IS 3963 (1987): Roof extractor units [ETD 5: Electric Fans]

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Indian Standard

SPECIFICATION FOR ROOF EXTRACTOR UNITS

(First Revision)

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Indian Standard

SPECIFICATION FOR ROOF EXTRACTOR UNITS

(First Revision)

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Indian Standard

SPECIFICATION FOR ROOF EXTRACTOR UNITS

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards on 7 July 1987, after the draft finalized by the Electric Fans Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 With the setting up of a large number of big factories, worksheds, power plants, steel mills, etc, the use of roof extractor units for the purpose of extracting the hot and polluted air from inside of the workshed through the roof has steadily increased. These units essentially consist of an extraction fan together with a strong casing or cowl for protection of the fan from weather and climatic hazards.

0.3 The indigenous manufacture of roof extractor units has been progressively increasing and this standard has been drawn up to meet the requirements having a uniform basis for the determination of the performance of such units together with adopting a uniform method of their testing.

0.4 This standard was originally published in 1966. This revision has been undertaken to take into account the experience gained since then and to align some of the safety requirements with the provisions of IS : 302-1979*. The amendments issued to the previous edition of the standard have also been incorporated in this revision.

0.5 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†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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*General and safety requirements for household and similar electrical appliances (*fifth revision*).

†Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard specifies the requirements and tests for roof extractor units in which the extraction fan is driven by an electric motor operated from either single-phase supply voltage not exceeding 250 volts or three-phase supply voltage not exceeding 440 volts. It covers the following types of roof extractor units:

a) 'Vertijet' type in which there are two or more shutters (on the top of the cowl) which open only when the fan is operated and the air leaves the weather-protection casing vertically upwards substantially parallel to the axis of the fan impeller, and

b) 'Cowl' type in which the top of the weather-protection casing is closed and the air driven vertically upwards by the fan impeller rebounds from the top of the cowl and leaves the casing downwards through openings at its sides (*see* Fig. 1).

1.2 This standard also covers speed regulators, if any, associated with the extractor fans.

1.3 This standard does not cover units in which the fan impeller is not directly driven by the motor.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions in addition to those given in IS : 1885 (Part 55)-1981* shall apply.

2.1 Roof Extractor Unit — A combination of an extractor fan and a strong casing or cowl for protection of the fan from weather hazards, designed for mounting on the roof of a building or workshed for the purpose of extracting inside air and discharging the same to the outside atmosphere.

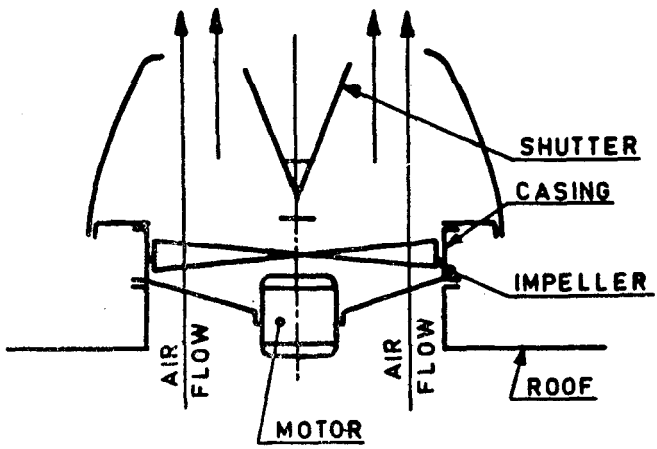
2.2 Extractor Fan — A fan in which air leaves the impeller in a direction substantially parallel to the axis. These fans are designed normally to operate under free inlet and outlet conditions, though they necessarily have to overcome the small resistance set up by the casing or cowl of the roof extractor units.

2.3 Mounting — The framework provided to support the roof extractor units in the required position on the top or roof of the building or workshed which may by flat or inclined at an angle to the vertical.

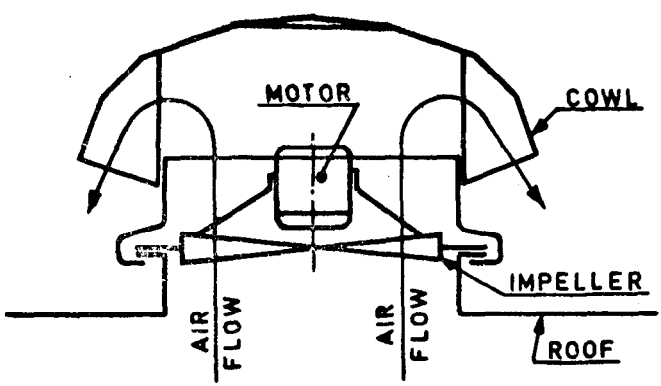
2.4 Casing — A mounting incorporating means for weather-protection of the fan unit. It should be so designed that during storm and rain, the outside dust or rain-water does not get inside the extractor fan and also the inside of the roof of the shed on which the roof extractor unit is installed, irrespective of whether the extractor fan operates or not.

