European Commission

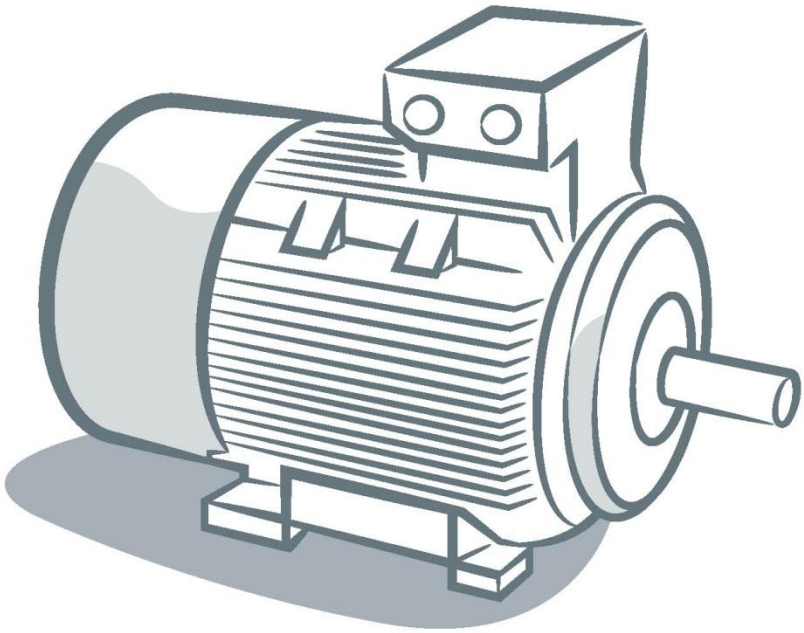
Guidelines accompanying

December 2014

Commission Regulations (EC) No 640/2009 of 22 July 2009 implementing Directive 2005/32/EC with regard to **ecodesign requirements for electric motors**

and

No 4/2014 of 6 January 2014 amending Regulation (EC) No 640/2009



Energy

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1. PURPOSE OF THE GUIDELINES AND DISCLAIMER

The Ecodesign and Energy Labelling regulations for electric motors were published in 2013. The regulations establish minimum requirements for the products in scope. These guidelines aim to help relevant stakeholders, including industry and public authorities, to implement the Regulation in practice. They summarise the most relevant information from the regulations to give SMEs an introduction to the subject matter and answer the most common questions.

The guidelines are intended to be used only for facilitating the implementation of the Regulations. They are not intended to replace the Regulations or to provide "interpretation" beyond their intent. The guidelines only reflect the opinion of the Commission services and are not legally binding. A finally binding legal interpretation of EU legislation may only be provided by the European Court of Justice. The guidelines are without prejudice to the position the Commission might take should an issue arise in a procedure before the European Court of Justice.

1.1. The Regulations

The Commission has published the following regulations concerning electric motors:

- Commission Regulation (EU) No 640/2009 of 22 July 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for electric motors[1];
- Commission Regulation (EU) No 4/2014 of 6 January 2014 amending Regulation (EC) No 640/2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for electric motors[2].

2. SCOPE

An "electric motor" is usually defined as a device that converts electric energy into mechanical energy. The ratio of this conversion gives us its efficiency:

$$Efficiency = \frac{Output\ mechanical\ power}{Input\ electrical\ power}$$

For the purposes of Regulation 640/2009, "motor" means an electric single speed, three-phase 50 Hz or 50/60 Hz, squirrel cage induction motor that:

