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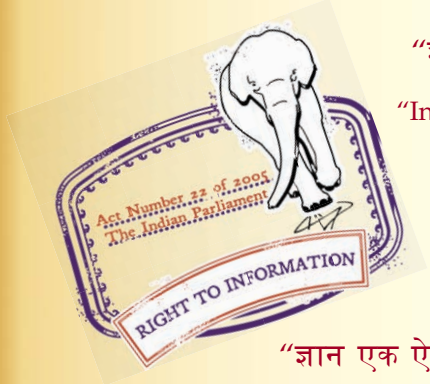
IS 8148 (2003): Packaged Air Conditioners [MED 3: Refrigeration and Air Conditioning]



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भारतीय मानक

पैकेजबंद एअर कंडीशनर — विशिष्टि

(पहला पुनरीक्षण)

Indian Standard

PACKAGED AIR CONDITIONERS — SPECIFICATION

(First Revision)

ICS 23.120

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

November 2003

Price Group 7

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Refrigeration and Air Conditioning Sectional Committee had been approved by the Mechanical Engineering Division Council.

This standard was first published in 1976. The experience gained in implementation of this standard necessitates this revision and certain changes that are necessary are incorporated in this revision.

The methods of test for room air conditioners of capacity up to 10 000 W[1)] (approximately 9 000 kcal/h) specified in IS 1391 (Part 1) : 1992 'Room air conditioners — Specification : Part 1 Unitary air conditioner (*second revision*)' and IS 1391 (Part 2) : 1992 'Room air conditioners : Part 2 Split air conditioners (*second revision*)' are limited to those making use of room calorimeters. Such methods are considered cumbersome and not suitable for packaged air conditioners of capacity 10 000 W and above covered in this standard. This standard has, therefore, been prepared to specify psychrometric and other methods of test suitable for such units.

The quantities have been expressed in International System of Units (SI). The basic units of measurement together with their symbols for the various quantities used in the text have been listed in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

[1)] 1 kcal/h = 1.162 78 W.

Indian Standard

PACKAGED AIR CONDITIONERS — SPECIFICATION

(First Revision)

1 SCOPE

This standard prescribes constructional and performance requirements and methods for establishing rating of packaged air conditioners of the nominal cooling capacity 10 000 W (approximately 9 000 kcal/h) and above, which operate non-frosting when cooling and dehumidifying at standard rating conditions.

2 REFERENCES

The following standards contain provisions, which through reference in this text constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
101 (Part 6/ Sec1) : 1988	Methods of sampling and test for paints, varnishes and related products : Part 6 Durability tests, Section 1 Resistance to humidity under conditions of condensation (*third revision*)
196 : 1966	Atmospheric conditions for testing (*revised*)
302 (Part 1) : 1979	General and safety requirements for household and similar electrical appliances (*first revision*)
325 : 1996	Three phase induction motors (*fifth revision*)
996 : 1979	Single phase small ac and universal electric motors (*second revision*)
1391 (Part 1) : 1992	Room air conditioners — Specification : Part 1 Unitary air conditioners (*second revision*)

3 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

3.1 Packaged Air Conditioner

3.1.1 An encased assembly as a self-contained unit primarily for floor mounting designed 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 cleaning of air, with or without external air distribution ducting. It may also include means for heating, humidifying or ventilating air.

3.1.2 This definition shall also include split air conditioners consisting of an evaporating unit comprising an evaporator coil and a fan (which is located indoors) and a condensing unit comprising a condenser and a compressor (which is usually located outdoors).

3.1.3 These machines are equipped with either water-cooled or air-cooled condenser. For the purpose of this definition, the unit for which the air-cooled condenser is built as a separate package for remote field installation and interconnection shall also be considered as a packaged air conditioner.

3.2 Standard Barometric Pressure

Barometric pressure of 101.325 kPa [1].

3.3 Wet-Bulb Temperature

Temperature indicated when the temperature-sensing element and wetted wick have reached a state of constant temperature (evaporative equilibrium) and when air is flowing over the cotton wick at a velocity of 5 to 10 m/s, wick is wetted with constant source of distilled water.

3.4 Discharge Air Flow of a Unit

Rate of flow of air from the outlet of the unit.

3.5 Intake Air Flow of a Unit

Rate of flow of air into the unit from the conditioned space.

3.6 Nominal Water Flow Rate

Rate of water flow through the condenser of water-cooled unit under capacity rating test conditions.

3.7 Nominal Condenser Air Flow Rate

Rate of air flow through condenser coil specified as m^3/h of standard air at 27°C dry bulb, 65 percent

[1] 100 kPa = 1 bar.

relative humidity and a pressure of 101.325 kPa as specified in IS 196.

3.8 Net Total Cooling Effect of a Unit

Total available capacity of the unit for removing of sensible and latent heat from the space to be conditioned.

3.9 Net Dehumidifying Effect (Latent Cooling Effect)

Total available capacity of the unit for removing latent heat from the space to be conditioned.

3.10 Net Sensible Cooling Effect

Available capacity of the unit for removing of sensible heat from the space to be conditioned.

3.11 Net Sensible Heat Ratio

Ratio of the net sensible cooling effect to the net total cooling effect.

3.12 Test Room

Any room or space in which the unit is installed for test, with conditioning apparatus to ensure proper temperatures of air and water entering the unit. In case of water-cooled unit single room is required for the evaporator side along with water handling equipment to feed water into the condenser at desired temperature and rate of flow. In case of air-cooled unit two rooms are required, one for evaporator side and the other for condenser side, each with appropriate conditioning apparatus.

3.13 Rated Voltage

Voltage shown on the nameplate of the unit.

3.14 Rated Frequency

Frequency shown on the nameplate of the unit.

4 CONSTRUCTION (GENERAL)

4.1 The unit shall be constructed with sufficient strength and rigidity to withstand normal manual and mechanical handling, transportation and usage without damage or failure and shall withstand mechanical strength test as given in **21** of IS 302 (Part 1).

4.2 All parts that require periodic cleaning or maintenance shall be easily accessible when the unit is installed in accordance with manufacturer's instructions. These shall be resistant to corrosion and withstand neutral salt spray test for 72 h in accordance with **3** of IS 101 (Part 6/Sec 1).

4.3 Self-tapping screws shall not be used for any load bearing parts or any part that has to be removed for routine maintenance.

4.4 Units shall be free from undue noise and vibration.

4.5 All parts that constitute an accident hazard shall be effectively guarded.

4.6 An adequate method of condensate removal shall be provided. There shall be condensate tray of adequate size so that no water overflows after 8 h continuous operation at rating conditions of indoor air. The tray and drain shall be made of corrosion-resistant material, or suitably treated with corrosion-resistant coating to withstand neutral salt spray test for 72 h in accordance with **3** of IS 101 (Part 6/Sec 1). The tray shall be adequately insulated to avoid condensation over its external surface.

4.7 Pipes and connections to moving or resiliently mounted parts shall be so arranged as not to foul, or to transmit undue vibrations to other parts and shall be so designed as to prevent failure due to fatigue. All other pipes and connections shall be securely anchored.

4.8 Suitable means shall be provided to prevent water condensed on cold parts of the refrigerating system from affecting the operation of the unit or its controls. Pipes shall be suitably insulated wherever necessary.

