BUREAU OF INDIAN STANDARDS
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Draft Indian Standard

Line Operated Three Phase a.c. Motors (IE CODE)

"Efficiency Classes and Performance Specification"

(Fourth Revision of IS 12615)

Rotating Machinery Sectional Committee, ETD 15	Last date for comments- 18/02/2025

FOREWORD

(Formal clauses of the draft will be added later)

This standard specifies the performance requirements and efficiency classes (IE Code) of line operated three phase a.c. motors.

This standard was originally published in 1989 and subsequently revised in 2004 and 2011. First revision was brought to include eff2 and eff1 classes, and the second revision was brought to include IE1, IE2 and IE3 efficiency classes. The third revision dropped the IE1 class. The Fourth revision of this standard has been undertaken to include IE5 motors and align it with the latest version of IEC 60034-30-1 ED2 'Rotating electrical machines - Part 30-1: Efficiency classes of line operated AC motors (IE code)'

The references for methods of testing have been referred from IS 15999 (Part 2/Sec 1): 2011/ IEC 60034-2-1 'Rotating electrical machines Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)'. This standard replaces IS 12615 : 2018 including all of its amendments..

Electric motors are the most important type of electric load in every industry. The motor driven systems account for about seventy percent of the energy consumed by the industry. There is a large potential for cost effective solution in the use of energy efficient motor systems by about twenty to thirty percent. Electric motor systems include a number of energy using products, such as motors, drives, pumps or fans, compressors, blowers and other machines. Energy efficient motors form a major component in contributing to the energy saving by way of increased efficiency of the product itself. Further, with the different test methods specified in different standards, one to one comparison becomes difficult for the buyer or the end user. Therefore, a need was felt globally to harmonize the motor standards with the international standards so as to have uniform test procedures to facilitate the end user to compare the performance and energy efficiency requirements.

Acknowledging the need for energy saving in view of the energy scarcity, climate change mitigations and the potential that exists with energy efficient motors, number of countries have issued directives to withdraw lower efficiency classes and adopt higher efficiency class motors as per latest IEC 60034-30-1 ED2 thus defining minimum efficiency performance

standards (MEPS) in their countries. Such regulations are expected to impose technical barriers to imports of motors which are with lower efficiency classes than the MEPS in to their countries.

This standard is based on IEC 60034-30-1 ED2 issued by the International Electrotechnical Commission.

Additional performance parameters other than efficiency values have also been included which are as following:

a) Locked rotor torque;
b) Locked rotor current;
c) Full load speed;
d) Full load current;
e) Frame size v/s output kW correlation;
f) Higher variation in voltage and frequency (± 10 percent and ± 5 percent respectively) than IS/IEC 60034-1 (5 percent and 2 percent respectively) defined for motors considering Indian grid conditions;
g) Temperature rise under extreme conditions of voltage variation (± 10 percent) defined to take care of Indian grid conditions and the use of required class of insulation; and
h) Schedule of tests.

Users should select the efficiency class in accordance with a given application depending on the actual operating conditions.

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 off 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.

Draft Indian Standard

LINE OPERATED THREE PHASE a.c. MOTORS (IE CODE) "EFFICIENCY CLASSES AND PERFORMANCE SPECIFICATION"

(Fourth Revision)

1 SCOPE

1.1 This standard covers the efficiency classes and performance specifications of single-speed line operated a.c. motors that are rated according to IS 15999 (Part 1)/IEC 60034-1, rated for operation on a sinusoidal voltage supply and :

a) Have a rated power from 0.12 kW to 1 000 kW;

b) Have 2, 4, 6 or 8 poles;

c) Have a rated voltage Un up to 1 000 V with a rated frequency of 50 Hz;

d) Frame size from 56 up to and including 315 M having Frame to output co-relation as specified in Table 3 of IS 1231;

e) Frame size 315 L with dimensions as per IS 1231 and having output rating as declared by motor manufacturer;

f) Frame size 355 and above, with dimensions and output ratings as declared by motor manufacturer but conforming to IS 8223;

g) Are capable of continuous operation at their rated power with a winding temperature rise within the specified insulation temperature class;

h) Are marked with any ambient temperature within the range of – 20 °C to + 60 °C;

j) Are marked with an altitude up to 4 000 m above sea level;

k) This standard covers motors with or without service factor;

m) Most motors covered by this standard are primarily rated for duty type S1 (continuous duty). Motors rated for duty cycles S2 and above with an equivalent S1 duty are also covered. These motors must also be marked with the equivalent S1 duty output and its corresponding IE class. Declaration of S1 duty output value may be as per mutual agreement between motor manufacturer and customer. (***see*** 12)

n) Motors with output power rating higher than as specified in Table 3 of IS 1231 for a given frame, must meet the efficiency class corresponding to that power rating.

1.2 This standard establishes a set of efficiency values based on frequency, number of poles and motor output power. No distinction is made between motor technologies, supply voltage or motors with increased insulation designed specifically for converter operation even though these motor technologies may not all be capable of reaching the higher efficiency classes (see Table 1 to Table 4). This makes different motor technologies fully comparable with respect to their energy efficiency potential.

1.3 Motors with customized dimensions different from IS 1231 are also covered by this standard. (*see* 7 also) Geared motors are covered by this standard including those incorporating non-standard shafts and flanges.

Totally enclosed air-over (TEAO IC418) machines, that is totally enclosed frame-surface

cooled machines intended for exterior cooling by a ventilating method external to the machine are covered by this standard. Efficiency testing of such motors may be performed with the fan removed and the cooling provided by an external blower with a similar airflow rate as the original fan.

Methods of cooling shall be IC411, IC511 or IC611. (*see* 6 also).

Sometimes motors are required to be offered in frame sizes higher than as stipulated in Table 3 of IS 1231. Such cases are covered for IE classification and marking. The motor shall meet the performance parameters of the rated power (Table 1 to Table 4).

1.4 This standard does not cover the following motors:

a) Single-speed motors with 10 or more poles or multi-speed motors;
b) Motors with mechanical commutators (such as Universal – a.c./d.c. motors);
c) Slip ring induction motors;
d) Screen protected drip proof motors with IP21, IP22 and IP23 protection.
e) Motors completely integrated into a machine (for example mono-block pump. fan and compressor) that cannot be practically tested separately from the machine even with provision of a temporary end-shield and drive-end bearing. This means the motor shall:

   1) Share common components (apart from connectors such as bolts) with the driven unit (for example. a shaft or housing) and;

   2) Not be designed in such a way as to enable the motor to be separated from the driven unit as an entire motor that can operate independently of the driven unit. That is for a motor to be excluded from this standard the process of separation shall render the motor inoperative;

f) Motors with integrated frequency-converters (compact drives) when the motor cannot be tested separately from the converter. Energy efficiency classification of compact drives shall be based on the complete product (PDS: Power Drive System) and will be defined in a separate standard;

   NOTE — A motor is not excluded when the motor and frequency-converter can be separated and the motor can be tested independently of the converter.

g) Brake motors when the brake is an integral part of the inner motor construction and can neither be removed nor supplied by a separate power source during the testing of motor efficiency;

   NOTE — Brake motors with a brake coil that is integrated into the flange of the motor are covered as long as it is possible to test motor efficiency without the losses of the brake (for example by dismantling the brake or by energizing the brake coil from a separate power source).