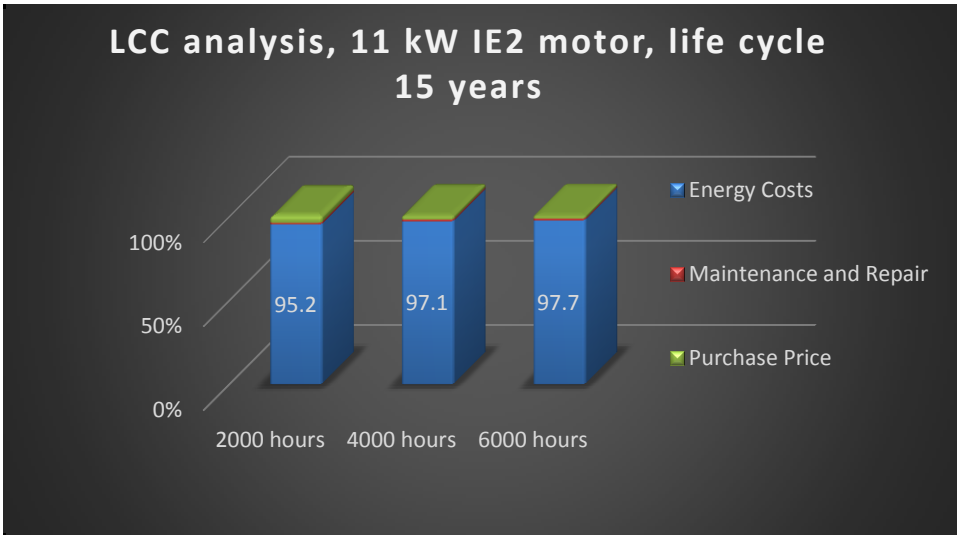
- has 2 to 6 poles;
- has a rated voltage up to 1000 V;
- has a rated power output between 0,75 kW and 375 kW;
- is rated on the basis of continuous duty operation.

[1] OJ L 191, 23.7.2009, p. 26.
[2] OJ L 2, 7.1.2014, p. 1.

In consequence the current Regulation covers part of the motors present in the market, those that comply with the definition of motor and are not subject to the exclusions indicated in Article 1.

Machines driven by electrical motors consume around 2/3 of all the electrical energy used in industry, which has also a great impact on the environment.

Since induction motors typically work for a large number of hours and have relatively long lifetimes, the greatest share of its environmental impact is in the use-phase. Hence, reducing motors' energy consumption, by increasing their efficiency, reduces its environmental impacts as well as its operational costs. The following graphic shows the result of a simple life cycle cost analysis (LCC) of a motor with 2, 4 and 6 thousand operating hours per year. This supports the fact that a higher initial purchase cost of a more efficient motor will, in fact, bring higher savings within short payback periods.



LCC analysis, 11 kW IE2 motor, life cycle 15 years (Source: (Almeida, Ferreira, Fong, & Fonseca, 2008)

The importance of electric motor systems as a major electricity consumer has been recognised for a long time, with a series of successful SAVE[3] studies showing the energy saving potential for these products. Recent ErP[4] studies on motors (Lot 11 and Lot 30) highlighted the importance of Minimum Efficiency Performance Standards (MEPS) related to these products in Europe. On the follow up of the Lot 11 study, the EU adopted a regulation regarding Ecodesign requirements for electric motors. The potential accumulated savings of this regulation are estimated at 657 TWh from 2010 till 2020.

This guide will help understand the implications that recent legislation and requirements have brought to electric motor´s manufacturers and suppliers, and how to comply with them towards a more energy efficient European market.

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3 Improving the Penetration of Energy- Efficient Motors and Drives, SAVE, 2000
Barriers Against Energy-Efficient Motor Repair, SAVE, 1999
VSD's for Electric Motor Systems, SAVE, 2001
Actions to promote energy efficient electric motors, SAVE, 1996