4.9 Water-cooled condenser shall have cleanable water passages, either by mechanical means or chemical or both. An adequate opening shall be provided in the casing so as to have access to the passages bearing water, from either end, for the design amenable to mechanical cleaning.

4.10 A suitable size refrigerant strainer shall be incorporated in the liquid line immediately before the expansion device.

4.11 All valves and refrigeration piping shall be properly clamped so as to avoid excessive vibrations.

4.12 Air Filter

The air filter shall be of the dry-air type or viscous-oil coated type. It may be of the throwaway type or washable and replaceable type. The filter may be made from synthetic or coconut fibre or any other suitable material, with proper bonding and impregnation to prevent fraying or loosening of fibres under its normal life.

5 DETERMINATION OF COOLING CAPACITY

5.1 Test Methods

The following three test methods for total cooling capacity are covered in this standard:

a) Psychrometric method — Evaporator side (*see* **5.3**),

b) Psychrometric method — Condenser side (*see* **5.3**), and

c) Condenser water method (*see* **5.4**).

5.2 Applicability of Test Methods

Equipment within the scope of this standard shall be tested simultaneously by two test methods, one for evaporator side and the other for condenser side. The test results by these two methods shall agree within limits specified in **10.1.3**.

5.3 Psychrometric Methods

5.3.1 *General Description*

In psychrometric methods, cooling capacities are determined from measurements of entering and leaving wet and dry bulb temperatures and the associated air flow rate. These methods shall be employed for the evaporator side tests of all equipment. Subject to the additional requirements of **5.3.6**, this method may be used for condenser side tests of air-cooled equipment.

5.3.1.1 The test apparatus for psychrometric methods consists of an air measuring device (*see* **12**) attached to the equipment air discharge (evaporator or condenser as applicable). A conditioning apparatus is attached to the inlet of the unit. This may be done through suitable ducting. Alternatively the test room in which the unit is placed may be supplied with conditioned air through conditioning apparatus. In the latter method the air leaving the unit may be caused to flow completely out of the test room or part of it may be diverted to the conditioning apparatus, so as to create suitable temperature conditions. Suitable means for measuring the wet and dry-bulb temperatures of the air entering and leaving the unit shall be provided.

Conditioning apparatus shall consist of arrangement for heating, cooling and humidifying air, along with fans or blowers.

Figures 1 and 2 show the typical test arrangement for air-cooled and water-cooled units respectively.

NOTE — Figures 1 and 2 which show only typical test arrangement are not to be construed as illustrating the exact layout. Suitable modifications may have to be made so as to ensure minimum losses.

5.3.1.2 Other means of handling the air flow measuring device and supply air at the proper conditions to the equipment inlet may be employed, provided that they do not interfere with the prescribed means of air flow rate, temperature and external resistance measurements nor create abnormal conditions surrounding the equipment.

5.3.2 *Test Room Requirements*

The test room or rooms shall meet the requirements prescribed in **12**.

5.3.3 *Air Flow Measurement*

The air flow measuring device shall be in accordance with the provisions of **13**.

5.3.4 *External Resistance Measurement*

External resistances shall be measured in accordance with the provisions of **13**. Connections to equipment outlet shall comply with the provisions of **13**.

5.3.5 *Temperature Measurement*

5.3.5.1 Evaporator outlet temperature measurements

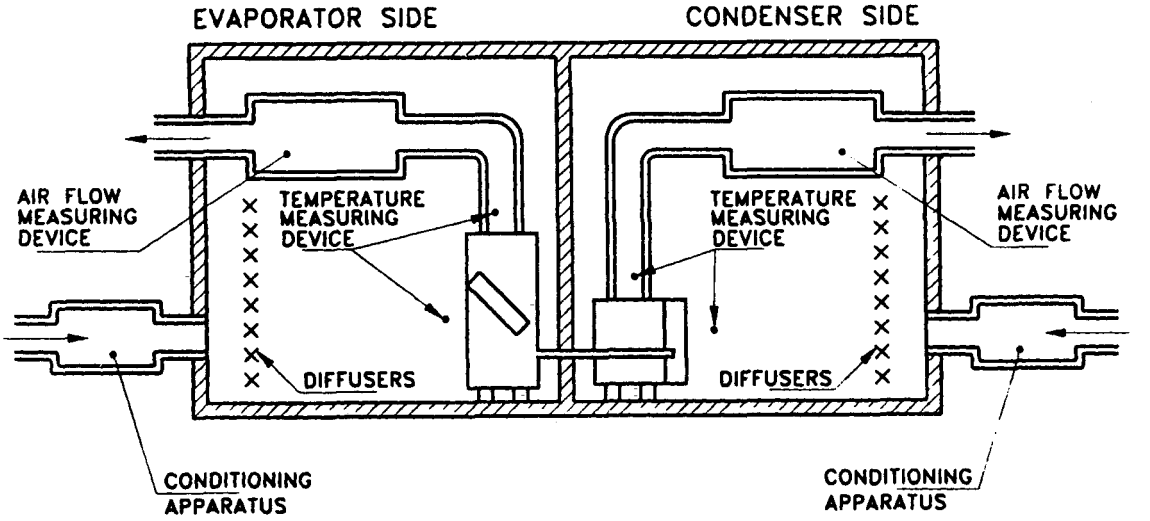


FIG. 1 TYPICAL TEST ARRANGEMENT FOR AIR-COOLED UNITS

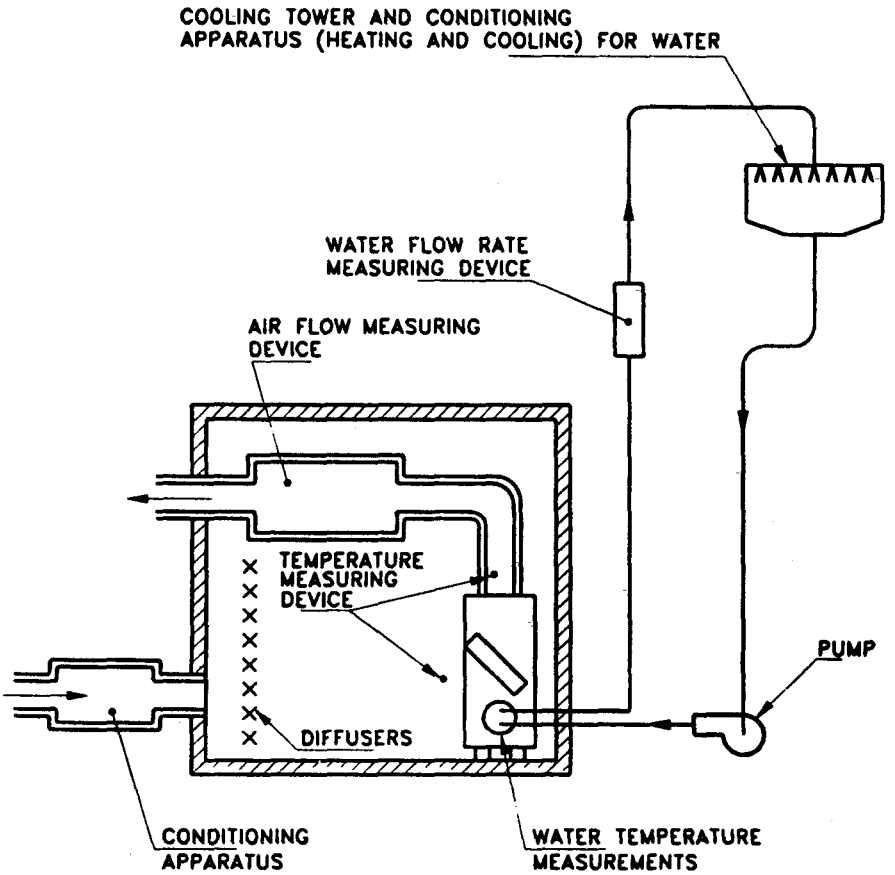


FIG. 2 TYPICAL TEST ARRANGEMENT FOR WATER-COOLED UNITS

shall be made using an air sampling device as shown in Fig. 3. The sampling device shall be located beyond the minimum static pressure duct length (*see* **13.1.2**) to avoid introducing any additional resistance. Ductwork connecting the evaporator outlet to the air flow measuring device shall be insulated between the place of temperature measurement and the evaporator outlet so that heat leakage through the ductwork does not cause a wet bulb temperature rise of more than 0.1°C.