When the manufacturer offers a motor of the same design with and without a brake the test of motor efficiency may be done on a motor without the brake. The determined efficiency may then be used as the rating of both motor and brake motor.

h) Submersible motors specifically designed to operate wholly immersed in a liquid; and
j) Smoke extraction motors with a temperature class above 400 °C.

2 REFERENCES

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

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 1885 (Part 35), IS 15999 (Part 2/Sec 1) and IS 15999 (Part 1) shall apply.

4 SITE CONDITIONS

The following shall constitute the preferred site conditions.

4.1 Altitude and Temperature

Motors shall be designed for the site conditions specified in **4.1.1** and **4.1.2** unless otherwise agreed between the manufacturer and the purchaser.

4.1.1 *Altitude*

The standard covers motors designed for altitudes up to and including 4 000 m. For altitudes up to and including 1 000 m, the frame to output co-relation as stipulated in Table 3 of IS 1231 shall be binding.

4.1.2 *Temperature*

The standard covers motors designed for ambient temperatures between -20 °C to + 60 °C. For ambient temperatures up to and including 50 °C, the frame to output co-relation as stipulated in Table 3 of IS 1231 shall be binding.

4.2 Electrical Operating Conditions

4.2.1 Clause 7 of IS 15999 (Part 1) shall apply.

4.2.2 *Form and Symmetry of Voltages and Currents*

The motors shall be so designed so as to be able to operate on virtually sinusoidal and balanced voltage conditions as defined in **7.2.1** of IS 15999 (Part 1).

4.3 Voltage and Frequency Variation

Motors shall be capable of delivering rated output with:

a) Terminal voltage differing from its rated value by not more than ± 10 percent,
b) Frequency differing from its rated value by not more than ± 5 percent, or
c) Combined variation — The sum of absolute percent variations of (a) and (b) not exceeding 10 percent.

5 LOCATION, MOISTURE AND FUMES

It shall be assumed that the location, moisture or fumes shall not seriously interfere with the

operation of the motor.

6 METHODS OF COOLING

Method of cooling shall be IC411. However, motors (using heat exchangers) with method of cooling IC511 and IC611 will be considered.

IC416 (and IC516 and IC616) are not preferred for motors meant for operation on line supply. If a manufacturer wishes to mark such a cooling method with an IE class then the motor must meet the efficiency requirement when tested on a sinusoidal supply and power input to the auxiliary fan motor is also included in the power input to the main motor to determine the efficiency of such a method of cooling. The auxiliary fan motor must meet the efficiency requirements described in this standard if it falls under the purview of the same.

IC417 (IC517 or IC617) method of cooling will be eligible for IE marking provided the manufacturer is able to establish the committed temperature rise and the efficiency at his test-lab by simulating the air-flow conditions mutually agreed with the user.

7 DIMENSIONS, FRAME NUMBER AND OUTPUT RELATIONSHIP

The fixing dimensions and shaft extensions of motors shall generally conform to the values specified in IS 1231 and IS 2223 as relevant for outputs up to 132 kW. Special customized dimensions are also permitted.

8 EARTHING

The earthing on the motor shall be provided in accordance with IS 15999 (Part 1).

9 TERMINAL MARKING

The terminal markings shall be as given in IS/IEC 60034-8.

10 RATED VOLTAGE AND FREQUENCY

10.1 Rated Voltage

The standard covers motors designed for terminal voltages up to and including 1 000 V. The full load current data in the Table 1 to Table 4 correspond to a 415 V, 50 Hz supply.

10.2 Rated Frequency

The rated frequency shall be 50 Hz.

> Note — The rated frequency for compliance to this standard is 50 Hz. However, if 60 Hz motors are operated on a 50 Hz supply, they must meet the performances outlined in Table 1 to Table 4 of this standard.

11 DUTY AND RATING

The motors shall be rated for duty type S1 (continuous duty) as specified in **4.2.1** of IS 15999 (Part 1).

In case equivalent S1 duty power rating (for example for duties S2 and above) lies between

two specified power ratings given in Table 1 to Table 4, the efficiency value shall be calculated using the formula given in **15.4.4**.

12 OVERLOAD

12.1 Momentary Excess Torque

See **16.2.5**

12.2 Pull-up-Torque

Unless otherwise specified, the minimum pull-uptorque of motors, at rated voltage and frequency shall be at least 0.5 times the rated full load torque.

12.3 Sustained Overloads

Motor rated in accordance with this standard are not expected to be capable of carrying sustained overloads.

13 PERFORMANCE VALUES

13.1 Operating at rated voltage and rated frequency, the performance of the motor at rated conditions shall be as specified in Table 1 to Table 4. All the performance values are subject to tolerance as specified in IS 15999 (Part 1).

13.2 The value of line current shall be taken as the arithmetic average of the currents measured in all the three lines.

13.3 For motors having rated voltage other than 415 V, the performance of the motor shall be as per the values in the relevant tables, except that the value of the maximum full load current will change in the inverse proportion of the voltage.

13.4 The value of the locked rotor current shall be as per Table 1 to Table 4.

NOTE — Energy efficient cage-induction motors are typically built with more active material to achieve higher efficiency and hence the starting performance of these motors differs somewhat from motors with a lower efficiency. The locked rotor current increases approximately by 10 to 15 percent for increase in each level of efficiency for the same output power and the values are as given in the Table 1 to Table 4.

15 EFFICIENCY

15.1 Determination

15.1.1 *General*

This standard deal with single-speed motors operated on-line. In order to make efficiency class ratings comparable between different motor technologies, all tests according to this standard shall be performed on sinusoidal voltage as defined in **7.2.1.1** of IS 15999 (Part 1).

Efficiency and losses shall be determined in accordance with the preferred method of the individual motor type as given in IS 15999 (Part 2/Sec 1).

NOTE — Motors operated by frequency-converters may have higher losses as compared to line (sinusoidal) power supply due to the harmonic voltage content. These motors must be tested on sinusoidal supply and efficiency to be minimum IE2 class.

15.1.2 Rated Voltages, Rated Frequencies and Rated Power

The rated efficiency shall be determined at rated power, rated voltage, and rated frequency of 50 Hz. Motors rated for an extended voltage tolerance (for example 415 V ± 10 percent) shall be assigned a single rated efficiency, at base voltage. That is the extended voltage tolerance shall be disregarded. Motors with rated voltage/frequency combinations of the same magnetic flux and power, for example 230 V/400 V (delta/star) or 230 V/460 V (double-star/ star), shall have only one rated efficiency and efficiency class (IE code).

Motors with more than one rated voltage/frequency/ power combination should be assigned a rated efficiency and a rated efficiency-class (IE code) for each rated voltage/frequency/power combination. However, as a minimum the lowest efficiency value and the associated IE code (of all rated voltage/frequency/ power combinations) shall always be printed on the rating plate.

