

BUREAU OF INDIAN STANDARDS
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Draft Indian Standard

**Mechanical Vibration of Rotating Electrical Machines with Shaft Heights 56 Mm and Higher -
Measurement, Evaluation and Limits of Vibration Severity**

(Fourth Revision)

Rotating Machinery
Sectional Committee, ETD 15

Last date for comments – **11/08/2024**

FOREWORD

This Indian Standard (*Fourth Revision*) was adopted by the Bureau of Indian Standards, after the draft finalized by the Rotating Machinery Sectional Committee had been approved by the Electrotechnical Division Council.

This standard was first published in 1959. The first revision was brought out in 1964, the second revision was brought out in 1979 and the third revision was brought out in 2009. This revision has been undertaken to bring it inline with international practices with the following significant technical changes with respect to previous version:

- a) Deletion of insulation class A and class E.
- b) Addition of new rating 150W for 4-Pole and 6-Pole Capacitor-Start and Run Motors
- c) Addition of the following new tests:
 - i) Winding resistance measurement
 - ii) Reduced Voltage running up test at No load.
 - iii) Ingress of protection
 - iv) Noise Level
 - v) Over Speed Test
- d) Reference standards have been updated with latest version.

This standard recommended the important dimensions for frame of motors with foot or resilient mounting either with sleeve or ball bearings which are necessary to ensure mechanical interchangeability.

This standard covers the requirements and tests for general purpose motors. The motors used in specific applications may have special requirements and these special requirements are subject to agreement between the user and the manufacturer.

The special requirements and the guidelines for selection of fan duty motors are given in Annex F.

Guidance for testing single-phase ac is given in IS 7572 'Guide for Testing Single Phase Universal Motors'.

To ensure satisfactory installation and maintenance of induction motors, it is urged that the recommendations contained IS 900 should be carefully followed.

If so desired, the thermistors may be used in the windings of the motors. The details and specifications of thermistors would be as agreed between the purchaser and the manufacturer.

In the formulation of this standard, assistance has been derived IEC 60034-30-1:2014 Rotating electrical machines – Part 30-1: Efficiency classes of line operated ac motors (IE code).

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 2:2022 'Rules for rounding of numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

**SINGLE PHASE a.c. INDUCTION MOTORS FOR GENERAL PURPOSE
(Fourth Revision)**

1 SCOPE

This standard covers single phase a.c. induction motors of the capacitor types for voltage upto and including 250 V and having windings with Class B, Class F and Class H insulation (*see* IS 1271) and output upto and including 2200 W.

Motors for use on systems complying to voltages and frequencies other than preferred (*see* 4) shall be considered as complying with this standard provided they comply in all other respects. The voltages and frequency for which they are designed shall be stated on the rating plate.

2 REFERENCES

The list of standards given in Annex A are necessary adjunct to this standard.

3 TERMINOLOGY

For the purpose of this standard, the following definitions in addition to those covered in IS 1885 (Part 35) shall apply.

3.1 Overload

Any load in excess of the rated output expressed as a percentage of rated output.

3.2 Momentary Overload

Any overload the duration of which is so short as not to affect appreciably the temperature of the motor.

3.2 Refrigeration Duty Motor

A special purpose ventilated motor suitable for driving open type compressor in condensing unit refrigeration.

3.4 Fan Duty Motors

A special purpose motor for driving shaft mounted fan or blower. The motor may be with single speed winding or multi – speed windings which give more than one distinct fan/blower speeds, wherein the cooling of motor winding is provided by the air handled by the shaft mounted fan(s) or blower(s)

3.5 Reversible Motor

A motor which is capable of being started from rest and operated in either direction of rotation.

3.6 Reversing Motor

A motor capable of being reversed even while running at normal speed by changing electrical connections.

3.7 Thermally Protected Motor

A motor provided with thermal protector

3.8 Thermal Protector

A protective device for assembly as an integral part of the motor and which when properly applied, protects the motor against dangerous overheating due to overload and failure to start.

3.9 General Purpose Motor

A motor designed in standard ratings with standard operating characteristics and mechanical construction for use under usual service conditions without restrictions to a specific application or type of application.

3.10 Breakaway (Starting) Torque

The lowest torque developed by the motor in the stand-still condition when the motor is supplied at the rated voltage and rated frequency.

3.11 Pull-up Torque

The smallest torque developed by the motor between zero speed and the speed which corresponds to the pull-out torque when the motor is supplied at the rated voltage and rated frequency.

3.12 Pull-Out Torque

The highest torque that the motor can develop while running at rated voltage and rated frequency.

3.13 Wide Voltage Motor

A motor rated for the voltage range of 190 – 240 V (or any other band specified on the nameplate). This motor shall meet all performance specifications at the mean of the voltage band. At the extreme voltage conditions the motor shall be capable of delivering the rated output. The motors may not necessarily have their other performance in accordance with Tables 1 to 11. In case of continuous operation under extreme voltage limit, the temperature rise specified in Table 7 of IS 15999 (Part 1) shall not exceed by 10 °C. No further tolerance (as given in **5.1.4**) on voltage is applicable on motors with this type of motor.

4 RATED CONDITIONS OF VOLTAGE, FREQUENCY, OUTPUT AND SPEED OF MOTORS

4.1 Rated Voltage

For the purpose of this standard, the preferred rated voltage shall be in accordance with IS 12360 be 230V.

4.2 Rated Frequency

The rated frequency shall be 50 Hz.

4.3 Rated output

The preferred output ratings shall be 2.5, 4, 7, 12, 18, 25, 40, 60, 90, 120, 150, 180, 250, 370, 550, 750, 1 100, 1 500 and 2 200 Watts.

4.4 Rated Speeds

Preferred rated speeds shall be corresponding to two poles, four poles and six poles.

5 SITE CONDITIONS

5.1 The following shall constitute the normal site conditions.

5.1.1 *Altitude and Temperature*

Motors shall be designed for the following site conditions unless otherwise agreed between the manufacturer and the purchaser.

5.1.2 *Altitude*

Altitude not exceeding 1 000 m.

5.1.3 *Temperature*

The cooling air temperature not exceeding 40° C.

5.1.4 *Voltage and Frequency Variation.*

Motors covered by this standard shall be capable of delivering rated output with,

- a) Terminal voltage differing from its rated value by not more than ± 6 percent, or
- b) Frequency differing from its rated value by not more than ± 3 percent, or
- c) Any combination of (a) and (b).

In case of continuous operation at extreme voltage limits, the temperature rise specified in Table 7 of IS 15999 (Part 1) shall not exceed by more than 10° C. Motors when operated under the extreme conditions of voltage and frequency variations may not necessarily have their performance in accordance with Tables 1 to 11.

5.2 Variation from Rated Speed

This shall be in accordance with Table 14.

6 ENVIRONMENT

It shall be assumed that the location and moisture or fumes shall not seriously interfere with the operation of the motor.

7 DIMENSIONS

7.1 The recommended dimensions for rigid base mounted, resilient base mounted and flange mounted motors shall be as in IS 1231 and IS 2223 (NEMA frame dimensions addition in this standard suggested in view of its popularity).

NOTES

- 1** Whenever the motor construction requires deviation from the recommended dimensions, the dimensional requirements shall be a matter of agreement between the manufacturer and the user.
- 2** Dimensional requirements of motors smaller than those corresponding to frame 56 shall be subject to an agreement between the manufacturer and the user.
- 3** Tolerance on centre height shall not be applicable for resilient base mounted motors. Centre height for a given frame size may not be as in IS1231 and the tolerance on the agreed centre height between the manufacturer and the user shall be -1.5 mm.
- 4** Open-ended slots are not permitted. In case of small frames numbers up to 160 L, oblong holes may be provided for convenience in sliding the motor. The minimum length of oblong holes shall not be less than dimension 'K' as given in Table 1 of IS 1231 for circular holes. The tolerances on dimensions of oblong holes are not applied.

7.2 Non-Standard Dimensions

Considering the wide variety of usage and application of motors covered by this standard, motors may be manufactured in frame sizes and dimensions other than those in **7.1**. Unless otherwise specified, the dimensional tolerances (on the declared dimensions) shall be corresponding to the nearest frame size.