5.3.5.2 Evaporator inlet temperatures shall be measured using suitable sampling devices covering the inlet area and located approximately 150 mm from the unit inlet or inlets.

5.3.5.3 For air cooled units, condenser inlet temperature shall be measured using suitable sampling devices covering the inlet area and located approximately 150 mm from the condenser air inlet or inlets. Condenser outlet temperature shall be measured in the ductwork connecting the unit to airflow measuring device in the same manner as described in **5.3.5.1**. For water-cooled units, condenser inlet and outlet temperatures shall be measured with suitable instruments located as close to the unit as possible.

5.3.6 *Additional Requirements for Condenser Side Use*

When the psychrometric method is employed for condenser or high temperature side tests, it is necessary to ascertain whether the attachment of the airflow-measuring device changes the performance of the equipment being tested and if so, it should be suitably corrected.

5.4 Condenser Water Method

In this method, total cooling capacity is determined from measurements of the condenser water temperature-rise and flow rate. This method may be used for the condenser side tests of water-cooled equipment.

5.4.1 *Water Flow Rate and Temperatures Measurement*

The condenser water flow rate shall be measured with a suitable liquid quantity or flow meter. Entering and leaving condenser water temperatures shall be measured with suitable instruments located at the equipment water connections. Data shall be taken at 1 minute intervals until seven consecutive sets of

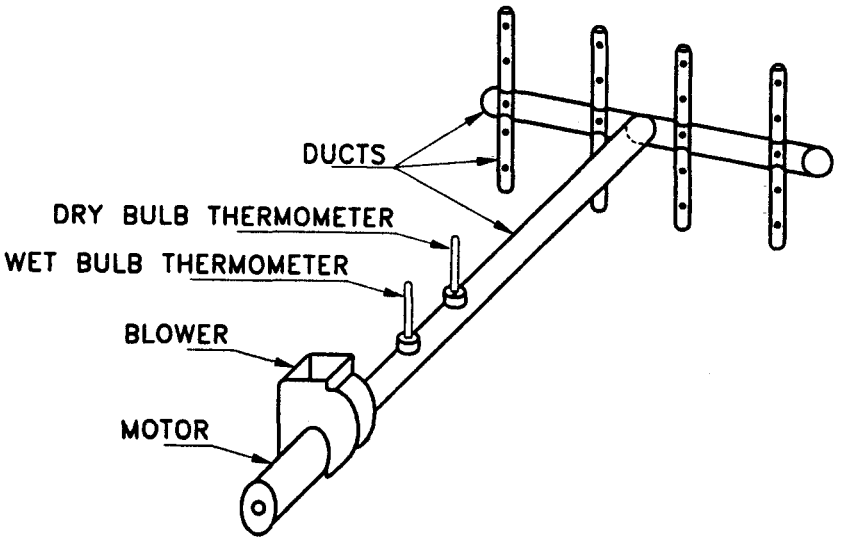


FIG. 3 SAMPLING DEVICE

reading agree with the tolerances prescribed in **10.1.4**.

6 CALCULATIONS

6.1 Psychrometric Method

6.1.1 Total, sensible and latent cooling capacities (*see* Note) on the evaporator or low side are calculated by the following equations:

$$q_t = Q_v(h_{e1} - h_{e2})/V_n$$

$$q_s = 1.02 \times 10^3 Q_v (t_{e1} - t_{e2})/V_n$$

$$q_l = 2.46 \times 10^6 Q_v (w_{e1} - w_{e2})/V_n$$

where

q_t = evaporator side total cooling capacity, in W;

q_s = evaporator side sensible cooling capacity in W;

q_l = evaporator side latent cooling capacity, in W;

Q_v = measured evaporator airflow rate, in m^3/s;

V_n = specific volume of air at place of air flow measurement, in m^3/kg dry air;

h_{e1} = enthalpy of air entering equipment, in J/kg dry air;

h_{e2} = enthalpy of air leaving equipment, in J/kg dry air;

t_{e1} = dry-bulb temperature of air entering equipment, in °C;

t_{e2} = dry-bulb temperature of air leaving equipment, in °C;

w_{e1} = humidity ratio of air entering equipment, in kg, water per kg dry air; and

w_{e2} = humidity ratio of air leaving equipment, in kg, water per kg dry air.

NOTE — These are the capacities delivered to the ductwork by the equipment under test. They do not take into account heat transfer through equipment casings, which normally are less than 2 percent of the capacity, nor evaporator fan motor heat when a fan is not furnished with the equipment. Where desired, casing transfer may be measured with the colorimeter method arrangement.

6.1.2 Total cooling capacity based on condenser side data is calculated by one of the following equations:

$$q_{tc} = Q_{mc}(h_{c2} - hc_1)/V_n - E_t$$

or for air-cooled equipment which does not re-evaporate condensate only

$$q_{tc} = 1.02 \times 10^3 Q_v (t_{c2} - t_{c1})/V_n - E_t$$

where

q_{tc} = condenser side total cooling capacity, in W;

Q_{mc} = measured condenser air flow rate, in m^3/s (*see* **12**);

V_n = specific volume of air at place of air flow measurement, in m^3/kg dry air;

h_{c1} = enthalpy of air entering equipment, in J/kg dry air;

h_{c2} = enthalpy of air leaving equipment, in J/kg dry air;

t_{c1} = dry-bulb temperature of air entering equipment, in °C;

t_{c2} = dry-bulb temperature of air leaving equipment, in °C; and

E_t = total power input to equipment, in W.

6.2 Condenser Water Method

Total cooling capacity based on condenser side data is calculated by the following equation:

$$q_{tc} = W_c c (t_{w2} - t_{w1}) - E_t$$

where

q_{tc} = condenser side total cooling capacity, in W;

W_c = condenser water flow rate, in kg/s;

c = specific heat of water, in J/kg °C;

t_{w2} = temperature of water leaving equipment, in °C;

t_{w1} = temperature of water entering equipment, in °C; and

E_t = total power input to equipment, in W.

7 RATING REQUIREMENTS

7.1 Tolerances

To comply with this standard, published or reported ratings shall be based on conditions specified in **7.2** to **7.6** and shall be such that the performance of any production unit shall have a capacity not less than 90 percent of the stated capacity.

7.2 Cooling Capacity Ratings

Cooling capacity ratings shall be based on tests conducted under conditions specified in **9.1** and with apparatus described in **12** and **13**. Ratings shall include the total cooling capacity and the latent cooling capacity.