*Electrotechnical vocabulary : Part 55 Electric fans.

2.5 Cowl — It is a special form of casing in which the top is sealed and air from the extractor fan rebounds at the top and leaves the cowl through openings at its side in a substantially downward direction.



VERTIJET TYPE



COWL TYPE

FIG. 1 ROOF EXTRACTOR UNITS

2.6 Shutter — A means for preventing the flow of external air through the fan when it is not running. The shutter may be part of the fan casing or may be a separate auxiliary. The shutter may be automatically operated by the air stream produced by the fan or it may be manually operated by cords or other device permitting control from accessible position.

2.7 Cooling Air Temperature — The temperature of the surrounding atmosphere in which the fan operates.

2.8 Type Tests — Tests carried out to prove conformity with the requirements of this standard. These are intended to prove general qualities and design of a given type of fan.

2.9 Routine Tests — Tests carried out on each fan to check the essential requirements which are likely to vary during production.

2.10 Acceptance Tests — Tests carried out on sample selected from a lot for the purpose of verifying the acceptability of the lot.

3. SIZES

3.1 The preferred sizes of roof extractor units shall be as as given below:

600, 900, 1200 and 1500 mm

NOTE — Other sizes are also permitted subject to agreement between the purchaser and the supplier.

3.2 Sizes of roof extractor units specified above are subject to a tolerance of ± 5 mm.

4. RATED VOLTAGE

4.1 The preferred rated voltage for roof extractor units shall be 240 volts for single-phase and 415 V for 3-phase operations (*see* IS : 585-1962*).

5. RATED FREQUENCY

5.1 The rated frequency shall be the standard frequency of 50 Hz.

NOTE — Nevertheless, fans made for other frequencies shall be considered to comply with the specification, provided they do so in all other relevant respects.

6. DESIGN AND GENERAL CONSTRUCTION

6.1 Motor Enclosure — The motor of fan shall be of the totally-enclosed type.

6.2 Blades — Fans shall be fitted with two or more well-balanced blades made from metal or other suitable material. The blades and blade carriers shall be securely fixed so that they do not loosen in operation.

*Voltages and frequency for transmission and distribution systems (*revised*).

6.3 Mounting — The means provided for securing the fan mounting or fan casing shall be such as to provide a secure fixing without damage. Where the casing contains members to be clamped against an exterior wall, these shall be capable of being sealed to prevent the ingress of rain-water at the point of attachment.

6.4 Guards — Suitably designed guards shall be made available by the manufacturer for supply on request and shall be fitted either to the inlet or the outlet side, or both, to prevent accidental contact with the rotating blades. The guards shall be securely attached and shall be adequately rigid to resist accidental contact with the blades. When the guards are in two pieces, positive locking arrangement to keep the two pieces together should be made.

6.5 Bearings — If necessary, the manufacturer shall, on enquiry, furnish information about the type of bearing and instruction of their proper lubrication (*see* Appendix A).

6.6 Capacitors — Capacitors, if any, shall be easily replaceable and placed at sufficient distance from the windings, so that its maximum working temperature is not exceeded. Capacitors shall be clearly marked with the maximum safe working temperature, and the corresponding voltage and capacitance. Capacitors shall comply with IS : 1709-1984*.

6.7 Protective Measures — From the point of view of protection against electric shock, electric fans shall be either of the following two types:

a) with basic insulation only, with the accessible metal parts designed to be connected to an earthing terminal or contact (Class I fans); and

b) with double or reinforced insulation, with the accessible metal parts not designed to be connected to an earthing terminal or contact (Class II fans).

6.7.1 In case of roof extractor units with basic insulation only, the chassis, framework and the fixed parts of the metal casing, where used, shall be provided with two separate earthing terminals (*see* **9.1.1**). These terminals shall be provided over and above all other means provided for securing metallic encloures (armour or other metallic coverings) of current carrying cables.

6.7.2 The earthing terminals shall be readily accessible and so placed that the earth connection of the roof extractor unit is maintained when the cover or any other movable part is removed.

*Specification for capacitors for electric fan motors (*first revision*).

6.7.3 The earthing terminals shall be of adequate size, be protected against corrosion and shall be metallically clean. Under no circumstances shall a movable metal part of the enclosure be insulated from the part carrying the earthing terminal when the movable part is in place.

7. GENERAL AND SAFETY REQUIREMENTS

7.1 Protection Against Electric Shock — In the assembled fan, live parts shall not be accessible to the standard test finger (*see* IS : 1401-1970*). In the case of a double insulated fan, both basically insulated parts and live parts shall not be accessible to the standard test finger. This requirement is applicable for all positions in the normal use.

7.2 Electric Insulation — The electric insulation of the fans shall be adequate and the leakage current in normal use shall not be excessive.