4 Energy related Products

3. HISTORIC DEVELOPMENTS

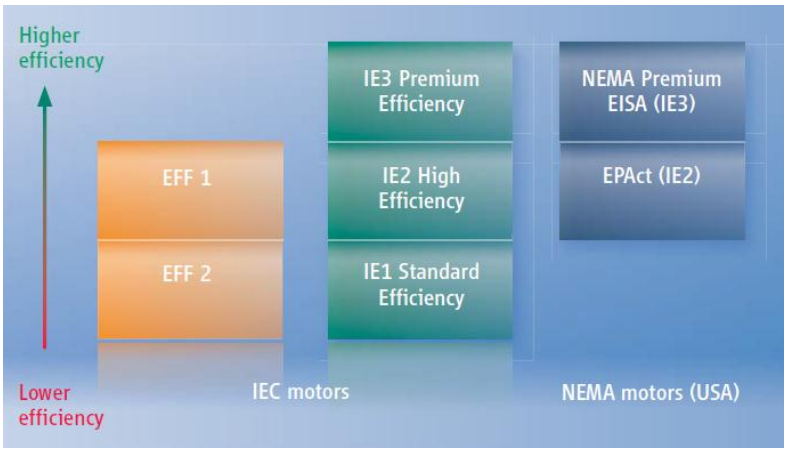
A voluntary agreement supported by CEMEP[5] and the European Commission was established in 1999 to define a motor classification scheme with three efficiency levels, EFF3, EFF2 and EFF1. The CEMEP/EU agreement was a very important first step to promote motor efficiency classification.

EFF3	Low efficiency level	1,1 kW < P < 90 kW (electric motor power range)
EFF2	Improved efficiency level	
EFF1	High efficiency level	

Meanwhile, other national systems were being developed (e.g. NEMA in the USA), being very different from the European system. This led the International Electrotechnical Commission (IEC) to develop a common international standard that would replace all the different national systems. Hence, IEC 60034-30:2008 was created and defined the following efficiency classes for 3-phase motors:

No designation	Below standard efficiency	(equivalent to EFF3 in the obsolete classification)
IE1	Standard efficiency	0,75 kW < P < 375 kW (electric motor power range)
IE2	High efficiency	
IE3	Premium efficiency	
IE4	Super premium efficiency	(no commercially available in 2008)

The following figure establishes a correlation between the different efficiency classifications previously mentioned.



[5] European Committee of Manufacturers of Electrical Machines and Power Electronics.

EFF, IE and USA's code efficiency classes comparison. Source: (ZVEI)

Recently, IEC 60034-30:2008 has been replaced by IEC 60034-30-1:2014. The IEC 60034-30-1:2014 has extended the scope of the standard, covering motors with a power range between 0,12 kW and 1000 kW.

A second step was the establishment of Ecodesign requirements for electric motors, aiming to improve the penetration of high-efficiency electric motors in the European market.

On 22 July 2009, Regulation 640/2009[6], specifying requirements regarding the Ecodesign of electrical motors and the use of a variable speed drives (VSD), was adopted. More recently the 640/2009 regulation was amended by Commission Regulation 4/2014. These regulations set mandatory minimum efficiency levels for motors in the European market.

4. SCOPE AND REQUIREMENTS

4.1. Scope

Regulation 640/2009, amended by Regulation 4/2014, covers 2-, 4- and 6-pole, single speed, three-Phase induction motors rated up to 1.000 V and on the basis of continuous duty operation.

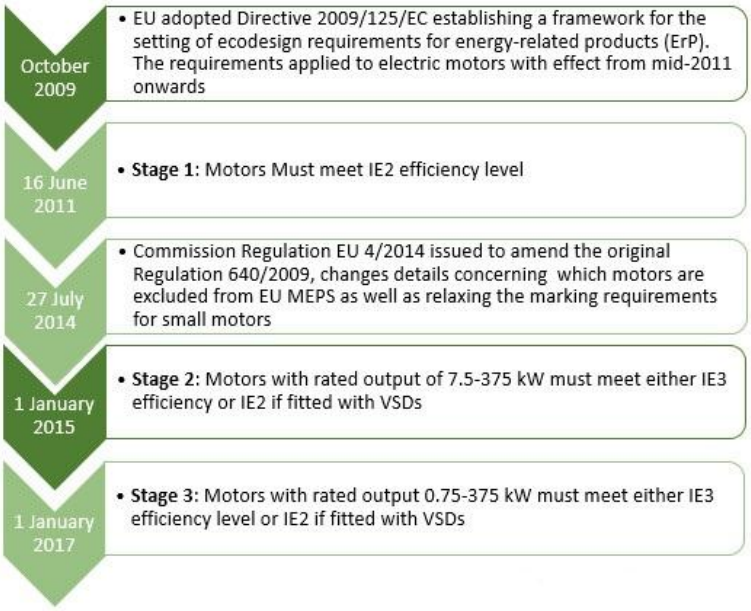
Excluded are:

- Motors designed to operate wholly immersed in a liquid;
- Motors completely integrated into a product (e.g. pump or fan) where the motor's energy performance cannot be tested independently from the product;
- Motors specifically designed to operate:
    - At altitudes exceeding 4000 meters;
    - Where ambient air temperatures exceed 60°C;
    - In maximum operating temperatures above 400°C.
    - Where ambient air temperatures are less than –30°C (any motor) or less than 0°C (water-cooled motors);
    - Where the water coolant temperature at the inlet to a product is less than 0°C or exceeds 32°C;
    - In potentially explosive atmospheres as defined in Directive 94/9/EC;
- Brake motors.

4.2. Requirements

The timing of coming into force of requirements is presented in the figure below:

[6] OJ L 191, 23.7.2009, p. 26.



Ecodesign implementation timeline.

In addition to the minimum ecodesign requirements, information requirements also apply to electric motors.

From June 2011, the motor information must be visibly displayed on:

- Motors technical documentation
- Technical documentation of products in which motors are incorporated
- Free access manufacturers web-sites
- Free access web-sites of manufacturers of products in which motors are incorporated

It is to be noted that the information shall be easily understood by end-users and by market surveillance authorities. Regarding technical documentation, the information must be provided in the order as presented below in points 1 to 12. The exact wording used in the list does not need to be repeated. It may be displayed using graphs, figures or symbols rather than text, however, the information needs to be visible and recognizable immediately:

1) nominal efficiency (η) at the full, 75 % and 50 % rated load and voltage (U_N)[7], except where the size of the rating plate is insufficient[8];
2) efficiency level: 'IE2' or 'IE3';
3) the year of manufacture[9];

[7] The efficiency of an electric motor is defined in IEC 60034-2-1:2007 as "the ratio of output power to input power expressed in the same units and usually given as a percentage".

[8] The size of the rating plate is to be considered insufficient when, if all the information requested by this Regulation and any other relevant legislation is provided, the necessary font size for providing all the information would be unreadable. As reference, Regulation 1169/2011 on the provision of food information to consumers (OJ L 304, 22.11.2011, p. 18) requires the use of characters with an x-height of at least 1.2 mm.

4) manufacturer's name or trade mark, commercial registration number and place of manufacturer[10];
5) product's model number;
6) number of poles of the motor;
7) the rated power output(s) or range of rated power output (kW);
8) the rated input frequency(s) of the motor (Hz);
9) the rated voltage(s) or range of rated voltage (V);
10) the rated speed(s) or range of rated speed (rpm);
11) information relevant for disassembly, recycling or disposal at end-of-life;
12) information on the range of operating conditions for which the motor is specifically designed:
    i. Altitudes above sea-level;
    ii. Ambient air temperatures, including for motors with air cooling;
    iii. Water coolant temperature at the inlet to the product;
    iv. Maximum operating temperature;
    v. Potentially explosive atmospheres.

The information referred to in points 1, 2 and 3 shall be durably marked on or near the motors nameplate. The information listed in points 1 to 12 does not need to be published on motor manufacturer's free access website for tailor-made motors with special mechanical and electrical design manufactured on the basis of client request. Manufacturers also have to provide information in the technical documentation files on any specific precautions that must be taken when motors are assembled, installed, maintained or used with VSDs, including information on how to minimise VSDs electrical and magnetic fields.