7.3 Discharge Air Flow Ratings

Discharge air flow ratings shall be stated in cubic metres per hour of standard air at 27°C dry bulb, 65 percent relative humidity and a pressure of 101.325 kPa as specified in IS 196 with the controls set for maximum cooling and with the fresh air properly closed and with external resistance adjusted in accordance with manufacturer's instructions.

7.4 External Static Pressure Rating

This is the static pressure rating external to the unit, against which the specified discharge of airflow occurs. This pressure is a necessary requisite to overcome friction losses in field conditions such as those produced, for example ducting.

7.5 Condenser Cooling Medium Flow Rating

The flow rating of cooling medium for condenser shall be specified by the manufacturer, in kg/s. Rated flow rate of cooling water shall be maintained for the condenser during capacity rating test. In other tests the flow rate of cooling medium shall be maintained as per test conditions described in **9.**

7.6 Electrical Heating Capacity Rating

An air conditioner equipped with an electrical heating element or elements shall have its electrical heating capacity ratings determined by measurement of the total electrical power consumed by the unit.

7.7 Electrical Ratings

Ratings, in watts, for packaged air conditioner shall be based on rated voltage. The units, however, shall be capable of working at any voltage within ±10 percent of the rated voltage.

7.8 Rated air quantities shall not exceed 64 m^3/h per 300 W of rated cooling capacity. The minimum external resistance for the range of cooling capacity shall be specified by the manufacturer and shall not be less than the values given below:

Cooling Capacity W	*External Resistance, Min* Pa
10 000 – 17 500	50
17 501 – 26 250	60
26 251 – 35 000	75
35 001 – 52 000	90
53 000 – 70 000	105

In interpreting the requirements, it is understood that the filters, heating coils and other equipment recommended as part of the unit be in place and that the net external resistance specified above are available for the duct system.

7.9 All standard ratings for the air-cooled units shall be determined at condenser air quantity specified by the manufacturer, where the speed of the fan is adjustable. However, the manufacturer need not necessarily specify the condenser air quantity where the fan speed is non-adjustable, in which case, the ratings shall be determined at the condenser air quantity inherent in the unit when operated with all the resistance elements associated with the inlet louvers, ductwork and other attachments considered by the manufacturer as normal in installation practice. Once established, the condenser air circuit of the unit shall remain unchanged throughout all the tests prescribed in this standard.

8 BASIS OF RATINGS

8.1 For the purpose of rating, information shall be provided regarding the functions, which the unit performs under rating conditions as per capacity rating test given in **9.1**, namely:

a) Cooling;
b) Dehumidifying;
c) Heating, if provided;
d) Air circulating; and
e) Filtering.

8.2 In addition to the above, the following information shall be furnished by the manufacturer as and when desired:

a) Manufacturer's name and address;
b) Model, size or type;
c) Net total cooling effect;
d) Total air capacity and external static pressure;
e) Required rate of water/air flow and its pressure drop across condenser;
f) Name of refrigerant;
g) Weight of the refrigerant charged into the unit;
h) Power input of each motor separately;
j) Total power input;
k) Nameplate ratings of each motor; and
m) Manufacturer's installation and operating instructions.

NOTE — All capacity ratings and power input shall be under the same conditions as for capacity rating test.

9 RATING AND TEST CONDITIONS

9.1 Capacity Rating Test Condition

The package air conditioner shall have nameplate rating determined by test conducted at the standard rating condition specified below:

Evaporator side inlet air temperature:	
a) Dry bulb	27°C
b) Wet bulb	19°C
Condenser side inlet air temperature:	
a) Dry bulb	35°C
b) Condenser water inlet temperature	30°C
c) Condenser water outlet temperature	35°C, *Min*
Test voltage [1]	Rated voltage
Test frequency	Rated frequency

9.2 Maximum Operating Test Condition

The maximum operating tests shall be conducted under the conditions specified below:

Evaporator side inlet air temperature:	
a) Dry bulb	35°C
b) Wet bulb	24°C
Condenser side inlet air temperature:	
a) Dry bulb	46°C
b) Condenser water inlet temperature	34°C
c) Water flow rate	Same as in **9.1**
Test voltage:	
a) For units with a single voltage rating	90 and 110 percent
b) For units with a dual voltage rating	90 percent, *Min*, 110 percent, *Max*
Test frequency	Rated frequency

9.3 Freeze-up Test Conditions

Freeze-up tests shall be conducted under the conditions specified below:

Evaporator side inlet air temperature:	
a) Dry bulb	21°C
b) Wet bulb	16°C
Condenser side inlet air temperature:	
a) Dry bulb	21°C
b) Condenser water inlet temperature	19°C
c) Water flow rate	Same as in **9.1**
Test voltage[1]	Rated voltage
Test frequency	Rated frequency

9.4 Enclosure Sweat Test Conditions

The enclosure sweat test shall be conducted under the conditions given below:

Evaporator side inlet air temperature:	
a) Dry bulb	27°C
b) Wet bulb	24°C
Condenser side inlet air temperature:	
a) Dry bulb	27°C
b) Condenser water inlet temperature	27°C
c) Water flow rate	Same as in **9.1**
Test voltage[1]	Rated voltage
Test frequency	Rated frequency

9.5 Condensate Disposal Test Conditions

Condensate disposal test shall be conducted under the same conditions as those specified for enclosure sweat tests (*see* **9.4**).

10 PERFORMANCE REQUIREMENTS

10.1 Capacity Rating Test

10.1.1 *Purpose*

The purpose of the capacity rating test is to determine the magnitude of the following functions:

a) Net total cooling effect,
b) Net dehumidifying effect,
c) Net sensible cooling effect,

[1] Units with dual rated voltages shall be tested at the lower voltage.

[1] Units with dual rated voltages shall be tested at higher voltage.

d) Net total air capacity for cooling,

e) External resistance to evaporator air flow, and

f) Total power input to equipment (*see* **10.6**) or power inputs to all equipment components.

10.1.2 *Test Condition*

Capacity rating test shall be conducted under the conditions specified in **9.1**. The air conditioners shall be in the condition as normally intended for use. Filters and grills where supplied shall be in position.

10.1.2.1 Test results shall be used to determine capacities without adjustment for permissible variations in test conditions except as specified for deviations from standard barometric pressure.

10.1.2.2 Capacities may be increased by 2.4 percent for each 10 kPa of barometric reading below 101.325 kPa at which the tests were conducted.

10.1.3 *Procedure*

Two simultaneous methods for determining capacities shall be used. One method shall determine capacity on the evaporator side and the other shall determine the capacity on the condenser side. The total cooling capacity will be the average of the two simultaneously conducted methods of test, which shall agree within 6 percent. Sensible and latent cooling capacities shall be those determined from the evaporator side test multiplied by the ratio of the average total cooling capacity to the evaporator side total cooling capacity. The air conditioner shall be tested in test room complying with **12**. Room discharge airflow measurement shall be in accordance with **13**.

10.1.3.1 Test conditions shall be maintained until equilibrium has been reached and maintained for not less than one hour, before recording data for the capacity test. The test shall then be run for 2 h recording data every 15 min.

10.1.3.2 The data to be recorded for this test is given in Table 1. This table shows general information required, but is not intended to limit the data to be obtained. Items required for different test methods are indicated by an '×' under the test method columns.

