

ADOPTION OF HIGHER EFFICIENCY MOTORS



International Copper
Association India
Copper Alliance

INDIAN STANDARD FOR ENERGY EFFICIENT MOTORS

(For Line operated Three Phase A.C. Motors)

Electric motors are a basic need of industry & are known as the "work horses" of industry as it is estimated that motors use about 70% of the total electrical load in industry. Electric motors are used in driving a broad range of industrial applications, such as pumps, compressors, fans or blowers, conveyors and other machines.

The poor efficiency of the substandard motors lead to more energy consumption and energy cost. Therefore improvement in efficiency of the motor must be a part of any comprehensive energy conservation effort.

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 IEC 60034-30-1: 2014, thus defining minimum efficiency performance standards (MEPS) in their countries. Such regulations are expected to impose technical barriers to all the imports of motors which are with lower efficiency classes than the MEPS in to their countries.

Upgrading the Indian Standard inline with International standards also addresses the threat of trade barriers for exports and at the same time arrest the potential influx of inefficient motors in the country.

IS 12615 was first published in 1989 with further revisions were implemented in 2004, 2011 & 2018 to harmonize with the global standards & international best practices to include all the efficiency classes present. Year 2018 was a historical year for LT Motor Industry as with the Quality Control Order(QCO) released by Dept. of Industrial Policy & Promotion(DIPP), **efficiency class IE2 became Minimum Energy Performance Standard(MEPS) in India.**

IS 12615 - PAST & PRESENT

1989

- 1st version of IS: 12615:1989
- Covers 4 pole motors up to 37kw

2004

- 1st revision of IS: 12615-2004
- Extends the range of motors (covers 2P and 4P motors from 0.37kw-160kw, 6P motors from 0.37-132kw 8P motors from 0.37-110kw)
- Efficiency Levels – Eff1 & Eff2 (CEMEP)
- Test method – 60034-2

2011

- 2nd revision of IS: 12615-2011
- Extends the range of motors (covers 2P, 4P and 6P motors from 0.37kw – 375kw)
- Test standard: IS 15999: 2011/ IEC 60034-2-1.
- Efficiency levels – IE1, IE2 & IE3 (IEC60034-30:2008)
- Additional parameters like breakaway torque, current & full load current are included.

2018

- 3rd Revision of IS 12615 :2018
- Extends range up to 1000kW & also includes 8P motors
- Testing Method: As per IS 15999 (Part 2)/IEC 60034-1
- Efficiency Classes: IE2, IE3, IE4 in line with IEC 60034-30-1: 2014
- Motors with customized dimensions different from IS 1231 are also covered by this standard.

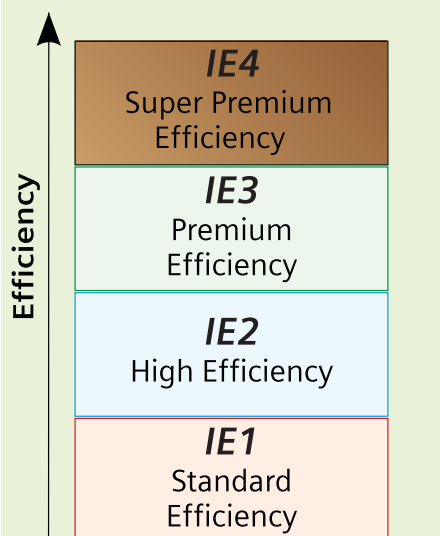
LIKELY FUTURE: Minimum Energy Performance Standard as IE3