All efficiency values and IE code shall be available in the product documentation (catalogue or operating instructions).

15.1.3 *Auxiliary Devices*

Some electric motors covered by this standard may be equipped with auxiliary devices such as shaft seals, external fans, mechanical brakes, back-stops and unidirectional bearings, speed sensors, tacho-generators in various combinations. However, as long as these auxiliary devices are not an integral part of the basic motor design, the determination of efficiency in all possible combinations is not practical. Tests for efficiency of such modified standard motors shall be performed on basic motors with original cooling without auxiliary devices installed.

The losses of a separately driven fan are to be included in the efficiency determination procedure when the external fan is an integral part of the basic motor construction. When the external fan is just an optional add-on to a mass-produced motor, which normally carries a shaft-mounted fan, the losses of the basic motor (with the shaft-mounted fan) can be used.

Angular-contact bearings (thrust bearings) or roller bearings for vertical mounted motors may be replaced by standard bearings during efficiency testing. Such motors may be tested horizontally.

Some types of motors (such as geared motors. pump motors and others) are equipped with shaft seals to prevent ingress of oil or water into the motor. External seals shall be removed for efficiency testing. This applies only to seals that are accessible from the outside without dismantling of the motor (dismantling of the fan-cover and the fan is accepted).

Electro-mechanical brakes shall be removed during testing of motor efficiency. When the motor construction prohibits a removal of the brake, the brake-coil shall be energized from a separate power source and the energy consumption of the brake-coil shall be disregarded in the calculation of motor efficiency.

15.2 Rating

The efficiency declared by the manufacturer on the rating plate (rated efficiency) shall be greater or equal to the nominal efficiency as defined in this standard (according to the efficiency class (IE code) on the rating plate).

The full-load efficiency of any motor, when tested at rated voltage and rated frequency shall not be less than the rated/classified efficiency minus the tolerance of the efficiency in accordance with IS 15999 (Part 1).

It is recommended to report efficiencies at 50 percent, 75 percent and full load in the product documentation. For the purpose of compliance to this standard only the efficiency at rated power applies.

Variations in materials, manufacturing processes and testing, result in motor-to-motor efficiency variations for a given motor design; the full-load efficiency for a large population of motors of a single design is not a unique value but rather a band of efficiency. Therefore, the energy efficiency limits given in this standard are nominal, and tolerance is applicable to these values.

15.3 Classification and Marking

15.3.1 *General*

The designation of the energy efficiency class consists of the letters “IE” (short for International Energy efficiency class), directly followed by a numeral representing the classification.

15.3.2 *Marking*

The rated efficiency and the IE code shall be durably marked on the rating plate, for example “IE2 — 84.0 percent”.

15.4 Nominal Limits for Efficiency Classes IE2, IE3 and IE4

15.4.1 For compliance with the requirements of this standard, the values of efficiency listed under appropriate efficiency class will be as per Table 1 to Table 4. The values given in Table 1 to Table 4 are subject to tolerance as specified in IS 15999 (Part 1).

15.4.2 The losses and efficiency of these motors shall be calculated according to IS 15999 (Part 2/Sec 1).

NOTE — The selected test method shall be stated in the test certificate. Test methods with low uncertainty as specified in **8.1.1** or **8.1.2** or **8.2.1** or **8.2.2.5.1** of IS 15999 (Part 2/Sec 1) as applicable shall be used. Alternatively test as per assigned loss method (**8.2.2.5.3**) may be applied if written acceptance of the user is available.

15.4.3 To ensure a representative test result for windage and friction losses and in accordance with the common practice, the test shall be carried out in a stabilized bearing condition. In the case of motors provided with seals and other auxiliary devices like external fans, mechanical brakes, back stops, speed sensors, tacho generators etc., in various combinations, tests shall be conducted without installing the seals and other auxiliaries.

Table 1 Values of Performance Characteristics of 2 Pole Line Operated a.c. Motors

(*Clauses* 1.2, 1.3, 1.6, 10.1, 10.2, 11, 13.1, 13.4, 15.4.1, 17.3.**5)**

Sl No.	Rated Output	Frame Size	Full Load Speed	Full Load Current	Locked Torque in Terms of Full Load Torque	Locked Rotor Current in Terms of Full Load Current				Nominal Efficiency			
						IE2	IE3	IE4	IE5	IE2	IE3	IE4	IE5
	kW		rev/ min	A	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
i)	0.12	56	2 750	0.65	170	600	650	730	870	53.6	60.8	66.5	71,4
ii)	0.18	63	2 750	0.84	170	600	650	730	870	60.4	65.9	70.8	75,2
iii)	0.25	63	2 750	1	170	600	650	730	870	64.8	69.7	74.3	78,3
iv)	0.37	71	2 750	1.2	170	650	700	780	900	69.5	73.8	78.1	81,7
v)	0.55	71	2 760	1.6	170	650	700	780	900	74.1	77.8	81.5	84,6
vi)	0.75	80	2 780	2	170	650	700	780	900	77.4	80.7	83.5	86,3
vii)	1.1	80	2 790	2.8	170	650	700	780	900	79.6	82.7	85.2	87,8
viii)	1.5	90S	2 800	3.7	170	650	700	780	900	81.3	84.2	86.5	88,9
ix)	2.2	90L	2 810	5	170	700	770	890	950	83.2	85.9	88	90,2
x)	3.7	100L	2 820	8	160	700	770	890	950	85.5	87.8	89.7	91,6
xi)	5.5	132S	2 830	11	160	700	770	890	950	87	89.2	90.9	92,6
xii)	7.5	132S	2 840	15	160	700	770	890	950	88.1	90.1	91.7	93,3
xiii)	11	160M	2 860	21.5	160	700	770	890	950	89.4	91.2	92.6	94,0
xiv)	15	160M	2 870	29	160	700	770	890	950	90.3	91.9	93.3	94,5
xv)	18.5	160L	2 880	35	160	700	770	890	950	90.9	92.4	93.7	94,9
xvi)	22	180M	2 890	41.5	160	700	770	890	950	91.3	92.7	94	95,1
xvii)	30	200L	2 900	55	160	700	770	890	950	92	93.3	94.5	95,5
xviii)	37	200L	2 900	67	160	700	770	890	950	92.5	93.7	94.8	95,8
xix)	45	225M	2 955	80	160	700	770	890	950	92.9	94	95	96,0
xx)	55	250M	2 960	95	160	700	770	890	950	93.2	94.3	95.3	96,2

