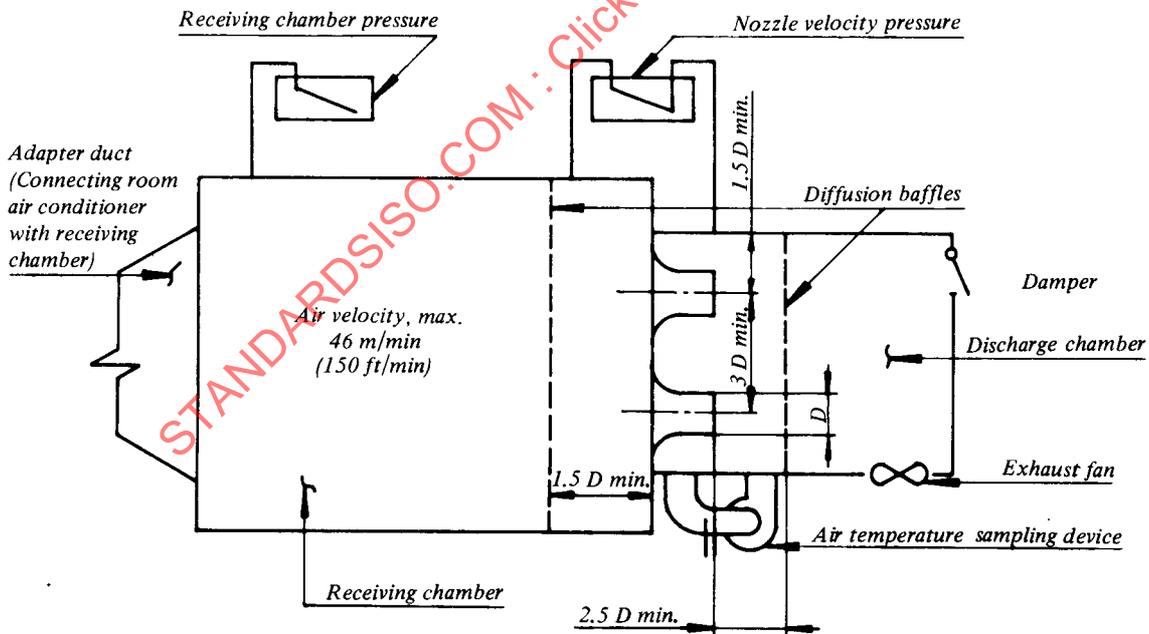


FIG. 4 - Air-flow measuring apparatus

6.5 Ventilation, exhaust and leakage air-flow measurements

- 6.5.1 Ventilation, exhaust, and leakage air-flows should be measured by apparatus similar to that illustrated in Figure 2 with the refrigeration system in operation and after condensate equilibrium has been obtained.
- 6.5.2 With the equalizing device adjusted for a maximum static pressure differential between room-side and outdoor-side compartments of 1 N/m^2 ; 0.01 mbar (0.1 mmH₂O; 0.004 inH₂O), the following readings should be taken :
- (a) barometric pressure,
 - (b) nozzle dry- and wet-bulb temperatures,
 - (c) nozzle velocity pressure.
- 6.5.3 Air-flow values should be calculated in accordance with clause 6.4.5.

7. PERFORMANCE TESTS (see Table 8)

7.1 Maximum operating conditions test

Room air conditioners should meet the following maximum operating conditions test when operating at the test conditions specified in clause 2.2. The unit's controls should be set for maximum cooling and all ventilating air dampers and exhaust air dampers should be closed.

- 7.1.1 *Voltage adjustments.* Test voltages should be as specified in clause 2.2. These voltages should be maintained at the specified percentages under running conditions. The electrical service supplied to the unit service connection should be such that the voltage will not rise more than 3% when the unit is stopped. After the service has been adjusted to accomplish this result, no subsequent adjustments should be made during either test.
- 7.1.2 *Procedure.* The room air conditioner should be operated continuously for 2 hours after the specified air temperatures and equilibrium condensate level have been established. All power to the room air conditioner should then be cut off for 3 minutes and then restored for 1 hour.
- 7.1.3 *Requirements*
- 7.1.3.1 During one entire test, the room air conditioner should operate without visible or audible indication of damage.
 - 7.1.3.2 The room air conditioner motors should operate continuously for the first 2 hours of the test without tripping of the motor overload protective devices.
 - 7.1.3.3 The motor overload protective device may trip only during the first 5 minutes after the shut-down period of 3 minutes. During the remainder of that 1-hour test period, no motor overload protective device should trip.
 - 7.1.3.4 For those models so designed that resumption of operation does not occur after initial trip within the first 5 minutes, the unit may remain out of operation for not longer than 30 minutes. It should then operate continuously for 1 hour.