8 DUTY AND RATING

8.1 Continuous Rating

For the purpose of this standard, unless otherwise specified, the general purpose motors shall be continuously rated.

8.2 Short Time Rating

If the motors are short time rated, the preferred periods shall be 5, 15, 30 or 60 min.

NOTE - For more details on selection and application of these motors (*see Annex E*).

9 GENERAL CONSTRUCTION

9.1 Mounting

The following types of mounting shall be used (*see also IS 2253*).

9.1.1 *Foot-Mounted Motor*

A motor with feet, the feet being used for fixing it in position.

9.1.2 *Flange-Mounted Motor*

A motor with flange, the flange being used in for fixing it in position.

9.1.3 *Foot-Cum-Flange Mounted Motor.*

A motor with flange and feet, the feet being used for fixing it in position.

9.1.4 *Resilient-Ring Mounted Motor*

A motor provided with resilient mounting so that it is supported between two resilient rings affixed to its end shields, the rings being used for mounting by the user.

9.1.5 *Resilient –Base Mounted Motor*

A resilient-ring mounted motor provided with mounting base, the base being used for fixing it in position.

9.1.6 *Stator-Pad Mounted Motor*

A motor provided with three or four pads on stator body, equispaced in angular position, duly tapped, the pads being used for fixing motor in position.

9.1.7 *End Shield Pad Mounting*

A motor provided with three or four pads on end shield equispaced in angular position in same plane, duly tapped, the pads being used for fixing motor in position.

9.1.8 *Foot-Cum-End Shield-Pad Mounting*

An end shield pad mounted motor with feet, the feet being used for fixing motor in position.

9.1.9 *Extended Bolt Mounting*

A motor where extended threaded studs or motor bolts are provided to be used for fixing motor in position.

9.1.10 *Frame –Mounted Motor*

A motor without driving end shield, the frame or stator body being used for fixing it in position.

NOTE - Dimensions for fixing the motor in position of motors in **9.1.4**, **9.1.6**, **9.1.7**, **9.1.8**, **9.1.9**, and **9.1.10**, shall be a matter of agreement between the manufacturer and the user.

9.2 Terminal Box

The position of terminal box, when provided, shall be a matter of agreement between the manufacturer and the user.

9.3 Mounting Constructions

Various mounting constructions are possible with shaft horizontal, vertically upwards or vertically downwards and the mountings covered in **9.1** which should form a subject matter of agreement between the manufacturer and the user.

9.4 Constructional Features

Motors shall be processed in a careful and workman like manner. The manufacturer shall use good measurement and production techniques to ensure the highest degree of product reliability and uniformity practicable with the materials used in the product.

9.4.1 *Non-Metallic Material Enclosure*

If the enclosure or main structure of the motor is non-metallic, the material of such enclosure or main structure shall be non flame supporting or self-extinguishing.

9.4.2 *Thermal Protector*

When motors are provided with thermal protectors it shall bear a warning label stating ‘THERMAL PROTECTOR FITTED’ or ‘THERMALLY PROTECTED’ and shall be conspicuous.

9.4.3 *Manual Resetting Protector*

When such protectors are of manual resetting type the resetting arrangement shall be readily accessible and identifiable through clear marking.

9.4.4 *Lubrication*

Readily accessible lubricating points shall be provided, wherever necessary.

9.4.5 Lubricant Temperature

The lubricant of the motor bearings shall be suitable for bearing temperatures which can result from operating conditions covered by this standard.

9.4.6 Centrifugal Switch

To ensure satisfactory operation the centrifugal switch where fitted shall be so disposed that it shall not be exposed to lubricating grease or oil which may be discharged from over lubricated bearings.

9.4.6.1 Each motor shall be subjected to the minimum of 5 cycles of switch operation at no load for motor fitted with centrifugal switch to ensure its proper operation.

NOTE - As type test the number of cycles of switch operation shall be conducted for 1 in 250 numbers of each type of switch.

9.4.7 Resilient Mounting Material

When resilient mountings are an integral part of the motor the mounting shall be oil resistant and resistant to heat which is produced by the motor.

9.4.8 Resilient Mounting Test

The resilient base mounted motor shall withstand without slippage between the frame and base an applied torque of 1.5 times the maximum value of any torque that can be developed by the motor at rated voltage.

9.4.9 Insulating Material

Insulating materials used shall be in accordance with IS 1271 as far as insulation class is concerned.

NOTE - Materials used shall be in accordance with the class of insulation, stated in the rating plate or superior.

9.4.10 Insulation of Leads

The insulation material of connection/external leads supplied with the motor shall be suitable for the maximum temperature of the part of motor coming in contact with these leads.

9.4.11 Capacitors

Capacitors where used shall comply to IS 2993.

NOTES

1 For capacitor-start or capacitor-start capacitor-run motors, the voltage of the electrolytic capacitor during locked rotor at rated voltage shall not exceed 90 percent of the rms surge voltage of capacitor

2 For two value capacitor/permanent split capacitor motor, during no load run at rated voltage of the motor the voltage of the paper dielectric capacitor shall not exceed the rated voltage of the paper dielectric capacitor excepting directly

loaded appliances such as monobloc pumps, mono-compressors and fans which always are run at or near full load. In such uses the voltage of the capacitor shall not exceed 95 percent of its rated voltage when the appliance is run at rated load at rated voltage.

9.4.12 Construction Material

All materials and components used in the manufacture of the motor shall conform to the relevant Indian Standard, wherever they exist. In case of any difficulty in complying with this requirement, it shall be subject to agreement between the manufacturer and the purchaser.

9.4.13 Finishing

All surfaces exposed to atmosphere which are not adequately protected by metal deposition shall be protected against corrosion by painting, enamelling, oxidizing or phosphatizing.

9.5 Earthing

9.5.1 Earthing Terminal

At least one separate earthing terminal of adequate current carrying capacity conveniently located and visible shall be provided on the motor. The earthing terminal shall be of suitable material adequately protected against corrosion and shall have mark or “E” on or adjacent to it.



9.5.2 Lead Earthing

If resilient mounted motor is supplied with external/loose leads to the motor windings, a separate earthing cord or lead shall be supplied.

9.5.3 Plug Earthing

If any type of motor is supplied with external/loose lead and plug the motor frame shall be connected to the earth pin of the plug.

10 TYPES OF ENCLOSURES

10.1 Motors covered by this standard shall have one of the enclosures stated below. The enclosures shall meet the requirements of IS/ IEC 60034 (Part 5).

10.1.1 Open Ventilated Motor

A motor having no protective enclosure.

NOTE - In case of non-protected motors additional protection shall be provided by the user.

10.1.2 Ventilated Motor

A motor having an enclosure so constructed as to give protection while ventilation is not materially impeded. The protection provided by enclosure shall meet requirements of IP20 in accordance with IS/ IEC 60034 (Part 5).

10.1.3 Drip Proof Motor

A ventilated motor so constructed as to exclude vertically falling water or dirt. The protection provided by enclosure shall meet requirements of IP21 in accordance with IS/ IEC 60034 (Part 5).

10.1.4 Water Protected Motor

A drip proof motor so constructed that drops of water falling at an angle up to 15° from the vertical shall have no harmful effect, the protection provided by enclosure shall meet requirements of IP22 in accordance with IS/ IEC 60034 (Part 5).

10.1.5 Totally Enclosed Motor

A motor so constructed as to prevent the free exchange of air between inside and outside of enclosing case. The protection provided by enclosure shall meet requirements of IP44 in accordance with IS/ IEC 60034 (Part 5).

10.1.6 Totally Enclosed Fan Cooled Motor

A totally enclosed motor with augmented cooling by means of a fan driven by the motor itself blowing air over motor body or cooling passages, if any. The protection provided by enclosure shall meet requirements of IP44 in accordance with IS/ IEC 60034 (Part 5).

10.1.7 Environment Proof Motor

A motor so constructed that it can work without further protection from the weather conditions specified by the user. The enclosure shall be designated by the letter 'E' example IPE44 or IPE55.

10.1.8 Weather Proof Motor

A motor is weather proof when its design reduces the ingress of rain, snow and airborne particles to an amount consistent with a correct operation. The enclosure shall be designated by the letter 'W' (placed between IP and the numerals for example IPW44).