xxi)	75	280S	2 970	130	160	700	770	890	950	93.8	94.7	95.6	96,5
xxii)	90	280M	2 970	150	160	700	770	890	950	94.1	95	95.8	96,6
xxiii)	110	315S	2 980	185	160	700	770	890	950	94.3	95.2	96	96,8
xxiv)	132	315M1)	2 980	220	160	700	770	890	950	94.6	95.4	96.2	96,9
xxv)	160	315L1)	2 980	265	160	700	770	890	950	94.8	95.6	96.3	97,0
xxvi)	200	As per manufacturer catalogue 2	2 980	340	160	700	770	890	950	95	95.8	96.5	97,2
xxvii)	250		2 980	425	160	700	770	890	950	95	95.8	96.5	97,2
xxviii)	315		2 980	536	160	700	770	890	950	95	95.8	96.5	97,2
xxix)	355		2 980	604	160	700	770	890	950	95	95.8	96.5	97,2
xxx)	375		2 980	640	160	700	770	890	950	95	95.8	96.5	97,5
xxxi)	400		2 980	As per manufacturer catalogue 2	As per manufacturer catalogue 2	700	770	890	950	95	95.8	96.5	97,2
xxxii)	450		2 980			700	770	890	950	95	95.8	96.5	97,2
xxxiii)	500		2 980			700	770	890	950	95	95.8	96.5	97,2
xxxiv)	560		2 980			700	770	890	950	95	95.8	96.5	97,2
xxxv)	630		2 980			700	770	890	950	95	95.8	96.5	97,2
xxxvi)	710		2 980			700	770	890	950	95	95.8	96.5	97,2
xxxvii)	800		2 980			700	770	890	950	95	95.8	96.5	97,2
xxxviii)	900		2 980			700	770	890	950	95	95.8	96.5	97,2
xxxix)	1000		2 980			700	770	890	950	95	95.8	96.5	97,2

NOTES

1 Output to frame size relation is maintained in accordance with IS 1231 for all motors except those marked as1), wherein the frame size indicated is ‘preferred size’.
2 If the pull-up torque occurs at 0 speeds, then minimum value of the starting torque permitted (subject to no tolerance) shall be 0.5 times the rated torque

3 Sometimes motors are required to be offered in frame sizes higher than as stipulated in Table 3 of IS 1231. Such cases are covered for IE classification and marking. The motor shall meet the performance parameters of the rated power (Table 1 to Table 4).

4 Speeds declared above are indicative and actual values may be obtained from man manufacturers.’

5 For intermediate power ratings, the performance characteristics (including efficiency) shall be as per the nearest standard rating .The maximum rated current will be declared by the manufacturer.

6 Full Load current of IE5 motors can be as per manufactuer catalogue

Table 2 Values of Performance Characteristics of 4 Pole Line Operated a.c. Motors

(*Clauses* **1.2, 1.3, 1.6, 10.1, 10.2, 11, 13.1, 13.4, 15.4.1, 17.3.5**)

Sl No.	Rated Output	Frame Size	Full Load Speed	Full Load Current	Locked Torque in Terms of Full Load Torque	Locked Rotor Current in Terms of Full Load Current				Nominal Efficiency			
						IE2	IE3	IE4	IE5	IE2	IE3	IE4	IE5
	kW		rev/ min	A	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
i)	0.12	63	1 320	0.62	170	550	600	650	780	59.1	64.8	69.8	74,3
ii)	0.18	63	1 320	0.82	170	550	600	650	780	64.7	69.9	74.7	78,7
iii)	0.25	71	1 330	1.05	170	550	600	650	780	68.5	73.5	77.9	81,5
iv)	0.37	71	1 330	1.4	170	600	650	700	780	72.7	77.3	81.1	84,3
v)	0.55	80	1 340	1.7	170	600	650	700	850	77.1	80.8	83.9	86,7
vi)	0.75	80	1 360	2.2	170	600	650	700	850	79.6	82.5	85.7	88,2
vii)	1.1	90S	1 370	2.9	170	600	650	700	850	81.4	84.1	87.2	89,5
viii)	1.5	90L	1 380	3.8	170	600	650	700	950	82.8	85.3	88.2	90,4
ix)	2.2	100L	1 390	5.1	170	700	750	830	950	84.3	86.7	89.5	91,4
x)	3.7	112M	1 410	8.1	160	700	750	830	950	86.3	88.4	90.9	92,6
xi)	5.5	132S	1 420	12	160	700	750	830	950	87.7	89.6	91.9	93,4
xii)	7.5	132M	1 430	15.4	160	700	750	830	950	88.7	90.4	92.6	94,0
xiii)	11	160M	1 440	22	160	700	750	830	950	89.8	91.4	93.3	94,6
xiv)	15	160L	1 440	30	160	700	750	830	950	90.6	92.1	93.9	95,1
xv)	18.5	180M	1 440	36	160	700	750	830	950	91.2	92.6	94.2	95,3
xvi)	22	180L	1 440	43	160	700	750	830	950	91.6	93	94.5	95,5
xvii)	30	200L	1 450	57	160	700	750	830	950	92.3	93.6	94.9	95,9
xviii)	37	225S	1 450	69	160	700	750	830	950	92.7	93.9	95.2	96,1
xix)	45	225M	1 460	84	160	700	750	830	950	93.1	94.2	95.4	96,3

xx)	55	250M	1 460	101	160	700	750	830	950	93.5	94.6	95.7	96,5
xxi)	75	280S	1 470	134	160	700	770	890	950	94	95	96	96,7
xxii)	90	280M	1 470	164	160	700	770	890	950	94.2	95.2	96.1	96,9
xxiii)	110	315S	1 480	204	160	700	770	890	950	94.5	95.4	96.3	97,0
xxiv)	132	315M1)	1 480	247	160	700	770	890	950	94.7	95.6	96.4	97,1
xxv)	160	315L1)	1 480	288	160	700	770	890	950	94.9	95.8	96.6	97,2
xxvi)	200	As per manufacturer catalogue 2	1 480	348	160	700	770	890	950	95.1	96	96.7	97,4
xxvii)	250		1 480	435	160	700	770	890	950	95.1	96	96.7	97,4
xxviii)	315		1 480	548	160	700	770	890	950	95.1	96	96.7	97,4
xxix)	355		1 480	618	160	700	770	890	950	95.1	96	96.7	97,4
xxx)	375		1 480	653	160	700	770	890	950	95.1	96	96.7	97,7
xxxi)	400		1 480	As per manufacturer catalogue 2	As per manufacturer catalogue 2	700	770	890	950	95.1	96	96.7	97,4
xxxii)	450		1 480			700	770	890	950	95.1	96	96.7	97,4
xxxiii)	500		1 480			700	770	890	950	95.1	96	96.7	97,4
xxxiv)	560		1 480			700	770	890	950	95.1	96	96.7	97,4
xxxv)	630		1 480			700	770	890	950	95.1	96	96.7	97,4
xxxvi)	710		1 480			700	770	890	950	95.1	96	96.7	97,4
xxxvii)	800		1 480			700	770	890	950	95.1	96	96.7	97,4
xxxviii)	900		1 480			700	770	890	950	95.1	96	96.7	97,4
xxxix)	1000		1 480			700	770	890	950	95.1	96	96.7	97,4

NOTES

1 Output to frame size relation is maintained in accordance with IS 1231 for all motors except those marked as1), wherein the frame size indicated is ‘preferred size’.

2 If the pull-up torque occurs at 0 speed, then minimum value of the starting torque permitted (subject to no tolerance) shall be 0.5 times the rated torque of IS 1231. Such cases are covered for IE classification and marking. The motor shall meet the performance parameters of the rated power (Table 1 to Table 4).