Table 1 Data to be Recorded

(*Clauses* 10.1.3.2 *and* 10.6.3)

Sl No.	Item	Units	Psychromatic Method		Condenser Water Method
			Evaporator Side	Condenser Side	
(1)	(2)	(3)	(4)	(5)	(6)
i)	Date and time	—	×	×	×
ii)	Observers	—	×	×	×
iii)	Barometric pressure	kPa	×	×	×
iv)	Equipment nameplate data	—	×	×	×
v)	External resistance to evaporator air flow	Pa	×	×	×
vi)	Power input to equipment (*see* Note 1)	W	×	×	×
vii)	Applied voltage(s)	V	×	×	×
viii)	Frequency	Hz	×	×	×
ix)	Fan speed(s), if adjustable	Rev/min	×	×	×
x)	Dry-bulb temperature of air entering equipment	°C	×	×	×
xi)	Hot-bulb temperature of air entering equipment	°C	×	(*see* Note 2)	×
xii)	Dry-bulb temperature of air leaving equipment	°C	×	×	
xiii)	Wet-bulb temperature of air leaving equipment	°C	×	(*see* Note 2)	
xiv)	Throat diameter of nozzle(s)	m	×	×	
xv)	Velocity pressure at nozzle throat or static pressure difference across nozzle(s)	Pa	×	×	
xvi)	Temperature at nozzle throat	°C	×	×	
xvii)	Pressure at nozzle	Pa	×	×	
xviii)	Condensing pressure or temperature	Pa, °C		×	
xix)	Evaporator pressure or temperature	Pa, °C		×	
xx)	Condenser water flow rate	kg/s			×
xxi)	Temperature of condenser water entering equipment	°C			×
xxii)	Temperature of condenser water leaving equipment	°C			×

NOTES

1 Total power input and, where required, input to equipment components.

2 Required for evaporative-cooled equipment and equipment which re-evaporates condensate.

10.1.4 *Test Tolerances*

10.1.4.1 All test observations shall be within the variations allowed as specified in Table 2, as appropriate to the test methods and type of equipment.

10.1.4.2 The maximum permissible variation of any observation during the capacity test is listed under 'maximum variation of individual reading from rating conditions' in Table 2. This represents the greatest permissible difference between maximum and minimum instrument observations during the test. When expressed as a percentage, the maximum allowable variation is the specified percentage of the arithmetical average of the observations.

10.1.4.3 Variations greater than those prescribed shall invalidate the test.

10.2 Maximum Operating Conditions Test

10.2.1 *Purpose*

The purpose of this test is to prove that the air conditioner is capable of operating satisfactorily under maximum operating conditions.

10.2.2 *Test Conditions*

The maximum operating conditions test shall be conducted under the conditions specified in **9.2**. The unit's controls should be set for maximum cooling.

10.2.3 *Voltage Adjustment*

Test voltage shall be as specified in **9.2**. These voltages shall be maintained at the rated voltages ±2 percent under running conditions. The electrical service supplied to the unit service connection shall be such that the voltage will not rise more than 3 percent when the unit is stopped.

10.2.4 *Procedure*

The packaged air conditioner shall be operated continuously for 2 h after the specified air temperatures and equilibrium condensate level have been established. All power to the packaged air conditioner shall then be cut off for 3 min and then restored for 1 h.

10.2.5 *Requirements*

10.2.5.1 During one entire test, the packaged air conditioner should operate without visible or audible indication of damage.

10.2.5.2 The packaged air conditioner motors should operate continuously for the first 2 h of the test without tripping of the motor overload protective devices.

10.2.5.3 The motor overload protective device may trip only during the first 5 min after the shut-down period of 3 min. During the remainder of that 1 h test period, no motor overload device shall trip.

10.2.5.4 For the models so designed that resumption of operation does not occur after initial trip within the first 5 min, the unit may remain out of operation for not longer than 30 min. It shall then operate continuously for 1 h.

10.3 Freeze-Up Tests

10.3.1 *Purpose*

The air blockage test and drip test shall be conducted to determine the ability of the air conditioner to operate

Table 2 Test Tolerances

(*Clauses* 10.1.4.1 *and* 10.1.4.2)

Sl No.	Reading	Variation of Arithmetical Mean Values from Specified Test Conditions	Maximum Variation of Individual Reading from Rating Conditions
(1)	(2)	(3)	(4)
i)	Temperature of air entering indoor side :		
	a) Dry-bulb	± 0.3°C	± 1.0°C
	b) Wet-bulb	± 0.2°C	± 0.5°C
ii)	Temperature of air leaving indoor side	—	± 1.0°C
iii)	Temperature of air entering outdoor side :		
	a) Dry-bulb	± 0.3°C	± 1.0°C
	b) Wet-bulb	± 0.2°C	± 0.5°C
iv)	Temperature of air leaving outdoor side Dry-bulb	± 1.0°C	± 1.0°C
v)	Air volume flow rate	± 5%	± 10%
vi)	Voltage	± 1 %	± 2%
vii)	Water temperature :		
	a) Inlet	± 0.1°C	± 0.2°C
	b) Outlet	± 0.1°C	± 0.2°C
viii)	Water volume flow rate	± 1%	± 2%
ix)	External resistance to airflow	± 5 Pa	± 10 Pa

satisfactorily under conditions with the maximum tendency to frost or ice the evaporator.

10.3.2 *Test Conditions*

Freeze-up test shall be conducted under the conditions given in **9.3**. The unit's controls, fan speeds, dampers and grills should 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.

10.3.3 *Air Blockage Test*

10.3.3.1 *Procedure*

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

10.3.3.2 *Requirements*

At the end of 12 h, the accumulation of ice or frost on the evaporator shall not obstruct the air passing through the evaporator coil.

10.3.4 *Drip Test*

10.3.4.1 *Procedure*

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

10.3.4.2 *Requirements*

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

10.4 Enclosure Sweat Test

10.4.1 *Purpose*

The purpose of this test is to determine the resistance to sweating of the air conditioner when operating under conditions of high humidity.

10.4.2 *Test Conditions*

An enclosure sweat test shall be conducted under the conditions specified in **9.4**. The unit's controls, fans, dampers and grillers shall be set to produce the maximum tendency to sweat, provided such settings are not contrary to manufacturer's operating instructions.

10.4.3 *Procedure*

After establishment of the specified temperature conditions, the unit shall be operated continuously for a period of 4 h.

10.4.4 *Requirements*

During the test, no condensed water shall drip, run or blow off the unit.

10.5 Condensate Disposal Test

10.5.1 *Purpose*

The purpose of this test is to determine the capability of the air conditioner to dispose off condensate. This test may be conducted concurrently with the enclosure sweat test (*see* **10.4**).

10.5.2 *Test Conditions*

A condensate disposal test shall be conducted under the conditions specified in **9.5**. The unit's controls, fans, dampers and grillers shall be set to produce the maximum tendency to sweat, provided such settings are not contrary to manufacturer's operating instructions.

10.5.3 *Procedure*

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

10.5.4 *Requirement*

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

10.6 Power Consumption Test

10.6.1 *Purpose*

The purpose of the power consumption test is to determine the power consumption, in watts.

10.6.2 *Test Condition*

The power consumption shall be determined during the capacity rating test (*see* **10.1**) under the condition given in **9.1**.