7.2.1 When measured according to the method specified in **10.5**, the insulation resistance shall not be less than 2 MΩ.

7.2.2 *Leakage Current* (*see* **10.10**) — Requirements of relevant Indian Standards on motors shall apply:

> The leakage current which may flow from the live parts to the accessible parts and metal foil on external insulating material connected together shall not exceed 300 μA (peak), that is 210 μA (rms).

7.2.3 There shall be no breakdown of the insulation when the fan is subjected to high voltage test as given in **10.3** or flash test (**10.4**), as the case may be.

7.3 Insulating Materials — Windings of fans and regulators (where provided) shall be insulated with either Class A, Class E or Class B insulating materials which comply with limits of temperature-rise specified in **7.4**. These insulating materials are detailed in IS : 1271-1985†.

7.4 Temperature-rise — The fan motor and regulator shall be tested at any cooling air temperature not exceeding 40°C, but whatever may be the value of this temperature, the permissible temperature-rise when measured as described in **10.15.2** shall not exceed the limits given in Table 1.

7.5 Finish — All the surfaces of the assembly and mechanism shall be suitably and adequately protected against corrosion.

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*Accessibility test probes (*first revision*).

†Thermal evaluation and classification of electrical insulation (*first revision*).

TABLE 1 PERMISSIBLE LIMITS OF TEMPERATURE-RISE

(*Clauses* 7.4, 10.15.2 *and* 10.15.2.1)

Sl No.	Part of Motor or Regulator	Temperature-Rise			Method of Measurement
		Class A Insulation	Class B Insulation	Class E Insulation	
(1)	(2)	(3)	(4)	(5)	(6)
i)	Insulated windings of motors	60°C	80°C	75°C	Change of resistance
ii)	Cores in contact with insulated windings of motors	50°C	70°C	65°C	Thermometer
iii)	Uninsulated parts of motors including cores not in contact with insulating material	The temperature-rise shall not reach such a value that there is a risk of injury to any insulating material on adjacent parts			Thermometer
iv)	Insulated windings, if any, of regulator (with continuous running on any contact)	60°C	80°C	75°C	Chage of resistance
v)	Regulator resistance unit (with continuous running on any contact)	The temperature-rise shall not reach such a value that there is a risk of injury to any insulating material on adjacent parts of the regulator			Thermometer
vi)	External surface likely to be touched during normal usage	40°C	40°C	40°C	Thermometer

NOTE — The temperature-rise values given above are for fans normally made to this specification to work in cooling air temperatures not exceeding 40°C. Nevertheless, fans made to work in higher cooling air temperatures can be regarded as complying with this specification, provided the temperature-rise values are reduced corresponding to the increase in cooling air temperature. Such fans shall be specially marked.

7.6 Speed Regulator

7.6.1 It is not usual for fans covered by this specification to be provided with regulators. However, if regulators are required, this shall be a matter of agreement between the purchaser and the supplier.

7.6.2 Enclosures of the fan regulators shall be either of the ventilated or the totally-enclosed types.

7.6.3 Where a regulator is provided with a capacitor not permanently connected across the motor terminals, provision shall be made so that the capacitor is discharged when the regulator is in the 'Off' position.

7.6.4 The regulator handle or knob shall be either of insulating material or, if of metal, it shall be adequately insulated electrically and thermally so that its temperature-rise above ambient is limited to 20°C. All metallic parts associated with it shall be protected from accidental contact.

7.6.5 The regulator handle or knob shall be so placed that it may be safe and conveniently manipulated with definite positioning action. The handle or knob shall be so designed that it does not become loose in use. The 'Running' and 'Off' positions of the regulator shall be distinctly and clearly marked and the indicator on the operating handle or knob shall correctly indicate the position of the regulator.

7.6.6 The mechanism of the regulator shall be so designed as to ensure positive contact at each running position. In the case of inductance type regulator, it is essential that the circuit should be opened between contacts in order to avoid short-circuits on the choke.

7.6.7 The regulator shall have mechanical stops for the regulator moving contact to prevent accidental contact with the metallic body of the regulator in the event of forced overtravel of the knob.

7.7 Interchangeability — The motor of the fan of a particular size and model and its associated regulator, if any, and set of blades shall be interchangeable such that the performance of the fan keeps within limits specified in this standard.

7.8 Silent Operation — Precautions shall be taken in the manufacture of fans and regulators to ensure a reasonable degree of silence at all speeds.

NOTE — The need for specifying limits of noise levels (acoustical) of the fans is recognised. However, it has not been found possible to specify these limits at present on account of:

a) dependency of these limits on the actual location of the fans,

b) lack of data on the acceptable noise levels for different applications, and

c) lack of agreed definition of noise level and method of evaluating the same.

The criterion of noise level may, therefore, be subject to an agreement between the manufacturer and the purchaser.

8. PERFORMANCE REQUIREMENTS

8.1 Minimum Standard of Performance — The minimum air delivery and maximum power input at test voltage shall be as given in Table 2.