10.1.9 Hose Proof Motors

A motor having enclosure which provides type of protection IP55 in accordance with IS/ IEC 60034 (Part 5).

10.1.10 Motors for Appliances

Motors which are intended ultimately to be incorporated in appliances may have enclosures not providing a specific degree of protection. Such motors also shall be considered conforming to this standard so long as they comply with all the requirements of this standard except that relating to enclosures.

10.1.11 Besides enclosures defined in **10.1** this standard also recognizes the enclosures arising out of various degrees of protection stated in IS/ IEC 60034 (Part 5).

11 METHODS OF COOLING

11.1 The method of cooling of motors and their designations shall be as given in IS 6362. Cooling methods shall be any one of the following types:

a) According to origin of cooling:

- i) *Natural cooling* - The motor is cooled without the use of a fan by the movement of air and radiation.
- ii) *Self cooling* - The motor is cooled by cooling air driven by a fan mounted on the rotor or one driven by it.
- iii) *Separate cooling* - The motor is cooled by a fan not driven by its shaft.

b) According to manner of cooling:

- i) *Open circuit ventilation* - The heat is given up directly to the cooling air flowing through the motor which is being replaced continuously.
- ii) *Surface ventilation* - The heat is given up to the cooling air from the external surface of a totally enclosed motor.

12 GENERAL CHARACTERISTICS

12.1 Torques

12.1.1 With rated voltage and frequency applied to terminals, the breakaway (starting), pull-up and pull-out torques shall comply with the requirements given in Table 1.

12.1.2 Motors conforming to this standard are not expected to carry sustained overloads. However (unless agreed to between the manufacturer and the user) motors rated in accordance with this standard shall be capable of withstanding on test (under gradual increase of torque) without injury, the overloads in torque for 15 s is given in Table 2, after having their rated load.

All the torque values shall be measured in accordance with IS 7572.

Table 1 Torques of Single-Phase a.c. Motors (in percentage of F.L.T)
(Clauses 3.1.13, 5.1.4, 12.1.1 and 12.3)

SI No.	Type of Motor	Pull Out Torque (min)	Pull up Torque (min)	Breakaway Torque (min)
(1)	(2)	(3)	(4)	(5)
i)	Capacitor –start Induction –run	200	150	200
ii)	Capacitor start and –run	150	20	30
iii)	Capacitor –start and capacitor-run	200	150	200
iv)	Shaded pole	120	20	30
v)	Split phase			
	a)	200	125	150
	b)	250	200	225

Table 2 Momentary Overload for Motors
(Clauses 3.1.3, 5.1.4, and 12.1.2)

SI No.	Type of Motor	Excess Torque as Percentage of Rated Torque
(1)	(2)	(3)
i)	Capacitor-start Induction – run	50
ii)	Capacitor start – and – run	25
iii)	Capacitor – start Capacitor – run	50
iv)	Shaded pole	10
v)	Split phase	60

12.2 Temperature Rise

Temperature rise of motors for all types of enclosures, when tested under the rated conditions and in accordance with the requirements of this standard shall not exceed the limits given in Table 7 of IS 15999 (Part 1). Motors shall, however, be capable of operating without injurious heating at extreme voltage limits stated in 5.1.4 (that is ± 6 percent of rated voltage) or the extremes of the voltage range specified on the rating plate. The temperature rise of motors to be incorporated in appliances shall be tested when the motor is installed in the appliance.

12.3 Short Time Rating

For motors having short time rating, the limits specified in Table 7 of IS 15999 (Part 1) may by agreement be increased by 10°C. Where such an agreement is made to increase the limits, the increased limits shall be indicated on the rating plate.

12.4 Method of Testing

The measurement of temperature rise shall be done according to the methods given in IS 7572.

NOTE - In many appliances the cooling of the motor is affected by air circulation through shaft mounted fans / blowers and the enclosure and as such temperature rise test cannot be conducted on the motor by itself. In such cases the manufacturer and the user shall arrive at a suitable rating of load and time for motor temperature rise test purposes. This rating shall be marked on the name plate and temperature rise tests may be conducted for this rating in the laboratory and shall be judged for compliance to the requirements of this standard.

12.5 Performance Values

12.5.1 The values of minimum full load speed, maximum full load current, nominal efficiency and maximum breakaway starting current for 2 pole, 4 pole and 6 pole general purpose ac single phase motors at rated voltage of 230V, 50 Hz shall be in accordance with Tables 1 to 13.

NOTES

1 For specific applications such as fans, blowers, domestic applications, air conditioners, room coolers, refrigerators, data processing equipments, and compressors etc., the performance values specified in Tables 3 to 11 may not be applicable as the motor design is based on the overall requirements of the application.

2 For motors having rated voltage or mean value of voltage range other than 230V, values given in Tables 3 to 11 shall be applicable except for maximum value of full load current and maximum breakaway starting current which would be in the inverse proportion of the voltage.

3 In case the manufacturer declares superior values of performance characteristics than specified in Tables 3 to 11, the declared values shall be subject to verification. The test values of the performance characteristics shall conform to those declared by the manufacturer within the tolerances specified in Table 14 and shall in no case be inferior to the values specified in Tables 3 to 11.

Table 3 Values of Performance Characteristics of 2-Pole Capacitor-Start Induction Run Motors
(Clauses 3.1.13, 5.1.4 and 12.5.1)

SI No.	Rated Output	Minimum Full Load Speed	Nominal Full Load Efficiency	Maximum Full Load Current	Maximum Breakaway Starting Current
	W	rev/min	Percent	A	A
(1)	(2)	(3)	(4)	(5)	(6)
i)	180	2 630	50	2.7	16
ii)	250	2 650	55	3.6	22
iii)	370	2 680	58	4.9	30
vi)	550	2 720	60	7.2	43
v)	750	2 740	65	8.9	55
vi)	1 100	2 760	67	12.3	74
vii)	1 500	2 780	69	15.9	96
viii)	2 200	2 800	70	20.3	122

Table 4 Values of Performance Characteristics of 2-Pole Capacitor Start and Run Motors
(Clauses 3.1.13, 5.1.4 and 12.5.1)

Sl No.	Rated Output	Minimum Full Load Speed	Nominal Full Load Efficiency	Maximum Full Load Current	Maximum Breakaway Starting Current
	W	rev/min	Percent	A	A
(1)	(2)	(3)	(4)	(5)	(6)
i)	180	2 630	52	2.1	9
ii)	250	2 650	57	2.8	11
iii)	370	2 680	60	3.8	15
iv)	550	2 720	66	5.0	20
v)	750	2 740	68	6.3	25
vi)	1 100	2 760	70	8.9	36
vii)	1 500	2 780	71	11.9	48
viii)	2 200	2 800	72	15.7	63

Table 5 Values of Performance Characteristics of 2-Pole Capacitor-Start Capacitor-Run Motors
(Clauses 3.1.13, 5.1.4 and 12.5.1)

Sl No.	Rated Output	Minimum Full Load Speed	Nominal Full Load Efficiency	Maximum Full Load Current	Maximum Breakaway Starting Current
	W	rev/min	Percent	A	A
(1)	(2)	(3)	(4)	(5)	(6)
i)	180	2 630	52	2.1	16
ii)	250	2 650	57	2.8	22
iii)	370	2 680	60	3.8	30
iv)	550	2 720	66	5.0	43
v)	750	2 740	68	6.3	55
vi)	1 100	2 760	70	8.9	74
vii)	1 500	2 780	71	11.9	96
viii)	2 200	2 800	72	15.7	122

Table 6 Values of Performance Characteristics of 4-Pole Capacitor Start Induction Run Motors
(Clauses 3.1.13, 5.1.4 and 12.5.1)

Sl No.	Rated Output	Minimum Full Load Speed	Nominal Full Load Efficiency	Maximum Full Load Current	Maximum Breakaway Starting Current
	W	rev/min	Percent	A	A
(1)	(2)	(3)	(4)	(5)	(6)
i)	180	1 340	50	3.0	17
ii)	250	1 340	55	3.6	23
iii)	370	1 360	58	5.0	31
iv)	550	1 375	60	6.5	44
v)	750	1 375	65	8.5	55
vi)	1 100	1 380	67	12.5	75
vii)	1 500	1 380	69	16.2	97
viii)	2 200	1 390	70	20.9	126