3 Speeds declared above are indicative and actual values may be obtained from manufacturers’ catalogue.

4 For intermediate power ratings, the performance characteristics (excluding efficiency) shall be as per the nearest standard rating. The maximum rated current will be declared by the manufacturer.

5 Full Load current of IE5 motors can be as per manufactuer catalogue

Table 3 Values of Performance Characteristics of 6 Pole line operated a.c. motors

(*Clauses* 1.2, 1.3, 1.6, 10.1, 10.2, 11, 13.1, 13.4, 15.4.1, 17.3.5)

Sl No.	Rated Output	Frame Size	Full Load Speed	Full Load Current	Locked Torque in Terms of Full Load Torque	Locked Rotor Current in Terms of Full Load Current				Nominal Efficiency			
						IE2	IE3	IE4	IE5	IE2	IE3	IE4	IE5
	kW		rev/ min	A	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
i)	0.12	63	860	0.73	160	600	650	700	750	50.6	57.7	64.9	69,8
ii)	0.18	71	860	0.92	160	600	650	700	750	56.6	63.9	70.1	74,6
iii)	0.25	71	860	1.1	160	600	650	700	750	61.6	68.6	74.1	78,1
iv)	0.37	80	870	1.4	160	600	650	730	770	67.6	73.5	78	81,6
v)	0.55	80	870	1.9	160	600	650	730	750	73.1	77.2	80.9	84,2
vi)	0.75	90S	890	2.3	160	600	650	730	830	75.9	78.9	82.7	85,7
vii	1.1	90L	900	3.4	160	600	650	730	830	78.1	81	84.5	87,2
viii)	1.5	100L	900	4	160	600	650	730	830	79.8	82.5	85.9	88,4
ix)	2.2	112M	910	5.7	150	700	750	830	890	81.8	84.3	87.4	89,7
x)	3.7	132S	920	8.8	150	700	750	830	890	84.3	86.5	89.3	91,2
xi)	5.5	132M	920	12.9	150	700	750	830	890	86	88	90.5	92,2
xii)	7.5	160M	930	16.7	150	700	750	830	890	87.2	89.1	91.3	92,9
xiii)	11	160L	935	23.3	140	700	750	830	950	88.7	90.3	92.3	93,7
xiv)	15	180L	940	32	140	700	750	830	950	89.7	91.2	92.9	94,3
xv)	18.5	200L	940	37.5	140	700	750	830	950	90.4	91.7	93.4	94,6
xvi)	22	200L	945	44	140	700	750	830	950	90.9	92.2	93.7	94,9

xvii)	30	225M	945	59.5	140	700	750	830	950	91.7	92.9	94.2	95,3
xviii)	37	250M	950	72	140	700	750	830	950	92.2	93.3	94.5	95,6
xix)	45	280S	960	87	140	700	750	830	950	92.7	93.7	94.8	95,8
xx)	55	280M	960	107	140	700	750	830	950	93.1	94.1	95.1	96,0
xxi)	75	315S	970	145	140	700	770	890	950	93.7	94.6	95.4	96,3
xxii)	90	315M	970	175	140	700	770	890	950	94	94.9	95.6	96,5
xxiii)	110	315M1)	970	214	140	700	770	890	950	94.3	95.1	95.8	96,6
xxiv)	132	315L1)	980	257	140	700	770	890	950	94.6	95.4	96	96,8
xxv)	160	As per manufacturer catalogue 2	980	315	140	700	770	890	950	94.8	95.6	96.2	96,9
xxvi)	200		980	370	140	700	770	890	950	95	95.8	96.6	97,0
xxvii)	250		980	463	140	700	770	890	950	95	95.8	96.6	97,0
xxix)	355		980	657	140	700	770	890	950	95	95.8	96.6	97,0
xxx)	375		980	694	140	700	770	890	950	95	95.8	96.6	97,4
xxxi)	400		980	As per manufacturer catalogue 2	As per manufacturer catalogue 2	700	770	890	950	95	95.8	96.6	97,0
xxxii)	450		980			700	770	890	950	95	95.8	96.6	97,0
xxxiii)	500		980			700	770	890	950	95	95.8	96.6	97,0
xxxiv)	560		980			700	770	890	950	95	95.8	96.6	97,0
xxxv)	630		980			700	770	890	950	95	95.8	96.6	97,0
xxxvi)	710		980			700	770	890	950	95	95.8	96.6	97,0
xxxvii)	800		980			700	770	890	950	95	95.8	96.6	97,0
xxxviii)	900		980			700	770	890	950	95	95.8	96.6	97,0
xxxix)	1000		980			700	770	890	950	95	95.8	96.6	97,0

NOTES

1 Output to frame size relation is maintained in accordance with IS 1231 for all motors except those marked as1), wherein the frame size indicated is 'preferred size'.
2 If the pull-up torque occurs at 0 speeds, then minimum value of the starting torque permitted (subject to no tolerance) shall be 0.5 times the rated torque
3 Sometimes motors are required to be offered in frame sizes higher than as stipulated in Table 3 of IS 1231. Such cases are covered for IE classification and marking. The motor shall meet the performance parameters of the rated power (Table 1 to Table 4).
4 Speeds declared above are indicative and actual values may be obtained from manufacturers' catalogue.
5 For intermediate power ratings, the performance characteristics (excluding efficiency) shall be as per the nearest standard rating.
The maximum rated current will be declared by the manufacturer.
6 Full Load current of IE5 motors can be as per manufactuer catalogue

Table 4 Values of Performance Characteristics of 8 Pole Line Operated a.c. Motors

(*Clauses* **1.2, 1.3, 1.6, 10.1, 10.2, 11, 13.1, 13.4, 15.4.1, 17.3.5)**

Sr. No.	Rated Output	Frame Size	Full Load Speed	Full Load Current	Locked Torque in Terms of Full Load Torque	Locked Rotor Current in Terms of Full Load Current				Nominal Efficiency			
						IE2	IE3	IE4	IE5	IE2	IE3	IE4	IE5
	kW		rev/ min	A	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
i)	0.12	71	620	0.8	150	500	550	600	700	39.8	50.7	62.3	67,4
ii)	0.18	80	630	1	150	520	550	600	700	45.9	58.7	67.2	71,9
iii)	0.25	80	630	1.2	150	520	550	600	700	50.6	64.1	70.8	75,2
iv)	0.37	90S	640	1.5	150	550	600	650	750	56.1	69.3	74.3	78,4
v)	0.55	90L	640	2.1	150	550	650	650	750	61.7	73	77	80,6
vi)	0.75	100L	650	2.7	150	550	650	650	750	66.2	75	78.4	82,0
vii)	1.1	100L	660	3.5	150	550	650	650	750	70.8	77.7	80.8	84,0
viii)	1.5	112M	670	4.5	150	550	650	650	750	74.1	79.7	82.6	85,5
ix)	2.2	132S	680	6.1	140	600	700	780	880	77.6	81.9	84.5	87,2
x)	3.7	160M	690	9.8	140	600	700	780	880	81.4	84.5	86.8	89,1
xi)	5.5	160M	690	14.2	140	600	700	780	880	83.8	86.2	88.3	90,4
xii)	7.5	160L	695	19	140	600	700	780	880	85.3	87.3	89.3	91,3
xiii)	11	180L	700	26	140	600	700	780	880	86.9	88.6	90.4	92,2
xiv)	15	200L	705	35	130	600	700	780	880	88	89.6	91.2	92,9
xv)	18.5	225S	705	45	130	600	700	780	880	88.6	90.1	91.7	93,3
xvi)	22	225M	710	52	130	600	700	780	880	89.1	90.6	92.1	93,6
xvii)	30	250M	710	70	130	600	700	780	880	89.8	91.3	92.7	94,1
xviii)	37	280S	710	86	130	600	700	780	880	90.3	91.8	93.1	94,4
xix)	45	280M	720	99	130	600	700	780	880	90.7	92.2	93.4	94,7
xx)	55	315S	720	118	130	600	700	780	880	91	92.5	93.7	94,9