TABLE 2 EXTRACTOR FAN PERFORMANCE CHARACTERISTICS

(*Clause* 8.1)

FAN SIZE	SYNCHRONOUS SPEED	AIR DELIVERY *Min*	WATTS INPUT* *Max*
(1)	(2)	(3)	(4)
mm	rev/min	m^3/h	W
600	600	5 000	170
	750	6 500	280
	1 000	8 400	600
900	500	14 000	650
	600	17 500	900
	750	22 000	1 450
1 200	500	30 500	1 650
	600	37 000	3 300
1 500	500	56 500	4 300
	600	69 000	7 000

*The input power shall be measured with the cowl or casing fitted to the extractor fan outlet.

8.2 Tolerance on Ratings

8.2.1 For an extractor fan covered by this standard, in no case shall the measured performance be inferior to that given in this standard.

8.2.2 In addition the observed results are pressed as a percentage of the rating assigned by the manufacturer shall be within the following limits:

Characteristic	*Tolerance Percent*
Electrical input power in watts	+ 10
Total air delivery	− 10
Fan speed	± 10

Where a tolerance in one direction is omitted, there is no restriction on the value in that direction.

9. MARKING

9.1 Each roof extractor unit shall be indelibly marked atleast with the following information:

a) Manufacturer's name, trade-mark of roof extractor unit (if any) and number,

b) Rated voltage(s) or voltage range and number of phases,
c) Input in watts,
d) Size of roof extractor unit,
e) Rated speed in rev/min,
f) Rated frequency,
g) Rated current,
h) Direction of rotation (Marking should be of permanent nature), and
j) Country of manufacture.

9.1.1 In the case of roof extractor units provided with earthing terminals, these shall be marked in a legible and indelible manner on or adjacent to these terminals, with the symbol  .

9.1.2 For additional information that the manufacturer may be requested to supply, *see* Appendix A.

9.2 BIS Certification Marking

The product may also be marked with Standard Mark.

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

10. TESTS

10.1 Categories of Tests

10.1.1 *Type Tests* — The tests specified below shall constitute type tests and shall be carried out on three samples of same type and rating selected, preferably, at random from a regular production lot:

a) High Voltage (**10.3**),
b) Insulation resistance (**10.5**),
c) Earthing continuity (**10.6**),
d) Electrical input (**10.7**),
e) Fan speed (**10.8**),

f) Power factor (**10.9**),
g) Leakage current (**10.10**),
h) Starting (**10.11**),
j) Moisture proofness (for regulators only) (**10.12**),
k) Mechanical endurance (for regulators only) (**10.13**),
m) Air delivery (**10.14**), and
n) Temperature-rise (**10.15**).

10.1.2 *Acceptance Tests* — The following shall constitute the acceptance tests:

a) High voltage (**10.3**),
b) Insulation resistance (**10.5**),
c) Earthing continuity (**10.6**),
d) Electrical input (**10.7**), and
e) Fan speed (**10.8**),

10.1.2.1 A recommended sampling plan for acceptance tests is given in Appendix B.

10.1.3 *Routine Tests* — The following shall constitute routine tests:

a) Flash test (**10.4**),
b) Insulation resistance (**10.5**), and
c) A simple running test to determine that the roof extractor unit mechanism is in working order.

10.2 General Conditions of Test

10.2.1 *Test Voltage and Frequency* — Unless otherwise specified, the test shall be carried out at rated voltage and frequency.

10.2.1.1 When a rated voltage is indicated on the nameplate, the test shall be conducted at the rated voltage. If the fan is specified for two or more distinct rated voltages with three or more supply terminals, the tests shall be carried out at the most unfavourable voltage. In case of doubt, the tests shall be carried out at all voltages.

10.2.1.2 When a rated voltage range is indicated on the name-plate, the test shall be conducted at the mean of the upper and lower limits of the range provided that the upper limit does not exceed the lower limit by more than 10 percent.

If the upper limits exceeds this value, the test shall be conducted at the voltage corresponding to either the upper limit or the lower limit whichever is more unfavourable to the particular test.

10.2.1.3 *Limits of voltage variation* — The variation in the test voltage shall not exceed $\pm$ 1 percent of the test voltage during air delivery tests.

While taking the current and watt readings during these tests, however, the voltage shall be maintained at the test voltage.

10.2.2 For a fan rated with a range of frequency, the test shall be made at the frequency which gives the most unfavourable results. Tolerance on frequency shall be $\pm$ 1 percent.

10.2.3 *Limits of Error of Electrical Instruments* — The ammeters, voltmeters and wattmeters used for type tests shall have a class index 0·5 or better [*see* IS : 1248 (Part 1)-1983*]. For routine and acceptance tests, instruments of class index 2 may be used.