10.6.3 *Test Procedure*

The power consumption shall be the average power consumption in watts measured during the capacity rating test (*see* **10.1** and Table 1).

10.6.4 The maximum power consumption when measured during the capacity rating test (*see* **10.1**) under the conditions given in **9.1** shall be as given below:

Cooling Capacity		*Maximum Power Consumption* in Watts	
Watts	Tons of Refrigeration	Water Cooled	Air Cooled
10 000	3	3 750	4 750
17 500	5	6 000	7 000
26 250	7.5	9 000	10 000
35 000	10	11 500	13 500
52 000	15	17 000	20 000

11 INSTRUMENTS

11.1 Temperature Measuring Instruments

11.1.1 Temperature measurements shall be made with one or more of the following instruments:

a) Mercury-in-glass thermometers,
b) Thermocouples, and
c) Electric resistance thermometers.

11.1.2 Instrument accuracy shall be within ± 0.1°C.

11.1.3 In no case shall be smallest scale division of the temperature-measuring instrument exceeding twice the specified accuracy.

11.1.4 In all measurements of wet bulb temperatures, sufficient wetting of the wick with distilled water shall be provided and sufficient time shall be allowed for the state of evaporative equilibrium to be attained.

Air velocities over the wet bulb temperature measuring instruments shall be 5 to 10 m/s. The same air velocity shall be maintained for the inlet and outlet temperature measurements. Figure 4 shall be used to correct wet bulb temperature readings at air velocities below 5 m/s.

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

11.1.6 Temperature of fluids within conduits shall be

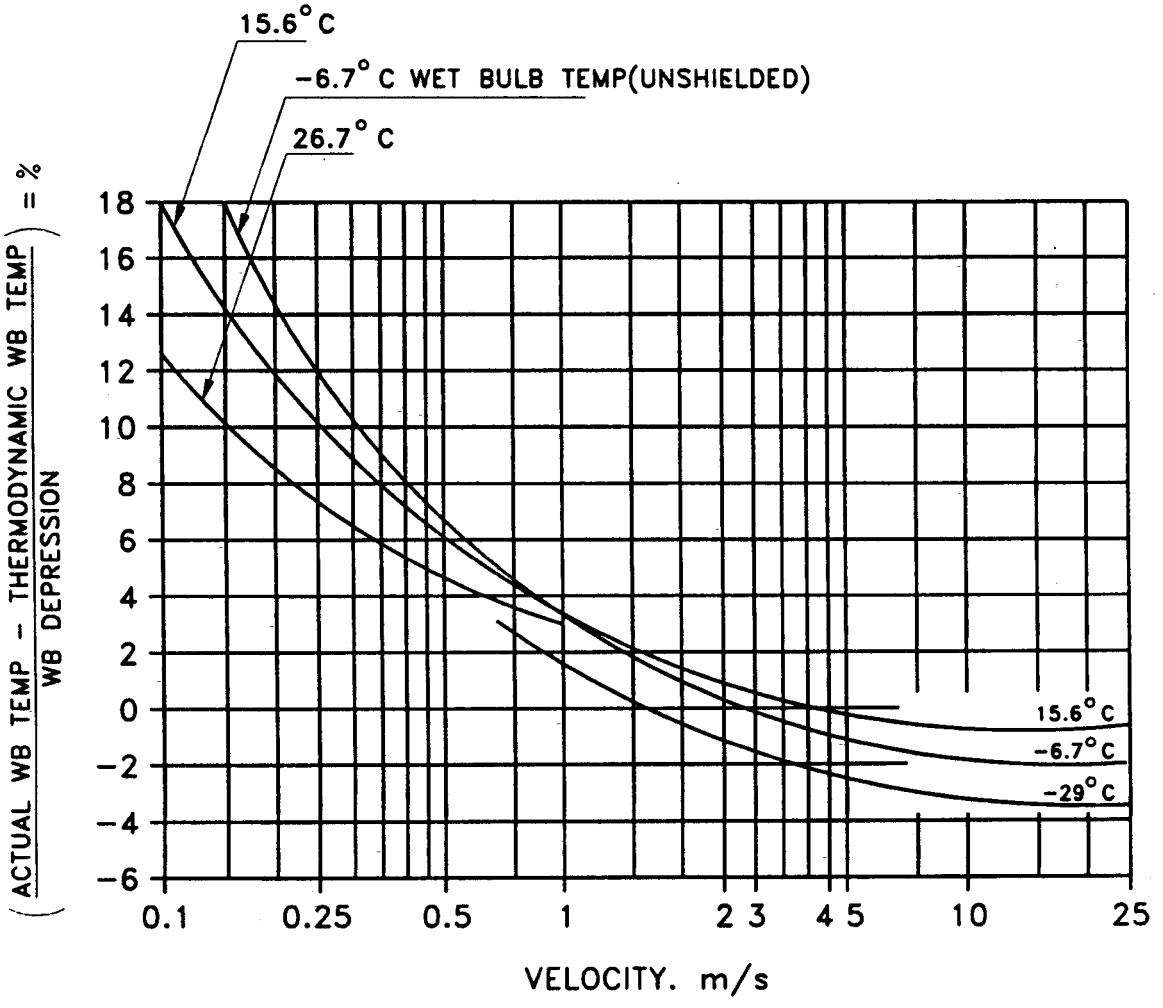


FIG. 4 THE EFFECT OF AIR STREAM VELOCITY ON THE WET-BULB PSYCHROMETER

measured by inserting 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 shall be calibrated for the effect of pressure.

11.1.7 Temperature measuring instruments shall be adequately shielded from radiation from any adjacent heat source.

11.2 Pressure Measuring Instruments

11.2.1 Accuracy of pressure measuring instruments for measuring air pressure shall permit measurements within ± 5 Pa.

11.2.2 In no case shall the smallest scale division of the temperature-measuring instrument exceeding twice the specified accuracy.

11.2.3 Barometric pressure shall be measured by a barometer having scale markings permitting readings with an accuracy within ± 0.1 percent.

11.3 Electrical Instruments

11.3.1 Electrical measurements shall be made with either indicating type or integrating type of instruments.

11.3.2 Instruments used for measuring all electrical inputs to the calorimeter compartments shall be accurate to ± 0.5 percent of the quantity measured.

11.4 Water Flow Measuring Instruments

11.4.1 Volume measurements shall be made with either of the following instruments having an accuracy of ±1 percent of the quantity measured:

a) Liquid quantity meter, measuring either mass or volume; and

b) Liquid-flow-rate meter.

11.4.2 Liquid quantity meter shall employ a tank having sufficient capacity to accumulate the flow for at least 2 min.

11.5 Other Instruments

11.5.1 Time interval measurements shall be made with instruments whose accuracy is ±0.2 percent of the quantity measured.

11.5.2 Mass measurement should be made with apparatus whose accuracy is ±1 percent of the quantity measured.

12 TEST PREPARATION

12.1 Test Room Requirements

12.1.1 Either one or two adjacent test rooms are required, depending upon the type of equipment to be tested and the manufacturer's installation instruments.

12.1.2 An evaporator or low side test room is always required. This may be any room or space in which the desired test conditions can be maintained within the permissible tolerances. It is recommended that air velocities in the vicinity of the equipment under test do not exceed 2.5 m/s.