xxi)	75	315M	730	153	130	600	700	780	880	91.6	93.1	94.2	95,3
xxii)	90	315L1)	730	182	130	600	700	780	880	91.9	93.4	94.4	95,5
xxiii)	110	315L1)	730	218	130	600	700	780	880	92.3	93.7	94.7	95,7
xxiv)	132	315L1)	730	260	130	600	700	780	880	92.6	94	94.9	95,9
xxv)	160	As per manufacturer catalogue 2	730	315	130	600	700	780	880	93	94.3	95.1	96,1
xxvi)	200		730	As per manufacturer catalogue 2	As per manufacturer catalogue 2	600	700	780	880	93.5	94.6	95.4	96,3
xxvii)	250		730			600	700	780	880	93.5	94.6	95.4	96,3
xxviii)	315		730			600	700	780	880	93.5	94.6	95.4	96,3
xxix)	355		730			600	700	780	880	93.5	94.6	95.4	96,3
xxx)	375		730			600	700	780	880	93.5	94.6	95.4	96,9
xxxi)	400		730			600	700	780	880	93.5	94.6	95.4	96,3
xxxii)	450		730			600	700	780	880	93.5	94.6	95.4	96,3
xxxiii)	500		730			600	700	780	880	93.5	94.6	95.4	96,3
xxxiv)	560		730			600	700	780	880	93.5	94.6	95.4	96,3
xxxv)	630		730			600	700	780	880	93.5	94.6	95.4	96,3
xxxvi)	710		730			600	700	780	880	93.5	94.6	95.4	96,3
xxxvii)	800		730			600	700	780	880	93.5	94.6	95.4	96,3
xxxviii)	900		730			600	700	780	880	93.5	94.6	95.4	96,3
xxxix)	1000		730			600	700	780	880	93.5	94.6	95.4	96,3

NOTES

1 Output to frame size relation is maintained in accordance with IS 1231 for all motors except those marked as1), wherein the frame size indicated is 'preferred size'.
2 If the pull-up torque occurs at 0 speed, then minimum value of the starting torque permitted (subject to no tolerance) shall be 0.5 times the rated torque
3 Sometimes motors are required to be offered in frame sizes higher than as stipulated in table 3 of IS 1231. Such cases are covered for IE classification and marking. The motor shall meet the performance parameters of the rated power (Table 1 to Table 4).
4 Speeds declared above are indicative and actual values may be obtained from manufacturer's catalogue.
5 For intermediate power ratings, the performance characteristics (excluding efficiency) shall be as per the nearest standard rating. The maximum rated current will be declared by the manufacturer.
6 Full Load current of IE5 motors can be as per manufactuer catalogue

15.4.4 Interpolation of nominal efficiency limits of intermediate rated powers for 50 Hz mains supply frequency.

To determine normative nominal efficiency limits of 50 Hz motors with rated powers not given in the tables above within the range of 0.12 kW up to 200 kW the following formula shall be applied:

$$\eta_N = A \cdot \left[\log_{10}\left(\frac{P_N}{1kW}\right)\right]^3 + B \cdot \left[\log_{10}\left(\frac{P_N}{1kW}\right)\right]^2 + C \cdot \log_{10}\left(\frac{P_N}{1kW}\right) + D$$

where,

A, B, C, D = interpolation coefficients (*see* Table 5 and Table 6): P_N is given in kW

NOTE — The formula and interpolation coefficient were mathematically derived to create a best fitting curve for the desired nominal efficiency limits. They do not have a physical meaning.

The resulting efficiency (percent) shall be rounded to the nearest tenth, that is, xx.x percent.

Table 5 Interpolation Coefficients for 0.12 kW up to 0.74 kW

(*Clause* **15.4.4**)

SI NO.	**IE code**	**Coefficients**	**8-poles**	**6-poles**	**4-poles**	**2-poles**
			750/min	**1000 /min**	**1500/min**	**3000/min**
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	IE2	A	6.4855	-15.9218	17.2751	22.4864
		B	9.4748	-30.258	23.978	27.7603
		C	36.852	16.6861	35.5822	37.8091
		D	70.762	79.1838	84.9935	82.458
ii)	IE3	A	-0.5896	-17.361	7.6356	6.8532
		B	-25.526	-44.538	4.8236	6.2006
		C	4.2884	-3.0554	21.0903	25.1317
		D	75.831	79.1318	86.0998	84.0392
iii)	IE4	A	-4.9735	-13.0355	8.432	-8.8538
		B	-21.453	-36.9497	2.6888	-20.3352
		C	2.6653	-4.3621	14.6236	8.9002
		D	79.055	82.0009	87.6153	85.0641
iv)	IE5	A	–7.0239	110118	–6.1120	-9.5776
		B	–16.9944	8.3635	–23.1331	-30.1627
		C	81.621	16.0368	1.6331	-4.5962
		D	87.7915	90.5323	86.0990	81.2564

Table 6 Interpolation Coefficients for 0.75 kW up to 200 kW

(*Clause* **15.4.4**)

Sl NO.	**IE code**	**Coefficients**	**8-poles**	**6-poles**	**4-poles**	**2-poles**
			750/min	1 000/min	1 500/min	3 000/min
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	IE2	A	2.1311	0.0148	0.0278	0.2972
		B	-12.029	-2.4978	-1.9247	-3.3454
		C	26.719	13.2470	10.4395	13.0651
		D	69.735	77.5603	80.9761	79.077
ii)	IE3	A	0.7189	0.1252	0.0773	0.3569
		B	-5.1678	-2.613	-1.8951	-3.3076
		C	15.705	11.9963	9.2984	11.6108
		D	77.074	80.4769	83.7025	82.2503
iii)	IE4	A	0.6556	0.3598	0.2412	0.34
		B	-4.7229	-3.2107	-2.3608	-3.0479

		C	13.977	10.7933	8.446	10.293
		D	80.247	84.107	86.8321	84.8208
iv)	IE5	A	0.3106	0.2459	0.3394	0.6183
		B	-2.6854	-2.136	-2.8578	-4.2672
		C	8.7516	7.1743	9.2088	12.0866
		D	87.4633	89.1712	86.8489	83.5379

16 SCHEDULE OF TESTS

16.1 Routine Tests

The following shall constitute the routine tests:

16.1.1 *Insulation Resistance Test*

The tests shall be carried out as given in IS/IEC 60034-27-4. The minimum value of insulation resistance shall be 30 MΩ.