Table 7 Values of Performance Characteristics of 4-Pole Capacitor-Start and Run Motors
(Clauses 3.1.13, 5.1.4 and 12.5.1)

Sl No.	Rated Output	Minimum Full Load Speed	Nominal Full Load Efficiency	Maximum Full Load Current	Maximum Breakaway Starting Current
	W	rev/min	Percent	A	A
(1)	(2)	(3)	(4)	(5)	(6)
i)	150	750	50	2.5	12
ii)	180	1 340	52	2.2	9
iii)	250	1 340	57	2.9	12
iv)	370	1 360	60	4.0	16
v)	550	1 375	66	5.4	22
vi)	750	1 380	68	6.8	27
vii)	1 100	1 380	70	9.4	38
viii)	1 500	1 380	71	12.5	50
ix)	2 200	1 390	72	16.5	66

Table 8 Values of Performance Characteristics of 4-Pole Capacitor Start Capacitor Run Motors
(Clauses 3.1.13, 5.1.4 and 12.5.1)

SI No.	Rated Output	Minimum Full Load Speed	Nominal Full Load Efficiency	Maximum Full Load Current	Maximum Breakaway Starting Current
	W	rev/min	Percent	A	A
(1)	(2)	(3)	(4)	(5)	(6)
i)	180	1 340	52	2.2	16
ii)	250	1 340	57	2.9	20
iii)	370	1 360	60	4.0	28
iv)	550	1 375	66	5.4	38
v)	750	1 380	68	6.8	48
vi)	1 100	1 380	70	9.4	66
vii)	1 500	1 380	71	12.5	88
viii)	2 200	1 390	72	16.5	116

Table 9 Values of Performance Characteristics of 6-Pole Capacitor Start Induction Run Motors
(Clauses 3.1.13, 5.1.4 and 12.5.1)

SI No.	Rated Output	Minimum Full Load Speed	Nominal Full Load Efficiency	Maximum Full Load Current	Maximum Breakaway Starting Current
	W	rev/min	Percent	A	A
(1)	(2)	(3)	(4)	(5)	(6)
i)	180	750	50	4.0	25
ii)	250	750	55	5.0	30
iii)	370	770	58	6.0	40
iv)	550	780	60	7.5	50
v)	750	780	65	10.0	60
vi)	1 100	800	67	14.5	90
vii)	1 500	800	69	19.0	115
viii)	2 200	800	70	24.0	150

Table 10 Values of Performance Characteristics of 6-Pole Capacitor-Start and Run Motors
(Clauses 3.1.13, 5.1.4 and 12.5.1)

Sl No.	Rated Output W	Minimum Full Load Speed rev/min	Nominal Full Load Efficiency Percent	Maximum Full Load Current A	Maximum Breakaway Starting Current A
(1)	(2)	(3)	(4)	(5)	(6)
i)	150	750	50	2.5	12
ii)	180	750	52	3.0	14
iii)	250	750	57	3.8	17
iv)	370	770	60	4.8	20
v)	550	780	66	6.4	26
vi)	750	780	68	8.5	32
vii)	1 100	800	70	11.0	44
viii)	1 500	800	71	14.0	56
ix)	2 200	800	72	20.0	72

Table 11 Values of Performance Characteristics of 6-Pole Capacitor Start Capacitor Run Motors
(Clauses 3.1.13, 5.1.4 and 12.5.1)

Sl No.	Rated Output W	Minimum Full Load Speed rev/min	Nominal Full Load Efficiency Percent	Maximum Full Load Current A	Maximum Breakaway Starting Current A
(1)	(2)	(3)	(4)	(5)	(6)
i)	180	750	52	3.0	25
ii)	250	750	57	3.8	30
iii)	370	770	60	4.8	40
iv)	550	780	66	6.4	50
v)	750	780	68	8.5	60
vi)	1 100	800	70	11.0	90
vii)	1 500	800	71	14.0	115
viii)	2 200	800	72	20.0	150

NOTES

1 Comprehensive values of performance characteristics are invited for all ratings of split-phase and shaded pole type motors in 2-pole, 4- pole and 6-pole all ratings not given in Tables 1 to 11.

2 For ratings not specified above performance values shall be declared by the manufacturer which shall be subject to tolerances in Table 14.

Table 12 Values of Performance Characteristics of 4 Pole Shaded Pole Motors*(Clause 12.5.1 and Notes 1 to 3)*

Sl No.	Rated Output w (1)	Minimum Full Load Speed rev/min (2)	Maximum Full Load Current A (3)	Minimum Product of Efficiency and Power Factor at Rated Load (4)	Maximum Breakaway Starting Current A (5)
(1)	(2)	(3)	(4)	(5)	(6)
i)	2.5	1 200	0.5	0.023	1.25
ii)	4.0	1 200	0.6	0.035	1.5
iii)	7.0	1 200	0.8	0.046	2.0
iv)	12	1 200	1.1	0.058	2.75
v)	18	1 200	1.3	0.069	3.25
vi)	25	1 200	1.6	0.081	4.0
vii)	40	1 200	1.8	0.104	4.5
viii)	60	1 200	2.2	0.127	5.5
ix)	90	1 225	2.8	0.150	7.0
x)	120	1 225	3.2	0.184	8.0
xi)	180	1 225	4.0	0.219	10.0
xii)	250	1 225	5.0	0.242	12.5
xiii)	370	1 225	8.8	0.196	22.0

Table 13 Values of Performance Characteristics of 4 Pole Split Phase Induction Motors*(Clause 12.5.1 and Notes 1 to 3)*

SI No.	Rated Output W (1)	Minimum Full Load Speed rev/min (2)	Maximum Full Load Current A (3)	Minimum Product of Efficiency and Power Factor at Rated Load (4)	Maximum Breakaway Starting Current A (5)
(1)	(2)	(3)	(4)	(5)	(6)
i)	12	1 325	0.65	0.08	6.5
ii)	18	1 325	0.8	0.09	8
iii)	25	1 325	1.0	0.10	10
iv)	40	1 325	1.2	0.14	12
v)	60	1 325	1.5	0.17	15
vi)	90	1 325	2.0	0.19	20
vii)	120	1 350	2.2	0.23	22
viii)	180	1 350	2.8	0.27	28
ix)	250	1 350	3.8	0.27	38
x)	370	1 350	6.0	0.26	60
xi)	550	1 375	7.0	0.33	70
xii)	750	1 375	10.0	0.31	100
xiii)	1 100	1 375	13.0	0.35	130
xiv)	1 500	1 375	18.0	0.35	180

12.5.2 Tolerances

Unless otherwise specified, tolerances on performance shall be in accordance with Table 14. Where a tolerance is stated in only one direction, the tolerance in the other direction is considered unimportant.

12.6 Limits of Vibration Severity

Unless otherwise specified the maximum rms-vibration-velocity shall not exceed 4.5 mm/s, as measured in accordance with IS 12075.

12.7 Insulation Resistance

Insulation resistance between all the windings combined and the motor frame shall be not less than 5 M Ω at 500V d.c. The test shall also be repeated on hot motor, soon after the temperature-rise test.

Table 14 Tolerances
(Clauses 5.2 and 12.5.2)

SI No.	Performance Parameter	Tolerance
(1)	(2)	(3)
i)	Efficiency	- 15 percent of (100 - η)
ii)	Power factor	- 1/5 (1-Cos ϕ), <i>Min</i> -0.02 <i>Max</i> -0.12

NOTE η - Declared efficiency expressed as percentage and $\cos\phi$ = Declared power factor.

13 HIGH VOLTAGE

13.1 High Voltage Values

Motor windings shall be capable of withstanding without failure, the test voltages specified in Table 15.

Table 15 Values of Test Voltage
(Clauses 13.1 and 13.2.14)

SI No.	Rated Voltage of Motor Volts (V_{rms})	Test Voltage
(1)	(2)	(3)
i)	50 volts or less	500
ii)	Above 50 volts upto and including 250 volts	1 500

13.1.1 High Voltage Test Method

High Voltage test shall be made in accordance with 6 of IS 7572.