12.1.3 An adjacent condenser or high side test room or space is required for tests of air-cooled equipment. This test room shall be of sufficient volume and shall circulate air in a manner such that it does not change the normal air-circulating pattern of the equipment under test. Dimensions shall be such that the distance from any room surface to any equipment surface from which air is discharged is not less than 2 m and the distance from any other room surface to any other equipment surface is not less than 1 m except for floor or wall relationships required for normal equipment installation. The room conditioning apparatus shall handle air at a rate not less than the condenser airflow rate.

12.2 Equipment Installation

12.2.1 The equipment to be tested shall be installed in the test room or rooms in accordance with the manufacturer's installation instructions using recommended installation procedures and accessories. Self-contained water-cooled equipment shall be located entirely within the evaporator side test room; air-cooled self contained equipment shall be located in or adjacent to an opening in the wall or partition separating the test rooms in accordance with the normal or primary recommendations of the manufacturer. In all cases, the manufacturer's recommendations with respect to distances from adjacent walls, amount of extension through walls, etc, shall be followed.

12.2.2 No alterations to the equipment shall be made except the attachment of required test apparatus and instruments in the prescribed manner.

12.2.3 Where necessary, equipment shall be evacuated and charged with the type and amount of refrigerant specified on the nameplate or as prescribed in the manufacturer's instructions.

12.2.4 When required, pressure gauges shall be connected to the equipment only through short lengths of small diameter tubing and shall be located so that the readings are not influenced by fluid head in the tubing.

12.2.5 No changes shall be made in fan speed or system resistance to correct for barometric variations.

13 AIR FLOW MEASUREMENT

13.1 Air Flow Determination

13.1.1 The following air quantities may be measured

using the apparatus and testing procedures described in 13 of IS 1391 (Part 1):

a) Room discharge airflow, and

b) Ventilation airflow.

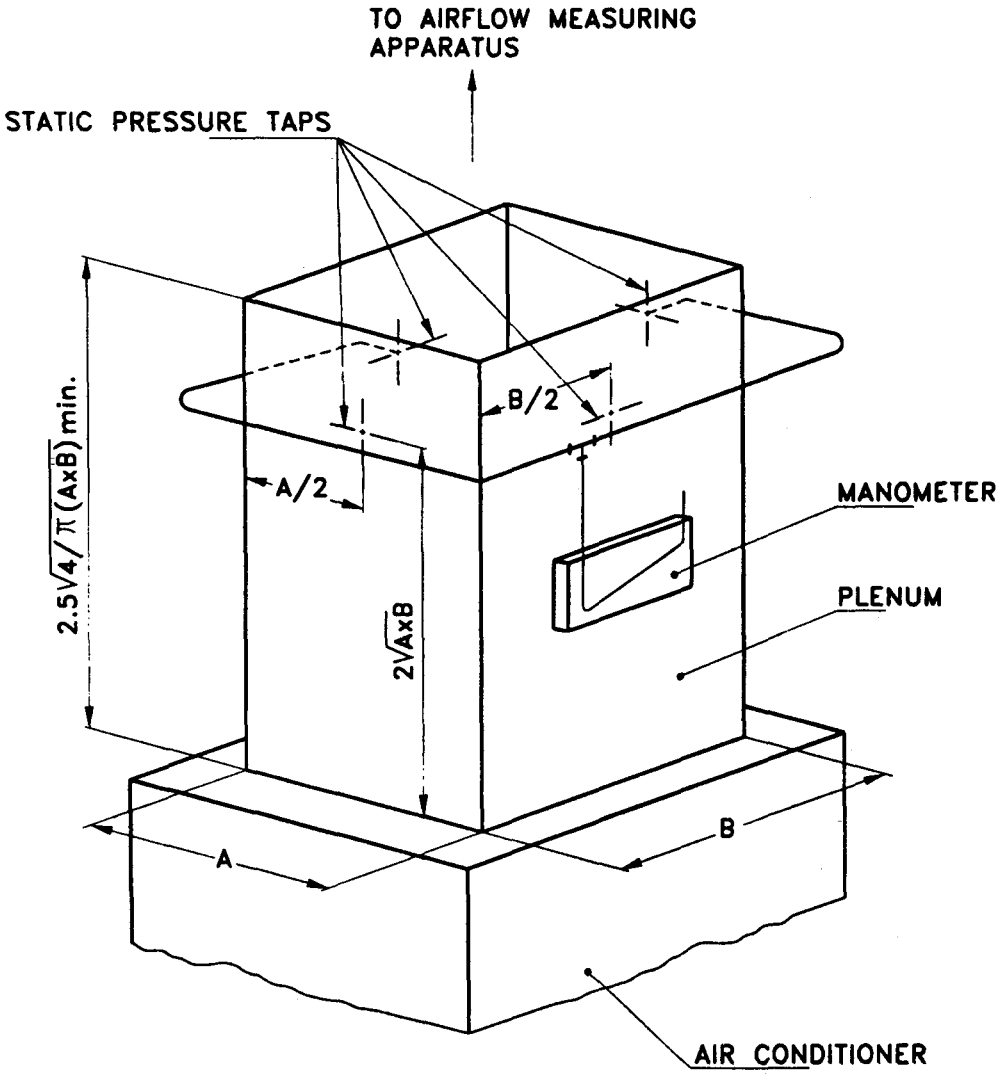
13.1.2 Specified external static pressure shall be maintained inside a discharge duct attached to the outlet of the unit under test (UUT) and having cross-sectional dimensions equal to the dimensions of the UUT outlet as shown in Fig. 5. This static pressure measurement duct shall discharge into air measuring device, either directly or through suitable connecting ducting. Minimum straight length of the static pressure duct shall be 2.5 times the equivalent diameters [that is, $2.5\sqrt{\frac{4}{\pi}(A \times B)}$ for rectangular ducts] and static pressure measurement shall be done at a distance of $2\sqrt{(A \times B)}$ from the UUT outlet, where A and B are the cross-sectional dimensions of the unit outlet.

The static pressure measuring duct shall be proceeded by a flow straightening section, of equivalent diameter length to prevent cross flow at the pressure tap, which is to be set perpendicular to the flow.

13.1.3 A static pressure measurement tap shall be provided at the center of each face and all the taps shall be manifolded externally for averaging. One side of a manometer (or differential pressure transducer) shall be connected to this manifold and the other side shall be open to the surrounding atmosphere.

14 NOISE LEVEL OF PACKAGED AIR CONDITIONERS

The noise level for packaged air conditioners shall be as low as possible.



NOTE — A and B are outlet dimensions.

FIG. 5 EXTERNAL STATIC PRESSURE MEASUREMENT

NOTE — It is recognized, that packaged air conditioners are usually located away from the conditioned space and the supply air as well as return air is handled through ducting. In some instances the packaged air conditioner is located directly in the conditioned space and conditioned air is supplied through a plenum chamber placed on the outlet(s) of the unit. It is recommended that the internal surfaces of the ducting, plenum chamber, as well as the packaged air conditioner should be acoustically treated so as to create suitably low noise level in conditioned space. The acceptable noise level and the corresponding acoustic treatment will naturally vary from establishment to establishment. With the intention of providing general guidelines, it may be stated that in applications where supply and return air is handled by ducting, the noise level in conditioned space should be of the order of 55 to 66 dB when measured on '*A*' scale. For applications where packaged air conditioner is located within the conditioned space, noise level of 65 to 70 dB on '*A*' scale may be permitted.