16.1.2 *Measurement of Resistance of Windings of Stator*

The method of measurement and the requirement shall be as given in **8.6** of IS 15999 (Part 1) and **5.7** of IS 15999 (Part 2/Sec1).

16.1.3 *No Load Test*

The tests shall be carried out as given in IS 15999 (Part 2/Sec1) and 9.1 of IS 15999 (Part 1)/IEC 60034-1 (*see* note).

NOTE— the no-load current and no-load power input values when motor is at temperature stabilized condition and when motor is at ambient temperature, will vary. However, these values may be obtained only from routine test certificate of the motor.

16.1.4 *Locked Rotor Readings of Voltage, Current and Power Input at a Suitable Reduced Voltage*

The test may be carried out at reduced voltage.

16.1.5 *Reduced Voltage Running up Test at no-load*

The test is conducted to check the ability of the motor to run up to its rated speed at no load. The motor shall be supplied with reduced voltage $1/\sqrt{3}$ of rated value for each direction of rotation.

16.1.6 *High Voltage Test*

The tests shall be carried out as given in **9.2** of IS 15999 (Part 1) (*see* Note)

NOTE— the leakage current drawn by the motor during high voltage test, will vary depending upon frame size, power, insulation and polarity of the motor. This test may be conducted only once at full stipulated voltage. Subsequent tests must be conducted at 80 percent voltage of the previous test.

16.2 Type Tests

All tests mentioned in **16.1**, are also to be conducted as type tests. In addition, following tests

are to be conducted.

16.2.1 *Dimensions*

The preferred dimensions of the motors shall be as specified in IS 1231, IS 2223, IS 2254 and IS 8223 as applicable. The dimensions can be special as agreed between manufacturer and buyer. However, the efficiency should be as per the IE code for the rated output and intermediate outputs also.

16.2.2 *Locked Rotor Test*

This test is carried out to determine the soundness of rotor in case of squirrel cage induction motors and their starting current, power factor, starting torque and impedance. This also enables a circle diagram to be drawn in case of squirrel cage induction motors and wound rotor motors. This test may be carried out at reduced voltage, one of the readings may be at a voltage that will produce rated current of the motor. Locked rotor torque test is not done on wound rotor motors but on squirrel cage motors to determine the torque developed. Locked rotor current test is carried out on both squirrel cage and wound rotor motors.

16.2.2.1 It should be recognized that testing of motors under locked rotor conditions involves unusual stresses and high rates of heating. Therefore, it is necessary that, the direction of rotation be established prior to the test;

a) The mechanical means of locking the rotor be of adequate strength to prevent possible injury to personnel or damage to equipment; and
b) As the windings gets heated very rapidly, the test shall be carried out as rapidly as possible. Care should be taken to ensure that the motor temperature does not exceed the value of permissible temperature of given class of insulation. The readings at any point shall be taken within 6 s.

16.2.2.2 The following mechanical arrangements may be used to measure the developed torque:

a) Dynamometer,
b) Brake or beam clamped rigidly to motor shaft, and
c) Torque transducer.

16.2.2.2.1 The torque should be measured with the rotor in various positions wherever possible and the minimum value shall be taken as starting torque.

16.2.2.2.2 The readings of voltage, current, frequency and power input should be taken. The starting torque and starting current should be extrapolated in accordance with **16.2.2.2.3** for rated voltage, when the test is carried out at reduced voltage.

16.2.2.2.3 For extrapolation of the test results at the rated voltage, the test shall be carried out at least at three test voltages. At each test voltage, the readings of voltage, current, torque, frequency and power input should be taken. Then a curve between values of the current and the applied test voltage should be drawn. Similarly another curve shall be drawn between the torque value and the square of the applied test voltage. The values of starting current and starting torque shall be extrapolated from these curves.

NOTE — Effect of the magnetic saturation is not considered in this test method.

16.2.2.3 *Determination of starting characteristics -locked rotor current*

The locked rotor current of induction machines shall be determined from the result of the test specified in **16.2.2**, by either of the following methods. When the voltage for a constant current varies conspicuously depending on the rotor position at locked rotor test, the minimum value of the voltage shall be adopted.

16.2.2.3.1 *Direct proportion method*

Locked rotor test shall be carried out at a current equal to nearly 100 percent of rated current and the locked rotor current is determined from the result by the following formula:

$$I_{st} = I_{s1} (V_1/V_{s1}) (A)$$

where,

V_1 = rated voltage, in V;

V_{s1} = voltage at locked rotor test, in V; and

I_{s1} = current at locked rotor test (mean value of line currents), in A.

16.2.2.3.2 *Logarithmic proportion method (I)*

Locked rotor test shall be carried out at currents nearly equal to 100 percent and 200 percent of the rated current. The currents I_{s1} and I_{s3} at the locked rotor test and the voltages V_{s1} and V_{s3} corresponding to the currents shall be measured. Locked rotor current is determined by the following formula. This method applied to machines with totally enclosed rotor slots.

$I_{st} = I_{st} (V_1/V_{s1})^B$

$B = 0.7a + 0.35$

$a = \log (I_{s3}/I_{s1})/\log (V_{s3}/V_{s1})$

16.2.2.3.3 *Logarithmic proportion method (II)*

Besides the locked rotor test in the logarithmic proportion Method (I), a locked rotor test shall be performed at a current nearly equal to 150 percent of the rated current. The current I_{s2} at the locked rotor test and the voltage V_{s2} corresponding to the current shall be measured. Locked rotor current is determined by following formula. This method applies to machines with semi-closed and with open rotor slots.

$I_{st} = 1.04\ I_{s3} (V_1/V_{s3})^y$

$y = 1.05y_2 - 0.35 (y_1 - 1)$ (when $y_2 > y_1$)

$= 0.7y_2 + 0.35$ (when $y_2 < y_1$)

$y_1 = \log (I_{s2}/I_{s1})/\log (V_{s2}/V_{s1})$

$y_2 = \log (I_{s3}/I_{s2})/\log (V_{s3}/V_{s2})$

NOTE — The locked rotor current and locked rotor power input values when motor is at temperature stabilized condition and when motor is at ambient temperature, will vary. However, these values may be obtained only from routine test certificate of the motor.

16.2.3 *Full Load Test to Determine Efficiency, Power Factor and Slip*

The tests shall be carried out at rated voltage and rated frequency as given in IS 15999 (Part 2/ Sec 1).

NOTE — For line start / operated permanent magnet motors, efficiency will be determined by direct measurement input-output method for all ratings.

16.2.4 *Temperature Rise Test*

The method of measurement and the requirement shall be as given in 8 of IS 15999 (Part 1). For ratings equal to and above 400 kW, temperature rise test may be carried out as per IEC 60034-29.