10.3 High Voltage Test

10.3.1 The source of supply for high voltage test shall be not less than 500 VA.

10.3.2 The high voltage test shall be applied to all new and completed fan motors in normal working conditions with all parts in place except the capacitors which should be disconnected. As type test, this test should preferably be done immediately, after the temperature-rise test.

10.3.3 An ac test voltage at any convenient frequency between 40 to 60 Hz of approximately sine wave-form shall be applied and maintained for one minute without showing any kind of breakdown or flashover.

The test voltage shall be applied as follows:

a) *For fan motors*

i) Between live parts and body in the case of motors intended to be earthed	1 500 volts
ii) Between live parts and other inaccessible metal parts (that is, over the functional insulation) in the case of double insulated motors	1 500 volts
iii) Between the inaccessible metal parts and the body (that is, over the supplementary insulation) in the case of double insulated moters	2 500 volts
iv) Between live parts and body (that is, over the reinforced insulation) for reinforced insulated motors	4 000 volts

b) *For regulators*

i) Between any terminal and the body	1 500 volts
ii) Between the terminals with the regulator in the 'Off' position	1 500 volts

*Specification for direct acting indicating analogue electrical measuring instruments and their accessories : Part 1 General requirements (*second revision*).

10.3.4 At the end of one minute, the test voltage shall be removed and the insulation-resistance test conducted as in **10.5**.

10.3.5 If this test is required to be repeated, the test voltage levels shall be reduced to 85 percent of the original value.

10.4 Flash Test — Every roof extractor unit and regulator (if provided) shall be subjected to a voltage 20 percent higher than that specified in **10.3** for one second.

10.5 Insulation Resistance Test

10.5.1 Insulation resistance test shall be carried out on fans and regulators immediately after conducting the high voltage of flash test, as the case may be.

10.5.2 The insulation resistance shall be not less than 2 megohms when tested with a dc voltage approximately 500 V applied between the points used for high voltage test or flash test.

10.6 Earthing Continuity Test — For fans intended to be earthed, the resistance shall not exceed 0·1 ohm between any exposed metal parts, except the rotating parts supported by metal bearings, and

a) the free end of the earthing conductor if the fan is fitted with a flexible cord, due allowance being made for the resistance of the earthing conductor of the flexible cord, or

b) the earthing terminal or contact, when the fan is supplied without a flexible cord.

The resistance measurement shall be made with a current of 10 A with a dc voltage not exceeding 6 V.

10.7 Electrical Input Test — The electrical input to the fan in watts shall be determined by running the fan at the test voltage and at the highest speed.

10.8 Fan Speed Test — The speed of rotation of the fan shall be determined by running the fan at the test voltage and its rated frequency. The method of measurement of the speed of fan shall be such that the speed of the fan is not appreciably affected.

10.9 Power Factor Test — The power factor of the fan motor at test voltage and highest speed setting shall be not less than 0·90 for single-phase capacitor type motors, 0·60 for non-capacitor type single-phase motors and 0·50 for 3-phase fan motors.

10.10 Leakage Current Test — This test shall be carried out in accordance with **13.2** of IS : 302-1979*.

10.11 Starting — The fan shall be capable of starting up from rest at the lowest speed step when 85 percent of the rated voltage or 85 percent of the lowest voltage in the voltage range is applied.

10.12 Moisture Proofness (for Regulators only) — The regulator shall be subjected to and shall satisfy the high voltage and insulation resistance tests immediately after having been placed for a period of 24 hours without current being passed through the motor and regulator in a closed receptacle in which relative humidity is maintained between 90 to 95 percent at any temperature chosen in the range of 40 to 50°C. Whatever temperature is chosen for this test, it shall be maintained constant to within ± 1 deg.

10.13 Mechanical Endurance Test (for Regulators only) — The regulator shall not show any sign of functional impairment when subjected, without applying electrical power, to a test of at least 5 000 operations, an operation including a full cycle of movement from the 'Off' position to the 'Full Speed' position (or to the other extreme position) and back to 'Off'.

10.14 Air Delivery Test — The following methods shall be followed for the determination of the air delivery. This test shall be carried out with the casing or cowl fitted with the extractor fan so that the air delivery measured will correspond to the roof extractor unit as a whole and not to the fan only.

10.14.1 *Test Method No. 1 : Square Duct Method*

10.14.1.1 To the inlet side of the extractor fan shall be attached to an airway of square cross-section (*see* Fig. 2) having sides D and length $1 \cdot 1/3\ D$, D being not less than 1·5 times the diameter of orifice in which the fan impeller rotates. To the inlet end of this airway shall be attached a mouthpiece of length $2/3\ D$, having an included angle 20 degree converging towards the fan, and a radial flange at its inlet end of width $D/25$.

10.14.1.2 At a distance of 300 mm from the outlet end of the test duct, there shall be flat plane baffle on all sides of the test duct; the baffle shall extend to a length of 600 mm from the outermost edge of the cowl or casing of the roof extractor unit on all sides.