13.2 Moisture Proofness

The testing chamber shall be so constructed that the conditions given in 13.2.1 to 13.2.6 may be obtained [see also IS 9000 (Part 3)].

13.2.1 The temperature can be varied between the laboratory temperature $25 \pm 10^\circ\text{C}$ and $40 \pm 2^\circ$ in 2 h and 30 min with the rate of change specified in 13.2.8 and Fig. 1.

13.2.2 The relative humidity shall be maintained at not less than 95 percent during the period of high temperature and not less than 80 percent during rest of the cycle.

13.2.3 Condensed water shall be continuously drained from the chamber and shall not be used again until it has been re-purified.

13.2.4 Water used for the maintenance of chamber humidity shall have a resistivity of not less than 500 Ω m.

13.2.5 Condensed water from the walls and roof of the chamber shall not fall on the items.

13.2.6 The items under test shall not be subjected to radiant heat from the chamber conditioning processes.

13.2.7 The items shall be introduced into the chamber in the unpacked, switched off, ready for use state.

13.2.8 The chamber temperature shall be raised from laboratory temperature $25 \pm 10^{\circ}\text{C}$ to $40 \pm 2^{\circ}\text{C}$ within a period of $2 \text{ h} \pm 30 \text{ min}$; the relative humidity during this period shall be not less than 80 percent and condensation on the item may occur.

13.2.9 The chamber temperature shall be maintained at $40 \pm 2^{\circ}\text{C}$ for a period of 16 h. During this period the relative humidity shall be not less than 95 percent.

13.2.10 The temperature within the chamber shall then be allowed to cool to laboratory temperature in not less than 1 h. The relative humidity during this cooling period shall be not less than 80 percent. The chamber temperature shall be maintained at the laboratory temperature and at relative humidity not less than 80 percent for the remainder period of the 24 h from the start of the test. However, this period shall be at least 3 h.

13.2.11 After removal from the chamber, the surface moisture on the items shall be removed. This may be by means of shaking or any other method.

13.2.12 The item shall then remain under standard atmospheric conditions for recovery for not less than 1 h not more than 2 h.

13.2.13 The value of insulation resistance (*see 12.7*) shall be not less than 2 M Ω . The motor shall also withstand the high voltage test at 80 percent of the values specified in Table 15.

NOTE - Relevant test procedure from IS 9000 (Part 5/Sec 1) has been incorporated above.

13.3 Leakage Current

Leakage current shall not exceed 3.5 mA (rms.) when a voltage equal to **1.1** times the rated voltage is applied to the motor and is measured between supply terminal of the system and the accessible metal parts, if any, and a metal foil covering the outer parts of the insulating material. The resistance of the test circuit shall be $2\ 000 \pm 50 \Omega$. In case of motors required for use in domestic appliances, the values of leakage current shall be in accordance with IS 302.

NOTE - The test is to be conducted in the no load condition with the motor placed on an insulating pad of suitable material.

14 WINDING RESISTANCE MEASUREMENT

The test shall be carried out as given in IS 7572.

15 REDUCED VOLTAGE RUNNING UP TEST AT NO LOAD

The test shall be carried out as given in IS 7572.

16 NOISE LEVEL

The test shall be carried out as given in IS 12065.

17 OVER SPEED TEST

The test shall be carried out as given in 9.7 of IS 15999 (Part 1)/IEC 60034-1.

18 TERMINAL MARKING

18.1 Terminal markings shall be in accordance with IS /IEC 60034 (Part 8).

18.1.1 Where no terminal board/box is provided the leads should be suitably coloured with green being always the earthing lead.

19 CRITERIA FOR LABELLING ENVIRONMENT FRIENDLY PRODUCTS

19.1 General Requirements

19.1.1 The motor shall conform to the requirements pertaining to the quality, safety and performance prescribed in this standard.

19.1.2 The product manufacturer must produce the clearance as per the provisions of *Water (PCP) Act, 1974, Water (PCP) Cess Act, 1977 and Air (PCP) Act, 1981* along with the authorization required under *Environment (Protection) Act, 1986* and rules made there under by the Bureau of Indian Standards while applying for the ECO-Mark.

19.1.3 The motor packaging may display in brief the criteria based on which the product has been labelled environment friendly.

19.1.4 The motor shall be sold along with instructions for proper use so as to maximize product performance and minimize wastage.

19.1.5 The motor shall conform to the noise levels as notified under the *Environment (Protection) Act, 1986* from time-to-time.

19.2 Specific Requirements

19.2.1 Efficiency

The motor shall have at least 3 percent improvement in efficiency over and above that prescribed in this standard.

20 MARKING AND DIAGRAM OF CONNECTIONS

20.1 A rating plate stating the following shall be supplied with each motor:

- a) Reference to this Indian Standard, that is, *see* IS 996;
- b) Type of motor (*see* Annex B);
- c) Name of the manufacturer;
- d) Manufacturer's number and frame reference;
- e) Type of duty rating;
- f) Rated voltage and frequency, in Hz;
- g) Rated output, in watts;
- h) Approximate current, in amperes at rated output;
- j) Approximate full-load speed, in revolutions per minute, at rated output;
- k) Class of insulation;
- m) Value of capacitor/s and voltage rating of capacitor/s;
- n) Efficiency at rated output, and;
- p) Power factor.

NOTES

1 For motors in frame sizes smaller than 56, the information to be marked on the motors may be agreed to by the manufacturer and the user.

2 For bulk supply to manufacturers of original equipments the information on rating plate may be as per agreement between them or bulk package may have suitable rating plate. However, in no case declaration of efficiency on rating plate shall be avoided.

3 The rating plate shall be made from suitable material like special grade paper, metal/plastic and shall be affixed to motor using adhesives/fasteners at conspicuous place. However, care shall be taken that information provided on rating plate shall have reasonable life and is protected from effect of light, heat, oil and / or moisture.

20.2 A diagram of connection, including instructions for changing direction of rotation, where applicable, shall be supplied preferably mounted inside the terminal cover.

20.3 BIS Certification Marking

The motors may also be marked with the Certification Mark.

20.3.1 The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 2016 and the Rules and Regulations made thereunder. The details of the conditions under which the license for use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a license for the use

of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

21 TESTS

21.1 Tests specified shall normally be made at the manufacturer's premises.

NOTES

1 For the purpose of this standard, the tests to determine performance characteristics shall be made in accordance with methods specified in IS 7572.

2 If normal test arrangements are inapplicable or additional tests are required, the tests to be made and the manner of their application shall be agreed to between the manufacturer and the user before order is placed.

21.2 The presence of user or his representative during the tests shall be as agreed to between the manufacturer and the user.

21.3 Type Tests

Type tests for single phase induction motors shall consist of the following:

- a) Winding Resistance Measurement (*see 14*)
- b) Test for no-load current, power input and speed at rated voltage and frequency
- c) Test for torques at rated voltage and frequency (*see 12.1.1*)
- d) Pull up Torque at rated voltage and frequency(*see 12.1.1*)
- e) Test for breakaway starting current at rated voltage and frequency (*see 12.1.1*)
- f) Breakaway (starting) Torque at rated voltage and frequency(*see 12.1.1*)
- g) Test for full-load performance at rated voltage and frequency (*see 12.5.1*);
- h) Pull out Torque at rated voltage and frequency(*see 12.1.1*)
- i) Temperature rise test (*see 12.2*);
- j) Momentary overload test (*see 12.1.2*);
- k) Insulation resistance test (*see 12.7*);
- l) High voltage test (*see 13.1*);
- j) Moisture proofness test (*see 13.2*); and
- k) Leakage current test (*see 13.3*).
- m) Vibration test (*see 12.6*).
- n) Dimensions (*see 7*).
- p) Reduced Voltage running up test at No load (*see 15*)
- q) Noise Level (*see 16*)
- r) Over Speed Test (*see 17*)

NOTES

1 Also capacitor voltage where applicable.

2 This test may be conducted at reduced voltage.

21.4 Routine Tests

Routine tests for induction motors shall comprise **21.3** (b), (e), (k) and (l) and also test for switching operation of centrifugal switch at no load.