7.2 Freeze-up tests

Room air conditioners should meet the following freeze-up tests when operating at the test conditions specified in clause 2.3. The unit's controls, fan speeds, dampers, and grilles should 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.

7.2.1 Air-blockage test

7.2.1.1 PROCEDURE. The test should be continuous, with the unit on the cooling cycle for 12 hours after establishment of the specified temperature conditions.

7.2.1.2 REQUIREMENTS. At the end of 12 hours any accumulation of ice or frost on the evaporator should not obstruct the air passing through the evaporator coil.

7.2.2 Drip test

7.2.2.1 PROCEDURE. The unit should be operated for 6 hours with the room-side air inlet covered to completely block the passage of air, so as to attempt to achieve complete blockage of the evaporator coil by frost.

After the 6-hour operating period, the unit should be stopped and the air-inlet covering removed until the accumulation of ice or frost has melted.

The unit should then be turned on again, with the fans operating at the highest speed, for 5 minutes.

7.2.2.2 REQUIREMENTS. During the test no ice should drop from the unit, and no water should drip or blow off the unit on the room side.

7.3 Enclosure sweat test

Room air conditioners should meet the following enclosure sweat tests, when operating at the test conditions specified in clause 2.4. The unit's controls, fans, dampers, and grilles should be set to produce the maximum tendency to sweat, provided such settings are not contrary to the manufacturer's operating instructions.

7.3.1 Procedure. After establishment of the specified temperature conditions, the unit should be operated continuously for a period of 4 hours.

7.3.2 Requirements. During the test, no condensed water should drip, run, or blow off the unit.

7.4 Condensate disposal test

Room air conditioners should meet the following condensate disposal test when operating at the test conditions specified in clause 2.5. The unit's controls, fans, dampers, and grilles should be set to produce the maximum tendency to sweat, provided such settings are not contrary to the manufacturer's operating instructions.

NOTE. – This test may be conducted concurrently with the enclosure sweat test (see clause 7.3).

7.4.1 Procedure. After establishment of the specified temperature conditions, the room air conditioner should be started with its condensate collection pan filled to the overflowing point, and should be operated continuously for 4 hours after the condensate level has reached equilibrium.

7.4.2 Requirements. During this test, the room air conditioner should have the ability to dispose of all condensate and there should be no dripping or blowing-off of water from the unit such that the building or surroundings may become wet.

7.5 Electrical-rating test

Electrical input values used for rating purposes should be measured during the cooling-capacity test as specified in section 5.

TABLE 8 – Variations allowed in performance test readings

Quantity measured	Allowable variation in individual reading from stated test conditions
Air temperatures	± 0.5 °C (1.0 °F)
Water temperatures	± 0.3 °C (0.5 °F)
Voltage	± 1.0 %

8. UNITS OF MEASUREMENT

Basic units of measurement and their symbols are given in Table 9 below.

TABLE 9 - Basic units of measurement and their symbols

No.	Quantity	International system (SI) units	Metric units	Non-metric units
1	Air mass flow rate	kilogramme per second (kg/s)	kilogramme per hour (kg/h)	pound per minute (lb/min)
	Air volume flow rate	cubic metre per second (m ³ /s)	cubic metre per hour (m ³ /h)	cubic foot per minute (ft ³ /min)
2	Air specific humidity	kilogramme per kilogramme (kg/kg)	kilogramme per kilogramme (kg/kg)	pound per pound (lb/lb)
3	Air specific volume	cubic metre per kilogramme (m ³ /kg)	cubic metre per kilogramme (m ³ /kg)	cubic foot per pound (ft ³ /lb)
4	Air static pressure or dynamic pressure	newton per square metre (N/m ²)	millimetre of water (mmH ₂ O)	inch of water (inH ₂ O)
5	Air velocity	metre per second (m/s)	metre per second (m/s)	foot per minute (ft/min)
6	Air volume	cubic metre (m ³)	cubic metre (m ³)	cubic foot (ft ³)
7	Area	square metre (m ²)	square metre (m ²)	square foot (ft ²)
8	Barometric pressure	newton per square metre (N/m ²)	bar (bar) millibar (mbar) millimetre of mercury (mmHg) (torr)	inch of mercury (inHg)
9	Cooling effect	watt (W)	kilocalorie * per hour (kcal/h)	British thermal unit per hour (Btu/h)
10	Dehumidifying effect	watt (W)	kilocalorie * per hour (kcal/h)	British thermal unit per hour (Btu/h)

* kilocalorie 15 °C = 4.1855 kJ