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*General and safety requirements for household and similar electrical appliances (*fifth revision*).

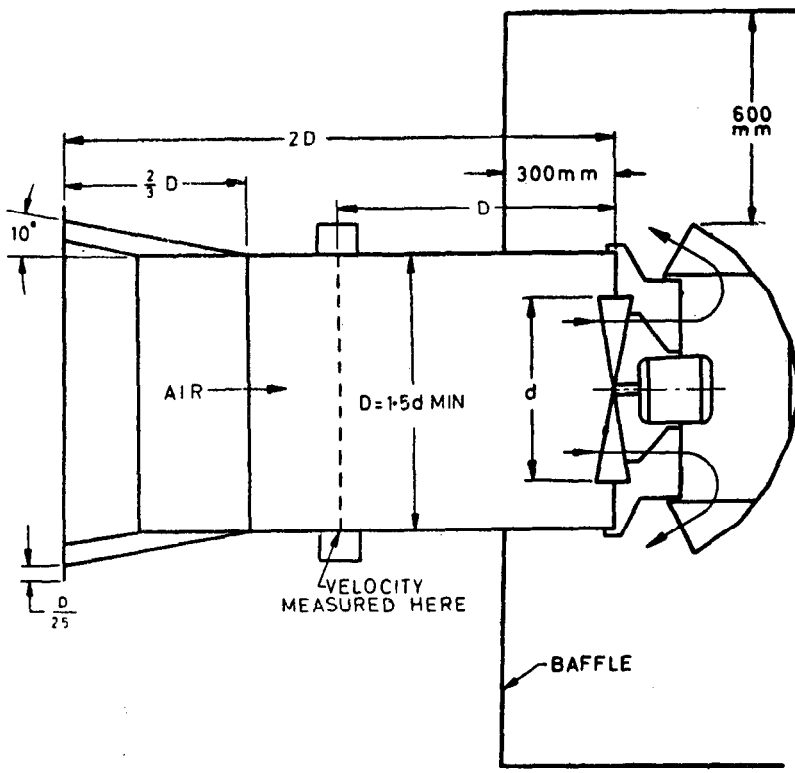
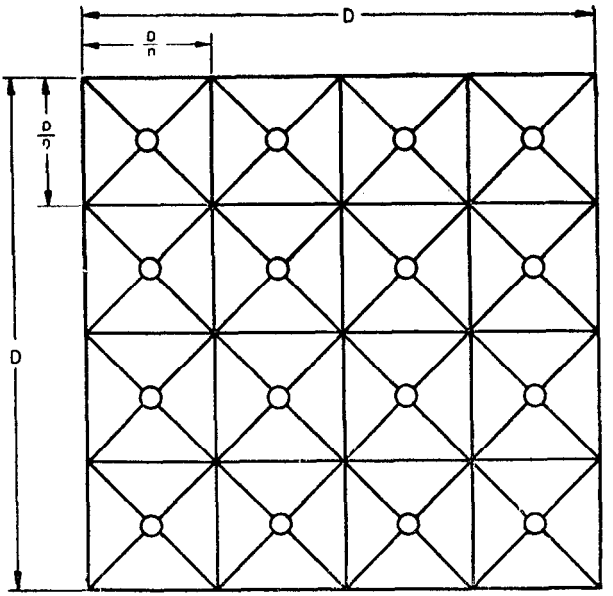


FIG. 2 TEST METHOD FOR ROOF EXTRACTOR IN SQUARE DUCT

10.14.1.3 The average air velocity shall be determined by readings of a vane anemometer taken across a plane measurement 1/3 D from the function of the mouthpiece of the inlet airway.

10.14.1.4 For the air delivery test, the square airway shall be considered as being divided into a number of equal square areas by lines parallel to its sides, and a measurement shall be taken with the centre of the anemometer vane wheel at the centre of each area (*see* Fig. 3). The number of areas shall be determined by the ratio of the length of the side of the test section to the diameter of the ring shrouding the anemometer vanes, the relationship being given in the table under Fig. 3.



Side of Airway, D	*Subdivision of each Dia, n*	*Number of Readings*
Not less than 4 ϕ, less than 5 ϕ	3	9
Not less than 5 ϕ, less than 8 ϕ	4	16
Not less than 8 ϕ, less than 15 ϕ	5	25
15 ϕ or greater	6	36

ϕ = Diameter of anemometer

FIG. 3 METHOD OF DIVIDING THE AREA OF THE AIRWAY

10.14.2 *Test Method No. 2 : Round Duct Method* — This method is an alternate to Test Method No. 1.