HIGHLIGHTS OF IS 12615: 2018

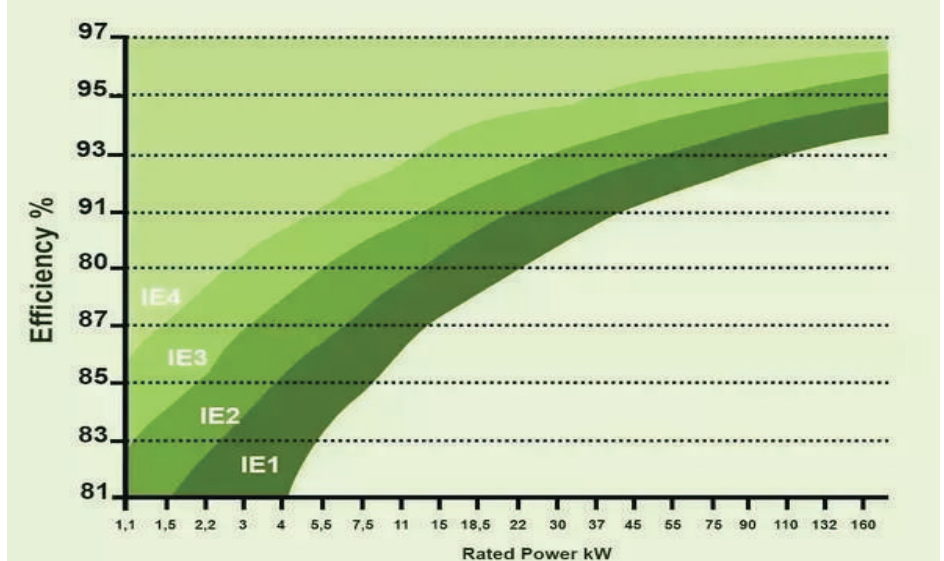
This standard covers the following range of single speed line operated a.c. motors, which:

- Have a rated power from 0.12 kW to 1 000 kW;
- Have 2, 4, 6 or 8 poles
- Have a rated voltage U_n up to 1000 V with a rated frequency of 50 Hz
- Frame size from 56 up to and including 315 M having Frame to output co-relation as specified in Table 3 of IS 1231
- Frame size 315 L with dimensions as per IS 1231 and having output rating as declared by motor manufacturer
- Frame size 355 and above, with dimensions and output ratings as declared by motor manufacturer but conforming to IS 8223
- Are capable of continuous operation at their rated power with a winding temperature rise within the specified insulation temperature class previously.
- Are marked with any ambient temperature within the range of -20°C to $+60^{\circ}\text{C}$
- Are marked with an altitude up to 4000 m above sea level
- This standard covers motors with or without service factor
- 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
- 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

THE MOTOR EFFICIENCY CLASSES ARE AS UNDER:



Note: Motor must at least meet IE2 to be classified as Energy Efficient.



IE Classes - 4 pole motors

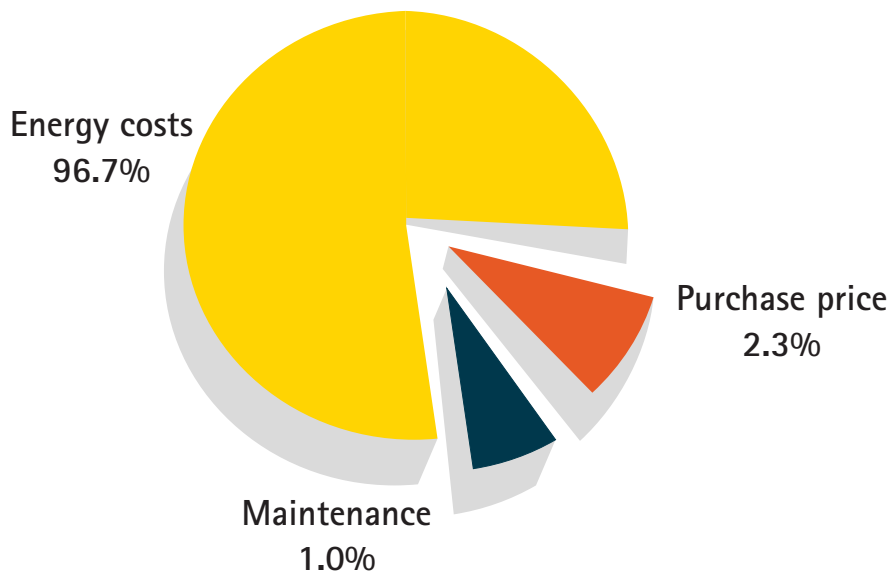
THE VALUES OF EFFICIENCY FOR MOTORS TO CLASSIFY AS IE2, IE3 OR IE4 IN ACCORDANCE WITH THE NEW IS 12615 ARE AS UNDER:

Range (kW)	Frame Size	2 POLE			Frame Size	4 POLE			Frame Size	6 POLE			Frame Size	8 POLE		
		Efficiency (%)				Efficiency (%)				Efficiency (%)				Efficiency (%)		
		IE2	IE3	IE4		IE2	IE3	IE4		IE2	IE3	IE4		IE2	IE3	IE4
0.12	56	53.6	60.8	66.5	63	59.1	64.8	69.8	63	50.6	57.7	64.9	71	39.8	50.7	62.3
0.18	63	60.4	65.9	70.8	63	64.7	69.9	74.7	71	56.6	63.9	70.1	80	45.9	58.7	67.2
0.25	63	64.8	69.7	74.3	71	68.5	73.5	77.9	71	61.6	68.6	74.1	80	50.6	64.1	70.8
0.37	71	69.5	73.8	78.1	71	72.7	77.3	81.1	80	67.6	73.5	78	90S	56.1	69.3	74.3
0.55	71	74.1	77.8	81.5	80	77.1	80.8	83.9	80	73.1	77.2	80.9	90L	61.7	73	77
0.75	80	77.4	80.7	83.5	80	79.6	82.5	85.7	90S	75.9	78.9	82.7	100L	66.2	75	78.4
1.1	80	79.6	82.7	85.2	90S	81.4	84.1	87.2	90L	78.1	81	84.5	100L	70.8	77.7	80.8
1.5	90S	81.3	84.2	86.5	90L	82.8	85.3	88.2	100L	79.8	82.5	85.9	112M	74.1	79.7	82.6
2.2	90L	83.2	85.9	88	100L	84.3	86.7	89.5	112M	81.8	84.3	87.4	132S	77.6	81.9	84.5
3.7	100L	85.5	87.8	89.7	112M	86.3	88.4	90.9	132S	84.3	86.5	89.3	160M	81.4	84.5	86.8
5.5	132S	87	89.2	90.9	132S	87.7	89.6	91.9	132M	86	88	90.5	160M	83.8	86.2	88.3
7.5	132S	88.1	90.1	91.7	132M	88.7	90.4	92.6	160M	87.2	89.1	91.3	160L	85.3	87.3	89.3
11	160M	89.4	91.2	92.6	160M	89.8	91.4	93.3	160L	88.7	90.3	92.3	180L	86.9	88.6	90.4
15	160M	90.3	91.9	93.3	160L	90.6	92.1	93.9	180L	89.7	91.2	92.9	200L	88	89.6	91.2
18.5	160L	90.9	92.4	93.7	180M	91.2	92.6	94.2	200L	90.4	91.7	93.4	225S	88.6	90.1	91.7
22	180M	91.3	92.7	94	180L	91.6	93	94.5	200L	90.9	92.2	93.7	225M	89.1	90.6	92.1
30	200L	92	93.3	94.5	200L	92.3	93.6	94.9	225M	91.7	92.9	94.2	250M	89.8	91.3	92.7
37	200L	92.5	93.7	94.8	225S	92.7	93.9	95.2	250M	92.2	93.3	94.5	280S	90.3	91.8	93.1
45	225M	92.9	94	95	225M	93.1	94.2	95.4	280S	92.7	93.7	94.8	280M	90.7	92.2	93.4
55	250M	93.2	94.3	95.3	250M	93.5	94.6	95.7	280M	93.1	94.1	95.1	315S	91	92.5	93.7
75	280S	93.8	94.7	95.6	280S	94	95	96	315S	93.7	94.6	95.4	315M	91.6	93.1	94.2
90	280M	94.1	95	95.8	280M	94.2	95.2	96.1	315M	94	94.9	95.6	315L1)	91.9	93.4	94.4
110	315S	94.3	95.2	96	315S	94.5	95.4	96.3	315M1)	94.3	95.1	95.8	315L1)	92.3	93.7	94.7
132	315M1)	94.6	95.4	96.2	315M1)	94.7	95.6	96.4	315L1)	94.6	95.4	96	315L1)	92.6	94	94.9
160	315L1)	94.8	95.6	96.3	315L1)	94.9	95.8	96.6		94.8	95.6	96.2		93	94.3	95.1
200 to 1000	As per manufacturer catalogue	95	95.8	96.5	As per manufacturer catalogue	95.1	96	96.7	As per manufacturer catalogue	95	95.8	96.6	As per manufacturer catalogue	93.5	94.6	95.4