21.5 Acceptance Tests

21.5.1 For carrying out the acceptance tests specified in this standard, the sampling procedure if not otherwise specified shall be according to Annex G.

21.5.2 Acceptance tests for induction motors shall comprise **21.3** (b), (c), (e), (j), (k) and (l).

21.6 Type Test Certificates

21.6.1 The performance characteristics of motor may include efficiency, power factor, breakaway starting torque, breakaway starting current and pull out torque. Temperature rise test is made on motor when required.

NOTE – For specific application motors, see relevant clauses of this standard.

21.6.2 It is recommended that type test certificate may be made in the form given in Annex C.

21.6.3 Unless otherwise specified when inviting tenders, the user, if so desired by the manufacturer shall accept as evidence of compliance of the motors with requirements of this standard, certificates of tests made on a motor identical in essential details with the one purchased and of routine tests on each individual motor.

21.6.4 Certificate of routine tests shall show that the motor purchased has been run and has been found to be electrically and mechanically sound and in working order in all particulars.

21.6.5 If user demands, then type tests as laid down in this standard shall be carried out on one motor in 250 provided the executive order quantity is 250 numbers or more, in one single lot.

22 GENERAL INFORMATION TO BE GIVEN WITH ENQUIRY AND ORDER

The general information to be furnished when enquiring for and ordering a motor is given in Annex D.

23 SELECTION AND APPLICATION

The Information on selection and application of different types of motors is given in Annex E. (The special requirements and the guidelines for selection of fan duty motors, as defined in **3.1.4** are given in Annex F).

ANNEX A
(Clause 2)

LIST OF REFERRED INDIAN STANDARDS

IS NO.	Title
302 (Part 1) : 2008	Safety of household and similar electrical appliances: Part 1 General Requirements (Sixth Revision)
900: 2019	Code of practice for installation and maintenance of induction motors (Second Revision)
1231: 2019	Dimensions of Three-phase Foot-mounted Induction Motors (Third Revision)
1271: 2012	Electrical Insulation-thermal Evaluation and Designation (Second Revision)
1391 (Part 1): 2017	Room Air Conditioners - Part 1: Unitary Air Conditioners (Third Revision)
1475 (Part 1): 2001	Self-contained Drinking Water Coolers - Part 1: Energy Consumption and Performance (Third Revision)
1885 (Part 1): 1961	Electrotechnical vocabulary: Part 1 Fundamental definitions
1885 (Part 35): 1993	Electrotechnical Vocabulary - Part 35: Rotating Machines (First Revision)
2223: 1983	Dimensions of flange mounted ac induction motors (Second Revision)
2253: 1974	Designation for types of construction and mounting arrangement of rotating electrical machines (First Revision)
2993: 1998	A.C. motor capacitors (Second Revision)
4905: 2015	Random Sampling and Randomization Procedures (First Revision)
6362: 1995	Designation of Methods of Cooling of Rotating Electrical Machines (First Revision)
7572: 1974	Guide for Testing Single-phase AC and Universal Motors
8148: 2018	Ducted and Package Air- Conditioners- Specification (Second Revision)
9000 (Part 5/Sec2): 1981	Basic environmental testing procedures for electronic and electrical items: Part 5 Damp heat (cyclic) test
12075: 2008	Mechanical Vibration of Rotating Electrical Machines with Shaft Heights 56 mm and Higher - Measurement, Evaluation and Limits of Vibration Severity (First Revision)
12360: 1988	Voltage Bands for Electrical Installations Including Preferred Voltages and Frequency
15999 (Part 1): 2016	Rotating Electrical Machines Part 1 Rating and Performance (First Revision)
60034 (Part 5): 2000	Rotating Electrical Machines: Part 5 Degrees of protection provided by the integral design of rotating electrical machines (IP CODE) – Classification (Second Revision)
60034 (Part 8): 2002	Rotating Electrical Machines: Part 8 Terminal markings and direction of rotation (Second Revision)

ANNEX B
(*Clause 20.1*)

TYPES OF MOTORS AND THEIR TORQUE CHARACTERISTICS

B-1 TYPES OF MOTORS

B-1.1 Capacitor - Start Induction – Run

These motors having higher starting torques and lower starting currents than split –phase motors are generally more suitable for loads of higher inertia and more frequent starting

B-1.2 Capacitor – Start Capacitor – Run

These motors have characteristics similar to those covered by capacitor-start induction-run motors but are more applicable where a greater degree of quietness or a higher efficiency and power factor are desirable.

B-1.3 Capacitor Start – and - Run

These motors are for use where low starting torques are acceptable. They are also generally quieter than split-phase or capacitor-start induction-run motors.

Unless otherwise specified these motors are provided with some means of switching out or modifying the auxiliary or starting winding for example centrifugal switches or electromagnetic relays.

NOTE - Starting, pull-up and pull-out torques for motors vary as the square of the voltage at the motor terminals. Unless the wiring is adequate to carry the starting current without excessive voltage drop the starting torque available may be seriously reduced.

B-1.4 Refrigeration Motors

The torque characteristics are intended to serve as guide to generally accepted practice in regard to small a.c. 50 cycle 4 pole motors.

B-1.5 Split-Phase

Owing to their high starting currents, split-phase motors are generally used for loads of low inertia and infrequent starting. When higher starting currents can be tolerated, motors of the higher torque rating can be used [type (b) motors in Table 16].

NOTE — Unless otherwise specified, these motors are provided with some means of switching out or modifying the auxiliary or starting winding, for example, centrifugal switches or electromagnetic relays.

B-1.6 Shaded-Poles

These motors are suitable for all applications where only a very low starting torque is required and motor efficiency is not important.

ANNEX C
(Clauses 21.6.2)

C-1 FORM FOR TEST REPORT OF SINGLE-PHASE INDUCTION MOTOR

Name and address of manufacturer as per IS 996:
 Certificate No.:
 Order acceptance No.:
 Purchaser:
 Purchaser's Order No.:.....

C-2 RATING PLATE DATA

Enclosure	Output	W	Voltage	V	50Hz
Frame	Speed	rev/min	Current	A	
Insulation Class	Rating		Efficiency	Percent	
			Starting capacitorV..... μ F
			Running capacitor V μ F

C-3 TEST CHARACTERISTICS

Loading Condition	Volts	Amperes	Watts	Speed rev/min	Power Factor	Efficiency percent
No load test						

C-4 FULL LOAD TEST

Breakaway Torque and Starting torque (Locked rotor), in kgm	(Locked Rotor) Current Breakaway Starting (Locked Rotor) Current	Input watts
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C-5 TEMPERATURE – RUN TEST

Condition of Test -----^-----	Temperature of Cooling Air °C	Temperature Rise -----^-----
Hours Voltage Current Watts		Winding Core R/T

Run R/T

Insulation resistance testM Ω

High voltage test.....Volts for one minute

Resistance of windings (hot)ohm at°C
(at room temperature)

Resistance of windings (cold)ohm at°C
(at room temperature)

Momentary overload for15 s Test ok

MOISTURE-PROOFNESS TEST

After conditioning in the humidity chambers for 18 h.

Insulation resistance test..... MΩ
High voltage testV/min for 1 min
Leakage currentmA (rms)

Tests conducted on motor No:

Tested by:

Approved by:

Date:

ANNEX D
(Clause 22)

INFORMATION TO BE GIVEN WITH ENQUIRY OR ORDER

1. Type of motor (*see* Annex B).
2. Reference to this Indian Standard that is IS 996.
3. Rated output in watts (at each speed multi-speed motors) (*see* **4.3**).
4. Approximate speed in rev/min at rated output (*see* **4.4**).
5. Voltage and frequency, in Hz (*see* **4.1** and **4.2**).
6. Class of rating (*see* **8**).
7. Type of enclosure (*see* **10**).
8. Maximum cooling air temperature in which motor is intended to work, if in excess of 40 °C
9. Altitude of operating site, if it exceeds 1 000 m.
10. The nature of atmosphere as to dust, moisture or chemical fumes if these would seriously interfere with the operation of motor.
11. Method of mounting (*see* **9.1**).
12. Details of drive, for example, belt, direct coupled, etc.
13. Installation position of motor for example horizontal or vertical shaft (*see* **9.3**).
14. Direction of rotation.
15. Type of bearings (sleeve or ball).
16. Method of starting, for example direct-on-line, resistance, etc.
17. Any restriction on starting torque.
18. Any restriction on starting current.
19. Nature of load or any information regarding driven equipment, which has bearing upon the torque required during acceleration period, the kinetic energy of the moving parts to be accelerated, the number of starts during specified period and nature of temporary overloads that may be encountered with.
20. Details of shaft extension.
21. Particulars of tests required and where they are to be carried out.
22. Provision of thermal protection.
23. Provision of radio interference suppression device.