10.14.2.1 To the inlet side of the extractor fan shall be attached a cylindrical airway of diameter D not less than $1{\cdot}1/2\ d$, where d is the diameter of the orifice in which the fan rotates (*see* Fig. 4). To the inlet side of the airway shall be fitted a conical mouthpiece of length $D/4$

having an included angle of 60 degree converging towards the fan, and a radial flange at its inlet end of width $D/25$. The total length of the test duct including the conical mouthpiece shall be not less than 2 D. At a distance of 300 mm from the outlet end of the test duct, there shall be a flat baffle surrounding the test duct. The baffle shall extend to a length of 600 mm from the outermost edge of the cowl or casing of the roof extractor unit.

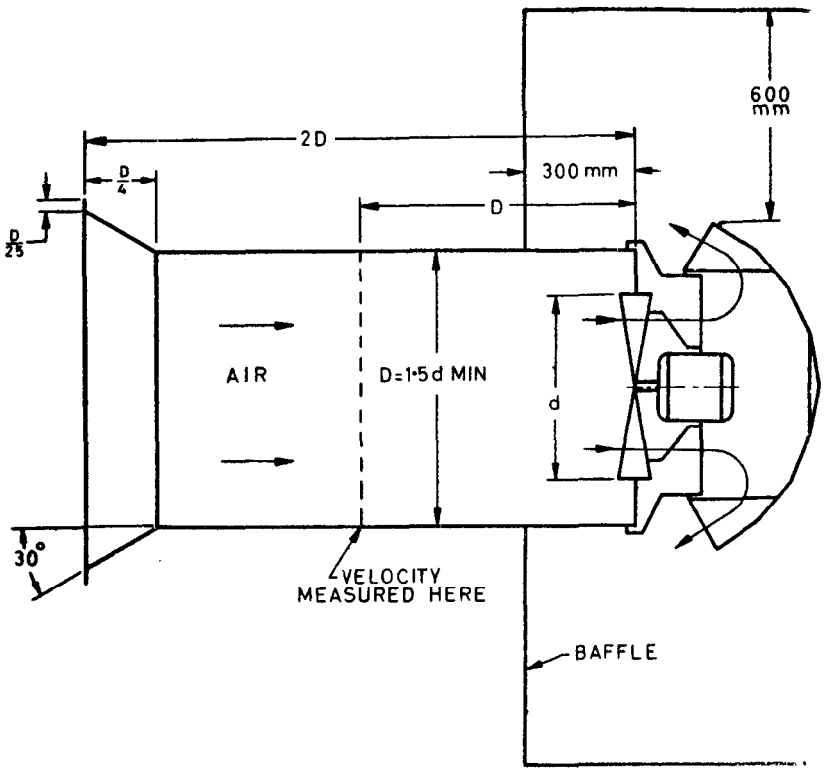
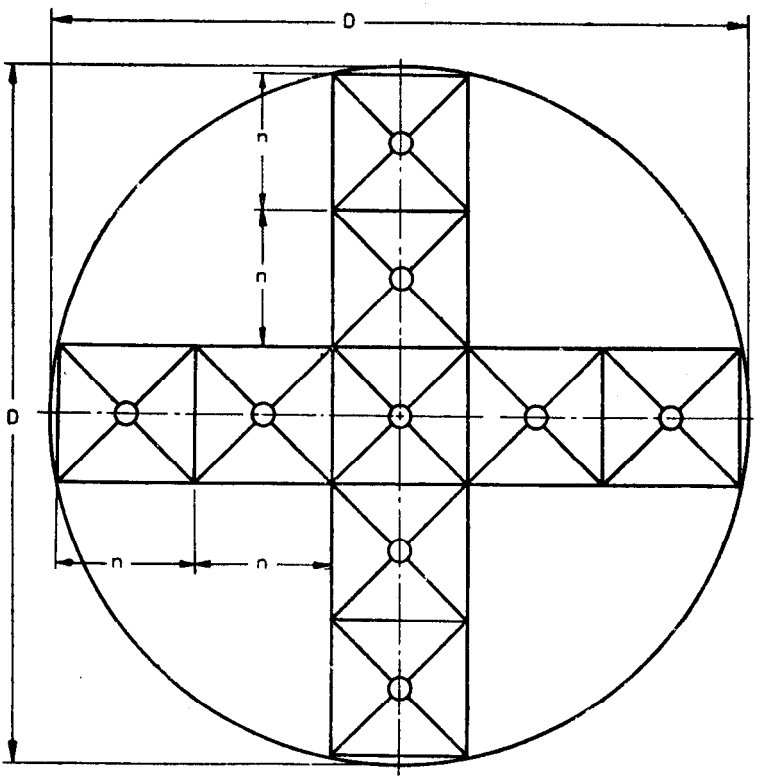


FIG. 4 TEST METHOD FOR ROOF EXTRACTOR IN ROUND DUCT

10.14.2.2 For the air delivery test, the cylindrical airway shall be considered to be divided into a number of equal square areas by lines parallel to the diameter D as shown in Fig. 5. Measurements shall be taken with the centre of the anemometer vane wheel at the centre of each area as shown in the figure. The number of areas shall be determined by

the ratio of D to the diameter of the ring shrouding the anemometer vanes the relationship being shown in the Table under Fig. 5.