LIFE CYCLE COST OF A MOTOR: BY FAR THE MOST SIGNIFICANT COST

Efficiency before purchase price! The cost of buying an electric motor can be deceptive; In a single year the cost of energy can be up to 10 times its purchase cost. So, when buying a new electric motor keep in mind: the electricity consumed by a motor during its lifetime, costs about 100 times more than the motor itself. The investment in a Higher Efficiency Motor generally pays so.

Life cycle costs of 11 kW premium motor (IE) during 15 years with 4000 operating hours per year.



MOTOR: REPAIR OR REPLACEMENT?

Generally, Induction motors are repaired several times during their lifetime. According to a rewinding assessment done by Bureau of Energy Efficiency (BEE) at one of the industrial clusters in Northern Region, average drop in motor efficiency per rewinding is close to 1.03%. An old motor, with a 10-12 years running history and rewind multiple times is typically an inefficient motor.

Repair cost for small and medium range motors say up to 30kW have a significant repair cost (around 45% of its purchase price) so it is recommended that after 3 rewinds the motor should be replaced with a premium efficiency (IE3) motor. Many large process plants have made a policy of replacing small & medium LT motors which have been rewind thrice previously.

FACT CHECK: MOTOR LOAD RESPONSE TO OPERATING SPEED

For centrifugal loads such as fans or pumps, even a minor change in a motor's full-load speed translates into a significant change in load and annual energy consumption.

Law of Affinity indicates that the horsepower loading imposed on a motor by centrifugal load varies as the cube of its rotational speed. In contrast, the quantity of air flow or water delivered varies linearly with speed.

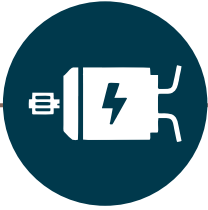
Higher Efficiency motors tend to operate with reduced "slip" or at a slightly higher speed than their standard-efficiency counterparts. A seemingly minor increase in a motor's full-load rotational speed from 1,430 to 1,455 RPM i.e. 1.7% can result in a 5% increase in the load that the rotating equipment places on the motor, completely offsetting the energy and cost savings typically expected as a result of purchasing a Premium efficiency motor.