The next figure has an example of such nameplates.

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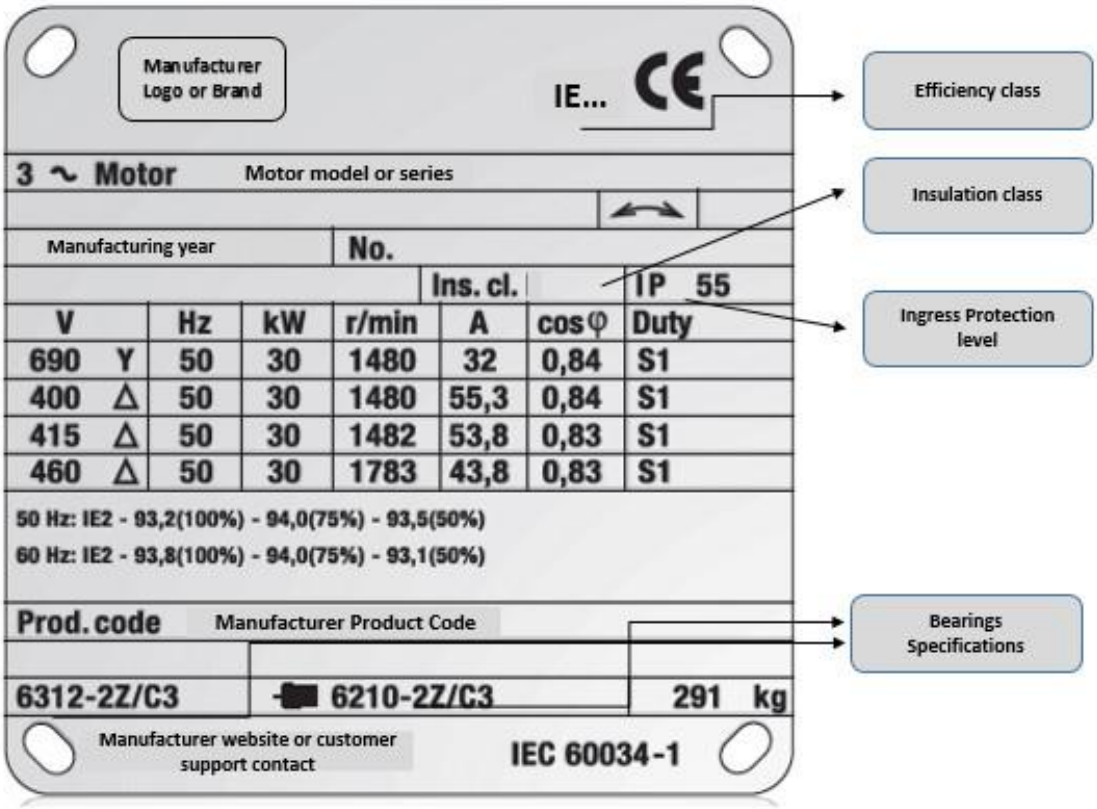
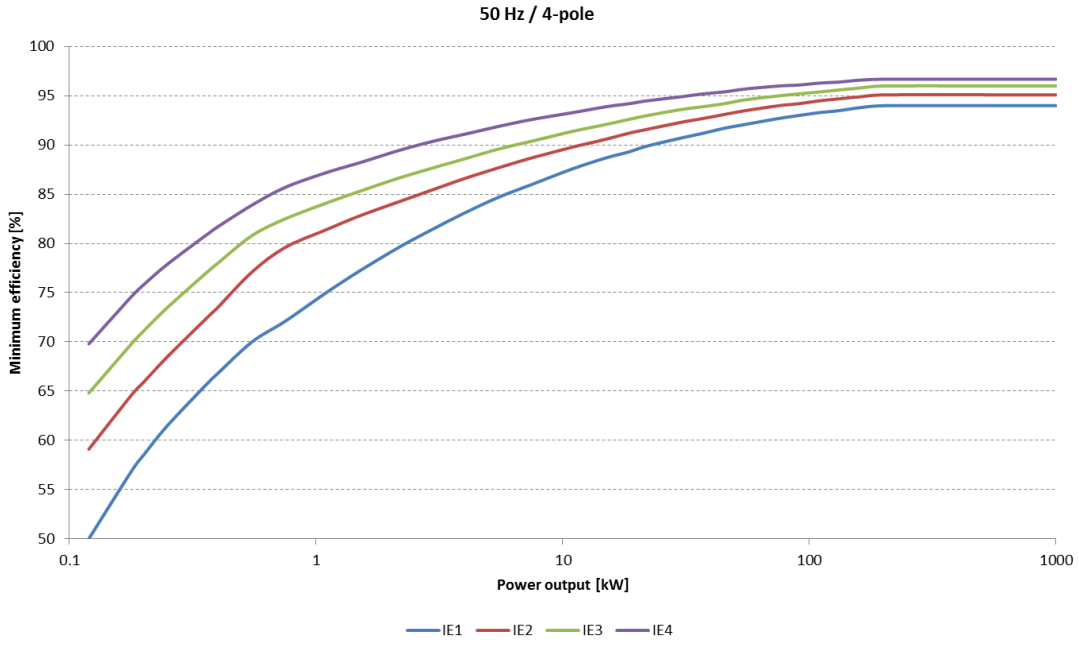
[9] The year of manufacture is not only meant for the manufacturer. For market surveillance authorities and consumers the year of manufacture must be apparent. If it is not practical to declare the full year of production (e.g. very small motors), the information can be given in code form if this code is explained in accompanying written information.