Diameter of Airway, D	*Subdivision of Each Dia, n*	*Number of Readings*
Not less than 4 ϕ, less than 5 ϕ	3	5
Not less than 5 ϕ, less than 8 ϕ	5	9
Not less than 8 ϕ, less than 15 ϕ	7	13
15 ϕ or greater	9	17

ϕ = Diameter of anemometer

FIG. 5 METHOD OF DIVIDING THE AREA OF THE AIRWAY

10.14.3 *Other Test Methods* — As an alternative to Method No. 1 and 2, test methods using pitot tube or any other suitable measuring instrument are also permissible. Such measuring instruments may be velocity measuring instruments or sensing probes for such instruments.

10.15 Temperature-Rise Test

10.15.1 *Measurement of Cooling Air Temperature During Tests* — The cooling air temperature shall be measured by means of several thermometers placed at different points around the fan motor at a distance of one to two metres, and protected from all heat radiations and extraneous draughts. The thermometers used for this test shall be accurate to $\pm$ 0·5°C.

The value to be adopted for the temperature of the cooling air during a test shall be the mean of the readings of the thermometers taken at equal intervals of time during the last quarter of the duration of the test.

10.15.2 *Measurement of Temperature-rise* — The temperature-rise measurements shall be carried out by the method indicating in Table 1, immediately after the air delivery test or after the fan has been run long enough to ensure that the temperature-rise has reached a constant value.

10.15.2.1 All temperature-rises to be measured by thermometer method [Items (ii), (iii), (v) and (vi) of Table 1] shall be taken at the hottest accessible surface of the part, as also on the parts which are likely to cause injury to any adjacent insulating material.

10.15.2.2 The method of measurement of temperature-rise by change in resistance for copper conductors is given below:

The temperature-rise $t_2 - t_1$ may be obtained from the ratio of the resistances by the formula:

$$\frac{t_2 + 235}{t_1 + 235} = \frac{R_2}{R_1}$$

where

R_2 = resistance of the winding at temperature t_2 (°C) at the end of the test, and

R_1 = initial resistance of the winding at temperature t_1 (°C) (cold).

From the above, the hot temperature (t_2) may be expressed as:

$$t_2 = \frac{R_2}{R_1} (t_1 + 235) - 235$$

APPENDIX A

(*Clauses* 6.5 *and* 9.1.2)

ADDITIONAL INFORMATION TO BE SUPPLIED BY THE MANUFACTURER

A-1. The following additional information in respect of an extractor fan shall be supplied by the manufacturer on request:

a) Power factor,
b) Rated speed in rev/min,
c) Air delivery at test voltage,
d) Number of blades,
e) Type of regulator and number of running positions,
f) Class of insulation,
g) Type of bearings, and
h) Instruction for lubrication of bearings.

APPENDIX B

(*Clause* 10.1.2.1)

RECOMMENDED SAMPLING PLAN

B-1. LOT

B-1.1 In any consignment, all the fans of the same type, size and speed and manufactured under similar conditions of production shall be grouped together to constitute a lot.

B-2. SCALE OF SAMPLING

B-2.1 The number of fans to be selected at random from each lot shall depend upon the size of the lot and shall be in accordance with col 1 and 2 of Tahle 3. If required (*see* **B-3.2**), additional fans as given in col 3 of Table 3 shall also be selected at random. All the fans so selected shall be subjected to the acceptance tests (*see* **10.1.2**).

TABLE 3 SAMPLE SIZE AND CRITERIA FOR ACCEPTANCE

(*Clauses* B-2.1, B-3.1 *and* B-3.2)

Lot Size	N_1	N_2	($N_1 + N_2$)	C_1	C_2
(1)	(2)	(3)	(4)	(5)	(6)
Up to 50	3	6	9	0	2
51 ,, 100	7	14	21	0	3
101 ,, 200	10	20	30	0	3
201 ,, 300	13	26	39	0	5
301 ,, 500	20	40	60	1	5
501 ,, 800	25	50	75	1	6
801 and above	35	70	105	2	7

B-3. CRITERIA FOR ACCEPTANCE

B-3.1 The lot shall be accepted if number of failures in any acceptance test, out of N_1 first tested, does not exceed C_1 as given in col 5 of Table 3. The lot shall be rejected if the number of failures, out of N_1 first tested, is equal to or greater than C_2 as given in col 6 of Table 3.

B-3.2 If number of failures, out of N_1 first tested, is between C_1 and C_2, additional number of fans equal to N_2 as given in col 3 of Table 3 shall be subjected to acceptance test. The lot shall be accepted if out of the total $N_1 + N_2$ fans tested, the number of failures is less than C_2 and the lot shall be rejected if number of failures out of the total $N_1 + N_2$ is equal to or greater than C_2.

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