To maximize energy savings with variable torque loads, be sure while selecting a Premium Efficiency Replacement Motor with a full-load operating speed that is same or lower than that of your original motor. Alternatively, when a motor is controlled with a VFD, replacement motor full-load speed can be matched with the driven equipment to maintain the energy consumption. While for the belt-driven equipment, motor speed is not critical when you can replace pulleys so that the original rotating equipment speed is maintained

Motor Load Type	Common Applications	Energy Considerations
Variable Torque Load <ul style="list-style-type: none">Power [kW] varies as the cube of the rotational speedTorque varies as the square of the rotational speed	<ol style="list-style-type: none">Centrifugal FansCentrifugal PumpsBlowers/Axial FansHVAC SystemsCentrifugal Compressors	Lower speed operation results in significant energy savings as the shaft power of the motor drops with the cube of the rotational speed
Constant Torque Load <ul style="list-style-type: none">Power [kW] varies in direct proportion to rotational speedTorque remain constant at all rotational speeds	<ol style="list-style-type: none">MixersConveyorsPrinting pressesScrew Compressors	Lower speed operation saves energy in direct proportion to the rotational speed reduction.

MOTORS DRIVE PUMPS, FANS AND OTHER CRITICAL DEVICES AROUND YOUR FACILITY, AND THEY CAN LAST FOR AT LEAST 15 YEARS


If your existing motor has been rewound a few times, should you repair it or replace it the next time it's experiencing a maintenance issue? Then ask yourself these questions:

1 

IS THE MOTOR'S RATED OUTPUT LESS THAN 30 KW?

Smaller motors are typically more economical to replace than repair


YES NO

2 

IS THE MOTOR MORE THAN 15 YEARS OLD? OLDER MOTORS HAVE MORE POINTS OF FAILURE.

Technology advances have improved the performance and efficiency of newer units.


YES NO

3 

DOES THE MOTOR REGULARLY OPERATE AT LESS THAN 60% OF RATED LOAD?

This is a sign that the motor may be oversized subject to application requirement. Motor efficiency is greatly reduced when operating at low loads.


YES NO

4 

DOES THE MOTOR OPERATING TEMPERATURE EXCEED ITS RATED TEMPERATURE RISE?

Every 10-degree increase in temperature rise will reduce the expected life of the motor winding by half.

YES NO

5 

ARE YOU USING A VARIABLE FREQUENCY DRIVE WITH A NON-INVERTER-RATED MOTOR?

High frequency pulses from a VFD and heat buildup at low speeds can damage these motors. Inverter-rated motors are hardened to these conditions.

YES NO

If you answered yes to most of these questions, it's probably time to replace the motor. Select a Premium Efficiency Motor (IE3) that's sized correctly to fit your needs.

FAQs

Q1. Which are the targeted application areas to use Higher Efficiency Motors (HEMs) ?

A. Nearly 55% of all loads is utility loads such as fans, pumps and compressors. They make a major target for IE3 applications. After choosing major loads, select those with over 16 hours of operation in a day to sustain the gains of IE3 motors. Also motors with loading factor or loading percentage greater than 60% should be initially targeted.

Q2. Are Higher Efficiency Motors (HEMs) suitable for use with adjustable speed drives (VFDs)?

A. Today leading manufacturers over HEMs (IE3 & above) with appropriate insulation having Dual coat wire and VPI treatment which makes it suitable for use with VFDs. However, if VFDs are improperly installed or used with unsuitable applications, negative side effects may occur when applying them to motors, regardless of the motor's efficiency. Negative side effects can include greater vibration, heat rise and an increase in audible noise. The high switching frequency that may occur with VFDs can cause a high rate of voltage rise, which in turn can cause insulation breakdown of the end turns of motor windings.

Q3. If higher efficiency motors have a higher starting current than lower efficiency motors, do they cause breakers to trip?

A. As motors with higher efficiencies have lower transient reactance than lower efficiency motors, their starting current can spike higher than the full-load current of less efficient motors. This very high starting current may cause the nuisance tripping of Instantaneous Trip Circuit Breakers (ITCB), though no fault or short circuit has occurred. However, starting current varies widely at each efficiency level. Type 2 coordination is a chart made available by the BIS as well as IEC (IS/IEC 60947-4-1) for control and protection components. If higher starting current is seen as fault current, the relay may get tripped. Type 2 coordination for IE2, IE3 and IE4 motors are published.

