



**MODEL REGULATION GUIDELINES**

**JULY 2019**

# ENERGY EFFICIENCY REQUIREMENTS FOR GENERAL PURPOSE ELECTRIC MOTORS



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## Foreword

The Model Regulation Guidelines are a supplement to the UN Environment Programme Programme’s United for Efficiency (U4E) Electric Motors Policy Guide “Accelerating the Global Adoption of Energy-Efficient Electric Motors and Motor Systems.”<sup>1</sup> It is intended for use by regulatory authorities in developing and emerging economies<sup>2</sup> with 50 Hz and 60 Hz power systems that are considering a legislative framework<sup>3</sup> to promote energy-efficient electric motors, or those that have a legislative framework but have not yet developed regulations for energy-efficient electric motors.

The Model Regulation Guidelines includes means to regulate a transition from inefficient general purpose, three-phase electric induction motors in the 0.75 kW to 375 kW range, to the international best practice efficiency levels. This range represents around two-thirds of the energy consumed by motors, globally. It includes all the key elements that are needed: definitions, scope, performance requirements, information requirements, applicable test methods and compliance criteria.

This Model Regulation Guidelines does not cover motors outside the 0.75 kW to 375 kW range, single-phase motors, motors designed for special applications or motor systems. In the future, U4E will consider developing and publishing similar guidance on model regulation documents to cover some of these, in particular, variable speed drives, the use of which can save considerable energy in applications requiring a variable speed, such as pumps, fans and compressors.

Using this Model Regulation Guidelines, countries that do not have a significant domestic motor manufacturing industry and import almost all motors, can choose to leapfrog to a “premium energy efficiency option” (A), the current international best practice. Other countries that do have a significant domestic motor manufacturing industry can choose a more gradual transition via a “high energy-efficiency option” (B), in order to provide it with (limited) additional time for upgrading technology.

This model regulation is a supplement to the Motors Policy Guide<sup>1</sup> which is one of a series of United for Efficiency reports along with lighting, room air conditioners, residential refrigerators and power transformers. As is described further in the Motors Policy Guide, United for Efficiency encourages countries to implement an integrated policy approach, which includes the following components:

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<sup>1</sup> Please visit the “United for Efficiency Policy Guide on Energy-Efficient Electric Motors and Motors Systems” for more information. (<https://united4efficiency.org/resources/accelerating-global-adoption-energy-efficient-electric-motors-motor-systems/>)

<sup>2</sup> This model regulation is not intended for governments that already have effective regulations and policy processes for energy-efficient electric motors in their country or region.

<sup>3</sup> An effective legislation framework consists of regulatory requirements which can be verified and enforced. In this sense, it’s recommended that the regulation include a collection of requirements which are based primarily on testing protocols and requirements set by the International Electrotechnical Commission (IEC) or their national mirror standards.

- Standards and regulations;
- Supporting policies (e.g. communication, information and education campaigns);
- Finance and financial delivery mechanisms;
- Monitoring, verification, and enforcement; and
- Environmentally sound management.

Please visit <http://united4efficiency.org/> for more information about United for Efficiency.

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## Subject Matter and Structure

This model regulation addresses the following for general purpose, three-phase electric induction motors with two, four, six and eight poles; rated output between 0.75 kW-375 kW (i.e. 1 HP to 500 HP); rated voltage up to 1,000 Volts at 50 and 60 Hz; and continuous duty operation:

- energy efficiency performance requirements;
- product information reporting and labelling requirements;
- demonstrating compliance with the requirements; and
- market surveillance and enforcement of the requirements.

This model regulation does not cover requirements on mechanical construction, functional performance, safety, hazardous substances or warranty, since these requirements are not primarily related to energy performance and are typically covered by relevant International Electrotechnical Commission (IEC) standards and their corresponding mirror national standards, or parallel regulations on these same products. When developing these requirements, countries should investigate and confirm that these other requirements are covered in parallel regulations; if not they could be considered for inclusion in this regulation.

The model regulation includes two options, to facilitate use by governments when initiating their national consultative policy-making processes. Countries would choose either Option A or B:

- **Option A** offers a draft policy framework designed to leapfrog directly to energy-efficiency class IE3, which is the current international best practice policy. This is suitable for countries that do not have a significant domestic motor manufacturing industry and import almost all motors,
- **Option B** offers a draft policy framework to other countries that do have a significant domestic motor manufacturing industry and opt for a graduated transition via energy-efficiency option IE2, in order to provide industry with additional, but limited time for technology updating.