16.2.5 *Momentary Overload Test*

The motors shall be capable of withstanding for 15 s without stalling or abrupt change in speed (under gradual increase of torque) 1.6 times their rated torque, the voltage and frequency being maintained at their rated values (at the motor terminals). Motor overloading test can be shown by loading the motor at 160 percent of rated load by direct loading or, mixed frequency method as per IEC 60034-29, for 15 s only.

16.3 Customer Specific Tests

These tests may be carried out as per the mutual agreement between the manufacturer and the purchaser.

16.3.1 *Test for Vibration Severity of Motor*

The test shall be carried out as given in IS 12075. Vibration grade will be normal as per Table 1 of IS 12075.

16.3.2 *Test for Noise Levels of Motor*

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

16.3.3 *Test for Degree of Protection by Enclosure*

The test shall be carried out as given in IS/IEC 60034-5.

16.3.4 *Over Speed Test*

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

16.3.5 *Temperature Rise Test at Limiting Values of Voltage and Frequency Variation*

The tests shall be carried out as given in 8 of IS 15999 (Part 1).

a) Voltage variation specified at **4.3 (a),**
b) Frequency variation specified at **4.3 (b),** or
c) Combination of voltage and frequency specified at **4.3 (a)** and **4.3 (b)**

NOTE — In the case of continuous operation at the extreme voltage limits specified at **4.3 (a)** and **(b),** the temperature rise limits of the winding specified in IS 15999 (Part 1)/IEC 60034-1 shall not exceed by more than 20 K. In such cases, motor may be designed with higher class of insulation. Motors operated under the extreme conditions of voltage and/or frequency specified in **4.3 (a)** and **(b),** the performance values given in Table 1 to Table 4 may not necessarily comply with this standard.

17 TEST CERTIFICATES

17.1 Unless otherwise specified, the purchaser shall accept manufacturer’s certificate as

evidence of compliance of the motor with the requirements of this standard together with a type test certificate on a motor identical in essential details with the one purchased, together with routine tests on each individual motor.

17.2 Certificate of routine tests shall show that the motor purchased has been run and has been found to be electrically and mechanically sound.

18 MARKING AND LABELLING

18.1 Marking on the rating plate shall be as given in **10** of IS 15999 (Part 1).

18.2 The motors will be marked for efficiency as per **15.3**.

18.3 BIS Certification Marking

The motors may also be marked with the Standard Mark.

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

ANNEX A
(Informative Data)

FIELDS OF APPLICATION

A-1 MOTOR TECHNOLOGIES

Table 7 gives information on line-start and energy-efficiency potential of various commonly used motor technologies.

Not all motor technologies are able to reach all efficiency classes nor can motors for all efficiency classes or sizes be produced or operated in an economically feasible way. Therefore, regulators are asked to consider the following constraints when assigning minimum energy efficiency performance standards (MEPS).

Motors marked with "Yes" in Table 7 are considered to be state of present technology and are consequently suitable for consideration in mandatory requirements in legislation.

Table 7 Motor Technologies and Their Energy Efficiency Potential

Sl NO.	Item	Motor type	IE1	IE2	IE3	IE4
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Three-phase cage- rotor induction motors (ASM)	Random wound windings (all enclosures. all ratings)	Yes	Yes	Yes	Difficult
		Form wound windings; lP2x (open motors)	Yes	Yes	Difficult	Yes
		Form wound windings; IP4x and above	Yes	Yes	Yes	Difficult
ii)	Three-phase wound-rotor induction motors		Yes	Yes	Yes	Difficult
iii)	Single-phase induction motors	Start capacitor	Difficult	No	No	No
		Run capacitor	Yes	Difficult	No	No
		Start/run capacitor	Yes	Difficult	No	No
		Split-phase	Difficult	No	No	No
iv)	Synchronous motors	Line-start permanent magnet (LSPM a)	Yes	Yes	Yes	Difficult

Line-start permanent-magnet motors have limitations on their line-start capabilities with respect to torque and external inertia and may not be suitable for all types of applications.

NOTE — with regard to the IE levels. "Yes" means the efficiency class is achievable with present technology (although in some cases it may not be economical); "No" means the efficiency class is not generally achievable with present technology; "Difficult" means that the energy-efficiency level may be achieved with present technology for some but not all power ratings and the standardized frame-size may be exceeded. "Line-start' means the capability of the motor to start direct on-line (Design N of IEC 60034-12 for single-speed. three-phase cage induction motors) without the need for a frequency converter.

Motors covered by this standard may be used in variable-speed drive applications. In such applications the actual efficiency of the motor with variable-speed drive power supply is lower than the rated efficiency with sinusoidal supply, due to increased losses from the

harmonic-voltage content of the variable-speed drive power supply.

The energy efficiency classification of motors in this standard is related to the losses at sinusoidal power supply only.

A-2 DRIVEN MACHINES

As we go higher and higher in efficiency classes, one may have to touch rotor resistance which causes higher efficiency motors to have a lower slip (higher speed).

Driven equipment with square law torque characteristics are very sensitive to increase in power consumption with minimum increase in speed. (Torque ~ $Speed_2$ implies Power ~ $Speed_3$)

User should be aware of the sensitivity of load and energy requirements to rated motor speed while replacing a standard motor with a higher efficiency class motor in a centrifugal pump or fan application. If the motor operates at a higher RPM, an appropriate retrofit arrangement to trim the pump impellers must be adopted to capture the full energy conservation benefits.

Annex B
(*Clause* 2)

LIST OF REFERRED STANDARDS

IS No.	*Title*
IS 1231 : 2019	Dimensions and output series of foot mounted induction motors — Frame numbers 56 to 315 L (*fourth revision*)
IS 1885 (Part 35) : 2021	Electrotechnical vocabulary Part 35 Rotating machinery (*second revision*)
IS 2223 : 1983	Dimensions of flange mounted a.c. induction machines
IS 2254 : 1985	Dimensions of vertical shaft motors for pumps (*second revision*)
IS 3043 : 2018	Code of practice for earthing (*second revision*)
IS/IEC 60034-27-4 : 2018	Rotating electrical machines Part 27 Winding insulation of rotating electrical machines Section 4 Measurement of insulation resistance and polarization index
IS 8223 : 1999	Dimensions and output series for rotating electrical machines (*first revision*)
IS 900 : 2019	Code of practice for storage, Installation and maintenance of induction motors (*third revision*)
IS 12065 : 1987	Permissible limits of noise level for rotating electrical machines
IS 12075 : 2024	Mechanical vibration of rotating electrical machines with shaft heights 56 mm and Higher —Measurement, evaluation and limits of vibration severity (*second revision*)
IS 15999 (Part 1) : 2021/ IEC 60034-1: 2017	Rotating electrical machines Part 1 Rating and performance
IS 15999 (Part 2/Sec 1) : 2023/IEC 60034-2-1	Rotating electrical machines Part 2 Standard Methods for determining losses and efficiency from Tests Section 1 Excluding machines for traction vehicles
IS/IEC 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*)
IS/IEC 60034-8 : 2014	Rotating electrical machines Part 8 Terminal markings and direction of rotation (*third revision*)