Q4. Any special protection requirement of IE3 motors? Do we need to delay the operation of protection?

A. The IE3 motors achieve their efficiency by reducing resistive losses in the motor windings (among other factors). These motors draw a very high inrush current greater than IE2 and IE1 motors, as well those of standard motors. For high inertia loads (fan & pumps) with greater than 10 seconds starting duration, class 20 or class 30 relay may be used. Use of microprocessor adjustable relays are recommended rather than thermal relays.

Q5. Is it true that Higher Efficiency Motors have a lower starting torque and may not be able to accelerate the load?

A. No. Starting torque, also referred to as locked rotor torque, is the minimum torque produced by the motor at rated voltage and frequency, at all angular positions of the rotor. On average, starting torque does not vary significantly for motors with different efficiency levels of the same size. When selecting a motor, it is important to specify needed starting torque because it varies widely across motor sizes and models. This is especially critical when sizing a higher efficiency motor replacement with E 1 series of motor.

Q6. Are there any specified Power quality limits (voltage, frequency, harmonics etc.) for smooth and reliable motor operation?

A. Power Quality limits shall be same as it is applicable for currently installed standard motors. A disclaimer is mentioned in IS: 12615/1989 for voltage variations which holds true for all efficiency class of motors not limited particularly to IE3 motors. The excerpt from IS 12615 is given below: - It may be noted that the efficiency and PF of the motor is affected by the variation in the supply voltage conditions and hence it is felt necessary to emphasize that the supply voltage condition should be stable to obtain the desired effect in conservation of energy. Otherwise, if the supply voltage conditions are not stable, the improvement in the efficiency of the motor will have only a marginal affect in the energy conservation.

Q7. Is there any special maintenance practices to be followed?

A. Maintenance practices are same for all motors in general though as a good practice for proper maintenance we should consider proper cable selection, feeder distance, harmonic protection, VFD duty compatibility, high temperature synthetic grease (Unirex N3), use proper mounting and dismounting tools for the bearings and proper alignment of the shafts.

Q8. Whether we need additional capacitor banks to compensate Low PF with new IE3 motor?

A. PF values for all E. class are mentioned in manufacturer's catalogue which has a slight incremental change. In order to avoid additional PF correction capacitors, we should optimally size the motor ratings such that the PF remains high. PF at partly loaded motors is very low.

ABOUT INTERNATIONAL COPPER ASSOCIATION INDIA

The International Copper Association India (ICA India) is a member of Copper Alliance and the Indian arm of the International Copper Association Limited (ICA), the leading not for profit organization for the promotion of copper worldwide set up in 1959.

ICA India was formed in 1998 to actively associate with the growing number of copper users in India. With a mission to "Bring together the global copper industry to develop and defend markets for copper and to make a positive contribution to society's sustainable development goals"

ICA India is a knowledge based organization that has the expertise and ability to implement market transformation projects. It provides a platform that represents a "non-commercial" voice by a group of independent and credible experts. ICA India conducts programs in the interest of Electrical Safety, Energy Efficiency and Sustainability. Employing a mix of market development and regulation advocacy approach to encourage the use of copper.

OUR CURRENT INITIATIVES:

- Encourage safe house wiring practices in the Building Construction sector
- Increase awareness of Power Quality through Asia Power Quality Initiative Platform (APQI)
- Reduce distribution losses in the Power sector by promotion of low loss Distribution Transformers
- Propagate the use of Energy Efficient Motors for energy savings in Industries
- Promote 5 mm Microgroove Copper Tube heat exchangers technology to OEMs

ICA India drives its program through interactive workshops across India in collaboration with like-minded organizations, institutions and trade bodies. It also publishes technical handbooks, training manuals and brochures aimed at spreading awareness and in-depth knowledge on the benefits of copper and its use in technology.

Our Program Partners:  **Bharat Bijlee**  **GRUNDFOS**  **SIEMENS**

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