15 TESTS

15.1 Classification of Tests

Tests shall be classified into the following three groups:

a) Production routine tests,
b) Type tests, and
c) Acceptance tests.

15.1.1 *Production Routine Tests*

These shall consist of routine tests that would be conducted on each and every unit after completion at the manufacturer's works (*see* **15.3**).

15.1.2 *Type Tests*

The type tests shall consist of the tests that would be necessary to check up the performance and characteristics of the units and components, and shall be carried out by a recognized testing authority that may be the manufacturer if approved by the purchaser. Once a packaged air conditioner has undergone type tests, any minor or essential alterations, which the manufacturer intends to make, shall be reported to the testing authority (*see* **15.4**).

15.1.3 *Acceptance Tests*

If the purchaser desires any of the production routine tests to be repeated at the time of purchase, then, where agreed to between the purchaser and the manufacturer, the tests may be carried out at the manufacturer's works; alternatively the tests may be repeated at the place specified by the purchaser provided that all the arrangements for tests are made by the purchaser at the specified place.

15.2 Sample for Tests

15.2.1 *Type Tests*

Two packaged air conditioners of each size shall be sent along with manufacturer's detailed specifications to the recognized testing authority for purposes of type tests. The samples shall be picked up at random from stock or routine factory production.

15.2.2 *Acceptance Tests*

The number of samples shall be as agreed to between the manufacturer and the purchaser.

15.3 Production Routine Tests

15.3.1 *General Running Test*

Each unit shall be given a run to ensure vibration-free and thorough running of mechanical parts.

15.3.2 *Pressure Test or Leakage Test*

No part of the assembly under test shall show signs of refrigerant leakage greater than 3 g/year under normal working pressure when tested with a leak detector. This shall be in addition to the manufacturer's production test on each unit at the appropriate pressure corresponding to the refrigerant used.

15.3.3 *Insulation Resistance Test*

The insulation resistance between all electric circuits and the metal parts when measured at normal room temperature with a voltage of not less than 500 V dc shall be not less than one meghom.

15.3.4 *High Voltage Test*

The electrical insulation of all circuits shall be such as to withstand a test voltage of 2 000 V rms applied for not less than 2 s between circuits and accessible metal parts at normal room temperature. The test voltage shall be alternating approximately sine wave form and of any convenient frequency between 25 Hz and 100 Hz.

15.3.5 *Performance Test*

Measurement shall be made of the following under the prevailing ambient conditions and the performance figures from (a) to (e) shall be compared with the unit, which has already passed the type test:

a) Temperature of air entering the unit,
b) Temperature of the air leaving the unit,
c) Air flow,
d) Current consumption,
e) Voltage, and
f) Wattage.

A vane type anemometer may be used for comparing the airflow of the production unit and the type tested unit.

NOTE — The tests at **15.3.1** and **15.3.2** may be carried out separately on each indoor and condensing unit by interconnecting. These tests on the interconnected units may be carried out as per sampling plan as agreed between manufacturer and purchaser.

15.4 Type Tests

15.4.1 Besides all the production routine tests outlined in **15.3**, the type tests shall comprise the following:

a) Capacity rating and other tests specified in **9**.

b) Room discharge air flow rating test in accordance with procedure given in **13** and under conditions in **7.3**;

c) Electrical rating (that is, measurement of current in amperes and power input and energy consumption at rated voltage and frequency of the blower fan motor and compressor motor) under conditions specified in **7.7**; and

d) Test for fan or blower motor to determine the conformity to the requirements specified in IS 996 and IS 325.

NOTE — The BIS Certification Mark on motors for fan and compressors guarantees conformity of the motors to IS 996 and IS 325. If the purchaser so desires, type test certificate may be obtained from the manufacturer.

15.4.2 The type test report shall also contain the name-plate particulars of the packaged air conditioners for purposes of identification.

16 MANUFACTURER'S GUARANTEE

The manufacturer shall give a guarantee for the soundness of construction and performance of the air conditioner, and shall be responsible for putting right any manufacturing defects free of charge for a period of 12 months right from the date of sale to the original purchaser or date of inspection or approval in the case of government or semi-government institutions. Such repairs or replacements of defective parts shall be carried out as per the manufacturers guarantee policy agreed upon by the manufacturer and the purchaser.

17 MARKING

17.1 The packaged air conditioner shall have the following information marked in a nameplate in a permanent and legible manner in a location where it is accessible and visible:

a) Name and address of the manufacturer;

b) Type of model number and serial number of the unit;

c) Power supply in '...V ... phase ...Hz';

d) Full load amperage;

e) Name and quantity of refrigerant charge;

f) Nominal capacity, in W, under temperature conditions specified in this standard;

g) Power consumption, in W, at the normal operating conditions specified in this standard; and

h) Locked rotor amperage.

17.2 BIS Certification Marking

17.2.1 Each unit may also be marked with the Standard Mark.

17.2.2 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standard Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which a licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

ANNEX A

(Foreword)

BASIC UNITS OF MEASUREMENT AND THEIR SYMBOLS

Sl No.	*Quantity*	*International System (SI) Units*		*Metric Units*	
		Name of Unit	Symbol	Name of unit	Symbol
i)	Air mass flow rate	Kilogram per second	kg/s	Kilogram per hour	kg/h
	Air volume flow rate	Cubic metre per second	m^3/s	Cubic metre per hour	m^3/h
ii)	Air specific humidity	Kilogram per kilogram	kg/kg	Kilogram per kilogram	kg/kg
iii)	Air specific volume	Cubic metre per kilogram	m^3/kg	Cubic metre per kilogram	m^3/kg
iv)	Air static pressure or dynamic pressure	Pascal[1)]	Pa	Millimeter of water	mm H_2O
v)	Air velocity	Metre per second	m/s	Metre per second	m/s
vi)	Air volume	Cubic metre	m^3	Cubic metre	m^3
vii)	Area	Square metre	m^2	Square metre	m^2
viii)	Barometric pressure	Pascal	Pa	Bar Millibar Millimetre of mercury (torr)	bar mbar mmHg
ix)	Cooling effect	Watt	W	Kilocalorie per hour	kcal/h
x)	Dehumidifying effect	Watt	W	Kilocalorie per hour[2)]	kcal/h
xi)	Electric current input	Ampere	A	Ampere	A
xii)	Electric frequency	Hertz	Hz	Hertz	Hz
xiii)	Electric power input	Watt	W	Watt	W
xiv)	Specific enthalpy	Joule per kilogram	J/kg	Kilocalorie per Kilogram[2)]	kcal/kg
xv)	Rotating speed	Radian per second	rad/s	Turn per second Turn per minute	tr/s tr/min
xvi)	Heat flow rate	Watt	W	Kilocalorie per hour	kcal/h
xvii)	Heat leakage rate	Watt	W	Kilocalorie per hour	kcal/h
xviii)	Linear measurements	Metre Millimetre	m mm	Metre Millimetre	m mm
xix)	Temperature Interval of temperature	Kelvin Kelvin	K K	Degree celsuis Degree celsuis	°C °C
xx)	Water mass flow rate	Kilogram per second	kg/s	Kilogram per hour	kg/h
xxi)	Acceleration	Metre per square second	m/s^2	Metre per square second	m/s^2

1) 1 Pa = 1 $N.m^2 = 10^{-5}$ bar.
2) Kilocalorie 15°C = 4.185 5 kJ.

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Review of Indian Standards

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