[10] The "place of manufacturer" is to be understood as the headquarters postal address of the manufacturer in order to allow market surveillance authorities to contact the manufacturer when necessary.



Example of an electrical motor nameplate.

The IE classification of electric motors is presented in standard IEC 60034-30-1:2014 for each class (IE1-IE4). Specific efficiency levels and interpolation rules, both for 50 and 60 Hz 2-, 4-, 6- and 8-poles motors are available in IEC 60034-30-1. The IE4 Super-Premium Efficiency class is also newly defined in this version of the standard.



IE class for 50 Hz 4-pole motors according to IEC 60034-30-1:2014

5. MEASUREMENTS

Regulation 640/2009 specifies that the measurements and calculations during tests shall be performed using a reliable, accurate and reproducible method. Such method shall be recognised as the state-of-the-art, and its results should be associated with low uncertainty.

In addition, titles and references of harmonised standards have been published in the OJEU for electric motors under Commission Communication 2012/C 394/06[11].

The standards cited are[12]:

- EN 60034-2-1:2007 Rotating electrical machines — Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles);
- EN 60034-30:2009 Rotating electrical machines — Part 30: Efficiency classes of single-speed, three-phase, cage-induction motors (IE-code).

The determination of total losses shall be carried out by one of the following methods:

- Measurement of total losses;
- Determination of separate losses for summation (P_{LL} determined from residual loss)

Motor losses can be split into five major areas:

- copper losses (determined from input power, voltage, current, rotational speed and torque)
- iron losses (determined from input power, voltage, current, rotational speed and torque)
- rotor losses (determined from input power, voltage, current, rotational speed and torque)
- friction and windage losses (determined from input power, voltage, current, rotational speed and torque)
- additional load losses (P_{LL}) (much more difficult to determine, IEC/EN 60034-2-1 specifies different methods of determining PLL which involve low, medium or high uncertainty.)