ANNEX E
(Clauses 8.2 and 23)

INFORMATION ON SELECTION AND APPLICATION

E-1 NUMBER OF STARTS

These shall be subject to an agreement between the manufacturer and the user. However, the following may be taken as a guide to the number of starts:

SI No.	Type of Motor	No. of Starts/Hour Max	Duration of Each Start Max seconds
(1)	(2)	(3)	(4)
i)	Capacitor-start induction-run	20	3
ii)	Capacitor-start and capacitor-run	20	3
iii)	Capacitor start-and-run	60	3
iv)	Shaded pole	80	3
v)	Split phase	10	1

E-2 SELECTION OF MOTORS

Motors should be properly selected to ensure their satisfactory service. Motors conforming to this standard are suitable for operation in accordance with their ratings under usual service conditions.

Usual service conditions in addition to those stated in **5** shall be as follows:

- a) Installation on a rigid mounting base;
- b) Installation in areas or supplementary enclosures which do not seriously interfere with the ventilation of the motor;
- c) Voltages and frequency in accordance with **4**; and
- d) Motors and driven equipment is direct-coupled with flexible couplings.

E-3 SHORT TIME RATED MOTORS

Unless otherwise agreed upon between the manufacturer and the user, the short time rated motors should not be used on any application where driven machine may be left running continuously.

E-4 EFFECTS OF VARIATION IN VOLTAGE AND FREQUENCY UPON THE PERFORMANCE OF INDUCTION MOTORS

Induction motors are at times operated on circuits of voltage and frequency other than those for which they are rated. Following would be a brief statement of some operating results caused by variation in voltage and frequency:

- a) With increase or decrease in voltage from that permitted by tolerances on rated voltage; the heating at rated output, in watts, may increase. Such operation for longer periods of time may deteriorate or accelerate deterioration of insulation system:
- b) Increase in voltage than rated voltage would usually result in lowering of power factor and *vice-versa*;
- c) Starting and pull out torques will be proportional to the square of voltage;
- d) Increase in voltage will result in decrease of slip the while decrease in voltage will result in increase of slip, for example, for 10 percent decrease in rated voltage, slip will increase from 5 to 6.05 percent.
- e) Frequency greater than rated frequency usually improves power factor but decreases starting torque and increases speed friction and winding loss. At frequency lower than rated frequency reverse can be expected:
- f) If frequency and voltage are both varying. Then cumulative affects shall be observed, for example if voltage is high and frequency is low, the starting torque would be greatly increased while power factor will be decreased and the temperature –rise increased with normal load. Therefore highest permissible voltage and lowest permissible frequency should not occur simultaneously; and
- g) The information given in (a) to (f) applies particularly to general-purpose motors. This may not be always applicable in connection with definite purpose motors (for example for fan duty motors) being built for particular purpose.

ANNEX F
(Clause 24)

GUIDELINES FOR SELECTION OF FAN DUTY MOTORS

F-1 The information given in **F-1** to **F-8** may be useful in selection and application of fan duty motors as defined in **3.1.4**.

F-2 TYPE OF MOTORS

Fan duty motors shall preferably be of shaded pole or capacitor start and run type (*see B-1.3*).

F-3 GENERAL MECHANICAL FEATURES

F-3.1 Motors shall be constructed with the following mechanical features:

- a) Unless otherwise specified the motors shall be totally enclosed (*see 10.1.5*).
- b) Unless otherwise specified, the horizontal motors rated up to 250 W shall have sleeve bearings. The motor shall be provided with means to withstand axial thrust imposed by the impeller fan. Horizontal motors rated above 250 W shall have ball bearings, unless otherwise agreed between the manufacturer and the user, and easily accessible re-lubrication points shall be provided for sleeve bearings.

F-4 DIMENSIONS

As these motors are meant for specific applications, dimensions including those of mounting and shaft extension should be as per the agreement between the user and the manufacturer.

F-5 SITE CONDITIONS

F-5.1 The site conditions shall be in accordance with **5**.

F-5.2 Ambient Temperature

When the fan motors are supplied for use in packaged air conditioners (*see IS 8148*) room air conditioners (*see IS 1391*) and drinking water coolers (*see IS 1475*) the ambient temperature for motor shall be taken as not exceeding 45°C.

F-5.2.1 This standard also covers motors used in evaporative air coolers (*see IS 3315*). The fan motors used in evaporative air coolers may have ambient temperature conditions as agreed to between the manufacturer and the user.

F-6 CHARACTERISTICS OF FAN MOTORS

F-6.1 The Fan duty motors shall meet the requirements of **12** and as modified by **F-5.1**.

NOTE- The values of performance (*see 12.5*) for motors other than 4 pole construction shall be as agreed between the manufacturer and the user, subject to tolerances specified in Table 14.

F-6.2 Torque

F-6.2.1 Pull Out Torques

Lower torque than specified in Table 1 may be acceptable provided motor meets other performance requirement for satisfactory operation of appliance in which it is used.

F-6.2.1 Pull Up and Break Away Torque

These should be sufficient to accelerate the fan satisfactorily under worst operating conditions of voltage and frequency (*see* Annex E) for which the appliance has been designed.

F-6.2.2 Momentary Overload Test

The requirement shall not be applicable to fan motors

F-6.2.3 Full Load Test

The power input and speed should be measured when motor is fitted with the fan and mounted in the appliance so that the actual condition under which it is loaded are simulated.

F-6.2.4 Temperature Rise Test

This shall be carried out, when motor is fitted with the fan as used in the appliance. As in most of the cases, the motor is cooled by the air drawn over its surface by the driven fan. In all such motors the rating on name plate should appear as AOM (Air oven motors). Motors with AOM ratings shall not be run without fan other than necessary for routine testing of motors as it may result in overheating of motor.

F-7 MULTISPEED MOTORS

F-7.1 In a single speed induction motor, the speed may be changed by virtue of fan load and motor characteristics by effective change of voltage. This change in voltage can either be achieved by tapped winding in the motor itself or by external means (for example, speed regulator). Close co-operation between the motor manufacturer and fan manufacturer is recommended in order to obtain satisfactory speed regulation.

F-7.1.1 The operational speeds shall be subject to agreement between the manufacturer and the user. The tolerances on speed shall be as per Table 14.

F-8 EFFECT OF VARIATION OF RATED VOLTAGE UPON OPERATING SPEED

F-8.1 The effect of variation from rated voltage upon the operation speed of typical designs of shaded pole and capacitor start and run motors used for fan drives are shown by speed-torque curves in Fig. 1 and Fig. 2 respectively. In each set of curves the solid curve intersecting the 0 torque axis near 100 percent of synchronous speed illustrates the speed torque characteristics of an average motor of a typical design. The dashed curves enveloping the solid curve illustrate the variation in speed-torque characteristics of the