The test methods recommended by Regulation 640/2009 are the same as the ones indicated in IEC60034-30-1:2014, where the efficiency classification is based on the preferred testing methods specified in the latest version of IEC 60034-2-1.

The motor documentation must state which method was used and efficiency values provided by different motor manufacturers should only be comparable if the same measuring method has been used.

[11] OJ C 394, 20.12.2012, p. 20.

[12] New versions of the standards have been published in 2014.

6. MARKET SURVEILLANCE

Member states are responsible for carrying out market surveillance activities performed by nominated official bodies.

Authorities of the Member States shall verify the compliance of the regulation 640/2009 by following a verification procedure as follows:

- A single unit shall be tested;
- If in the efficiency of the motor at full load, the losses of the unit being tested do not vary from the values set out in Annex 1 of Regulation 640/2009 by more than 15% in the power range of 0.75 – 150 kW and 10% in the power range > 150 – 375 kW, the model complies with the requirements of the respective regulation;
- In case that there is no compliance, the market surveillance authority shall randomly test three additional units following the same procedure described in point II.
- If the results are not achieved when performing tests for the samples set out in point III, the model shall be considered not to comply with the Regulation.

Example: *For a 1.5 kW IE2 motor with 4 poles, the minimum efficiency level is 82,8% according to Table 1 of the Regulation. The tolerance to be applied is 0.15 · (1 – 0.828) = 0.0258, or 2.58%.*

For a 160 kW IE3 motor with 6 poles, the minimum efficiency level is 95,6% according to Table 2 of the Regulation. The tolerance to be applied is 0.1 · (1 – 0.956) = 0.0044 or 0.44%.

7. FREQUENTLY ASKED QUESTIONS

Several frequent questions are presented below in addition to the questions and answers published on:

http://ec.europa.eu/enterprise/policies/sustainable-business/documents/eco-design/guidance/index_en.htm

Are inverter operated motors excluded from the requirements?

Operation with an inverter does not exclude the motor from the scope of the Regulation. When the motor is labelled for mains operation, it must meet the regulation and such motor must be designed as IE2 as of June 16, 2011. Motors specified to operate exclusively with a VSD (motors that cannot be used directly online) are excluded from the Regulation.

Is repairing and re-installing non-compliant motors allowed?

Yes, manufacturers may repair motors and deliver these repaired drives back to the customer also after the date of coming into force of the requirements. Repairing is not considered as a new placing on the market and hence the requirements do not apply.

What is the exact definition of continuous duty?

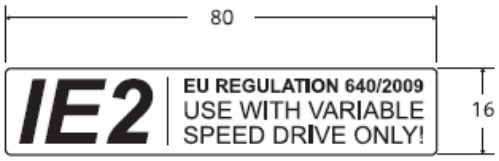
The Regulation states that motors rated for continuous duty are covered. This means motors are capable of continuous operation at their rated power with a temperature

rise within the specified insulation temperature. Apart from motor rated for (S1) continuous operation other duty cycles are to be considered continuous duty: S6 continuous duty with intermittent loads, or S9 continuous duty with non-periodic load and speed variations, or S3 intermittent duty with a continuous duty factor of 80% or more.

Duty types are defined in IEC 60034-1:2010 Rotating electrical machines – Part 1: Rating and performance.

Indication of the necessity to equip IE2 motors with a variable speed drive

From 1 January 2015, motors which do not meet the IE3 efficiency level need to be equipped with a variable speed drive. Information about the obligation of using a VSD shall be visibly displayed on the rating plate or an additional sticker/plate and on the technical documentation of the motor. Examples of the layout that can be used are found below.



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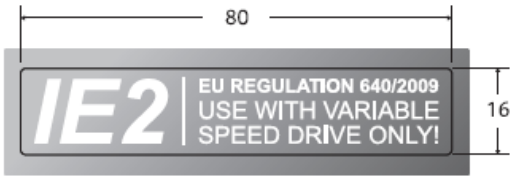

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