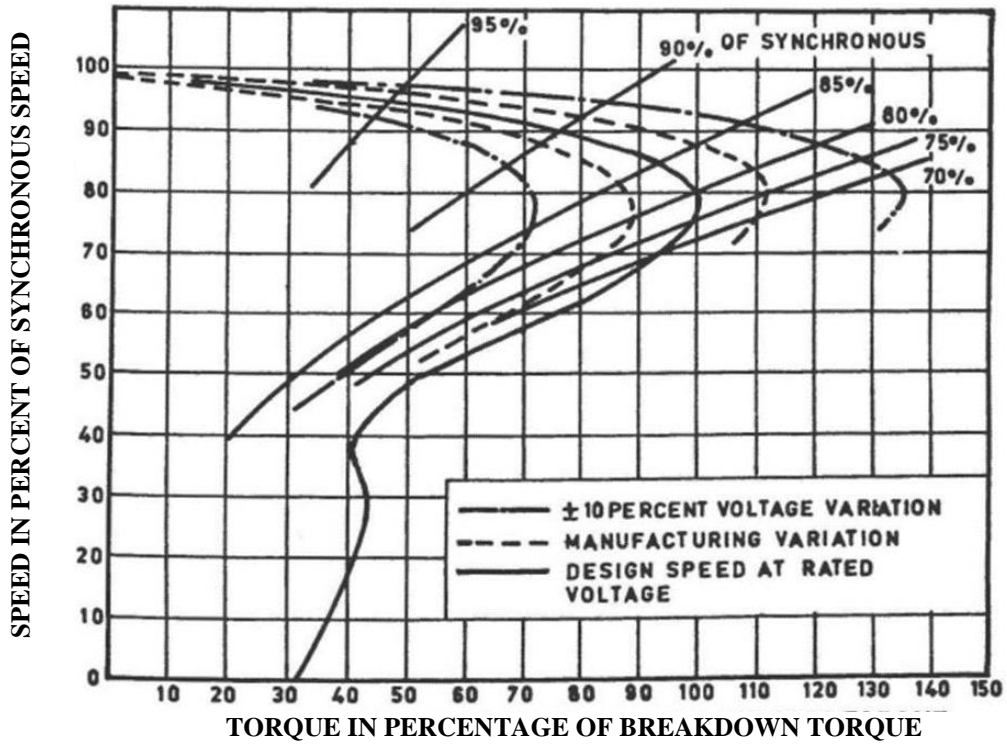


FIG 1 TYPICAL SHADED POLE SPEED TORQUE CURVE SHOWING EXPECTED SPEED VARIATION DUE TO MANUFACTURING AND VOLTAGE VARIATIONS

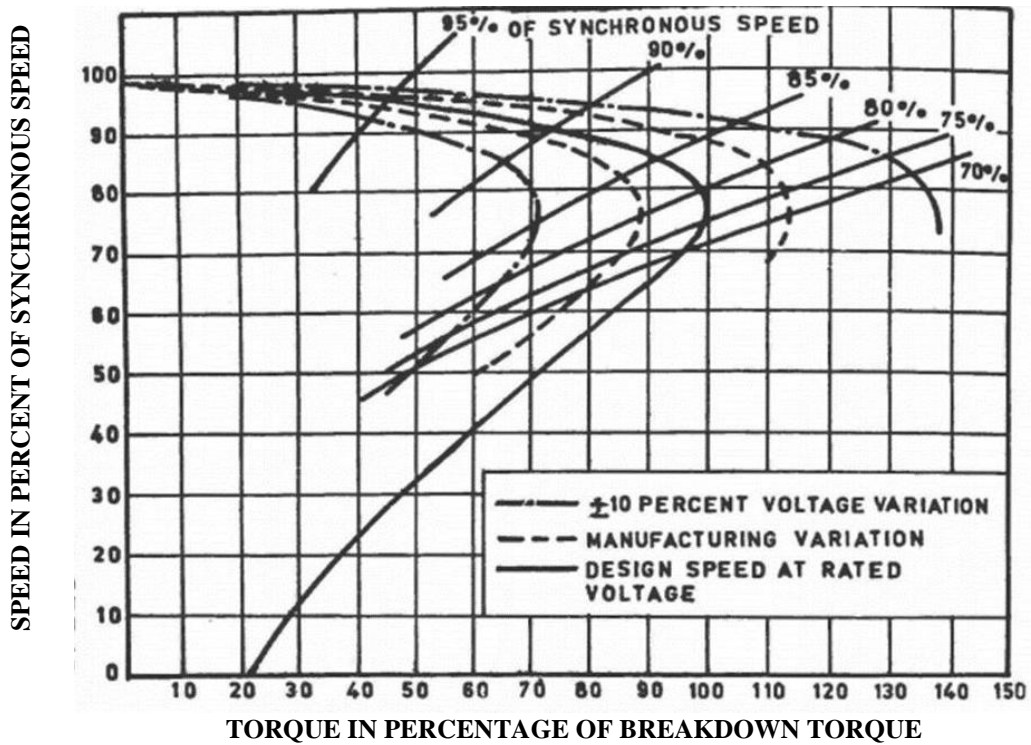


FIG 2 TYPICAL PERMANENT-SPLIT CAPACITOR SPEED-TORQUE CURVE SHOWING EXPECTED SPEED VARIATION DUE TO MANUFACTURING AND VOLTAGE VARIATIONS

typical motor design when tested at rated voltage and frequency. The dot dash curve illustrates the variation in speed torque characteristics within ± 10 percent variations in line voltage for the motor of the typical design when operated at rated frequency.

In order to illustrate the variation in motor speed when driving a specified fan, a family of typical fan speed-torque curves are shown intersecting the typical average motor speed-torque curve at operating speeds of 95, 90, 85, 80, 75 and 70 percent of synchronous speed.

F-8.1.1 A study of these curves show that when the operating speed is lower than 50 percent of synchronous speed extremely wide variations in operating speed of motor of a particular design may be expected within the ± 10 percent variation from rated voltage that may be encountered in service. The variation in air flow characteristics of the fan of a particular design are not included.

F-8.1.2 Care must be exercised in applying the motor to fan application particularly where two or three speed operation is desired so that the operating speed is kept within the range where tolerable starting characteristics and variations in operating speed may be obtained

F-9 TERMINAL MARKING

F-9.1 The terminal marking shall be in accordance with **14**. However, if terminal plate is not used and flexible cables are brought out of motor for connection the following colour code shall be used to identify the terminals:

Single speed motor :	Supply terminals	Red – Black
	Capacitor terminals	Yellow –Yellow
Two speed motor :	High speed	Blue – Black
	Low speed	Blue – Red
	Capacitor	Yellow –Yellow
Three speed motor :	High speed	Blue – Black
	Medium speed	Blue – White,
	Low speed	Blue – Red
	Capacitor	Yellow – Yellow,

ANNEX G
(Clause 17.5.1)

SAMPLING OF ELECTRIC MOTORS

G-1 SCALE OF SAMPLING

G-1.1 Lot

In any consignment, all the electric motors of the same type and rating from the same batch of manufacture shall be grouped together to constitute a lot.

G-1.2 The conformity of the lots to the requirements of this specification shall be ascertained for each lot separately. The number of electric motors to be selected for this purpose shall depend upon the size of lot and shall be in accordance with **2** and **4** of Table 16.

G-1.2.1 These electric motors shall be selected from the lot at random. In order to ensure the randomness of selection, procedures given in IS 4905 may be followed.

G-2 NUMBER OF TESTS AND CRITERIA FOR CONFORMITY

The electric motors at the first stage selected at random according to **2** and **4** of Table 16 shall be subjected to each of the acceptance tests. If an electric motor fails in any of the acceptance tests it shall be termed as defective. The lot shall be considered as conforming to the requirements if the number of defectives found in the sample is less than or equal to the acceptance number (*see 6*) and shall be rejected if it is greater than or equal to rejection number (*see 7*). If the numbers of defectives lie between the acceptance number and the rejection number the second sample of the same size shall be chosen at random and tested. If the number of defectives found in the combined samples is greater than or equal to the rejection number, the lot shall be rejected: otherwise the lot shall be accepted.

Table 16 Scale of Sampling and Permissible Number of Defectives
(Clauses G-1.2 and G-2.1)

SI No. (1)	Lot Size (2)	Stage (3)	Sample Size (4)	Cumulative Sample Size (5)	Acceptance Number (6)	Rejection Number (7)
i)	Up to 50	First	5	5	0	1
ii)	51 to 100	First	8	8	0	1
iii)	101 to 300	First Second	8 8	8 16	0 1	2 2
iv)	301 to 500	First Second	13 13	13 26	0 1	2 2
v)	501 to 1000	First Second	20 20	20 40	0 3	3 4
vi)	1001 and above	First Second	32 32	32 64	1 4	4 5

NOTE- For lot size up to 100, decision regarding acceptance or rejection of the lot shall be taken at the first stage only.