The UAE programme encourages countries to use Option A because it offers greater energy savings potential. By using option A, countries also avoid being locked into inefficient technology paths for a decade or two, which is the typical life span for electric motors.

It should be the eventual objective of countries to adopt super-premium energy-efficiency (IE4) to reflect the increasing availability of these motors in the international marketplace, and in line with the new global best-practice regulations coming into effect in the EU in July 2023.

The policy guidance presented in this document is meant to be a starting point for policy-makers in developing and emerging economies, to encourage regional harmonisation where possible, lowering costs and removing barriers to trade. The work presented in this supplement represents the best available information at the time of publication, however the authors recognise that the IEC standards that underpin the metrics and requirements set out in this report are evolving, thus countries are encouraged to investigate current requirements and standards at the time of adoption.

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## Acronyms

CAR	Conformity Assessment Report
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
UN	United Nations
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
UNDP	United Nations Development Programme
U4E	United for Efficiency

## Article 1. Scope of Covered Products

### 1.1 Scope

This regulation applies to all single-speed electric induction motors that are manufactured in or imported<sup>4</sup> into the country/region, and are either sold as standalone equipment or as a component of a motor-driven unit, and which meet the following criteria:

The motors:

- are rated for performance and operating characteristics according to IEC 60034-1<sup>5</sup> or the equivalent NEMA MG1 Standard; and
- have frame sizes according to IEC 60072-1<sup>6</sup> or equivalent NEMA frame sizes; and
- are rated for operation on a three- phase sinusoidal voltage supply; and
- have a rated power from 0.75 kW to 375 kW; and
- have 2, 4, 6 or 8 poles; and
- have a rated voltage of 50 Volts and above, up to and including 1,000 Volts; and
- have a rated frequency of 50 Hz or 60 Hz; and
- are capable of continuous operation at their rated power with a temperature rise within the limits of the specified insulation temperature class<sup>7</sup>; and
- are designed to operate in any ambient temperature within the range of -30°C to + 60 °C<sup>8</sup>; and
- are designed to operate at any altitude up to 4000 m above mean sea level<sup>9</sup>.

Motors which are rated for both fixed speed operation (i.e. directly on line) and variable speed operation (e.g. through an inverter or converter), are within the scope of this regulation, but shall bear the IE efficiency class (in accordance with IEC 60034-30-1) for fixed speed operation only.

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<sup>4</sup> The motors within the scope of this regulation fall within International Customs HS codes 850152 and 850153 (necessary, but not sufficient condition).

<sup>5</sup> IEC standards undergo revisions from time to time. The latest version of a standard as on the date of issuance of this regulation shall be referenced. Subsequent revisions if any, shall be ignored.

<sup>6</sup> It is not necessary for the motors to have flanges, feet and/or shafts with mechanical dimensions conforming to IEC 60072-1. Geared motors including those incorporating non-standard shafts and flanges are also covered by this regulation.

<sup>7</sup> Most motors covered by this regulation are rated for duty type S1 (continuous duty), S3>80% and S6>80%. However, some motors that are rated for other duty cycles are still capable of continuous operation at their rated power and these motors are also covered.

<sup>8</sup> The rated efficiency and efficiency classes are based on 25 °C ambient temperature according to IEC 60034-2-1

<sup>9</sup> The rated efficiency and efficiency class are based on a rating for altitudes up to 1 000 m above sea level.

The regulation applies to induction motors with squirrel-cage rotors as well as with wound-rotors.

## 1.2 Exclusions

This regulation does not apply to

- Motors other than induction motors;
- Induction motors that are rated for operation on a single-phase power supply;
- Induction motors that are mechanically or electrically integrated into the motor-driven unit to the extent that these are incapable of independent operation even if a temporary end shield or a drive end bearing is fitted;
- Motors rated for temperatures outside the range specified in Section 1.1 above as these are of special construction<sup>10</sup>;
- Motors specifically designed to operate wholly immersed in a liquid;
- Multi-speed motors, torque motors;
- Totally enclosed non-ventilated (TENV) motors IC410; Motors with cooling methods other than IC0Ax, IC1Ax, IC2Ax, IC3Ax or IC4Ax (see IEC 60034-6);
- Motors intended for use in explosive atmospheres and certified as “Ex eb” increased safety motors, as defined in IEC EN 60079-7:2015 (other explosion-protected motors certified as “Ex ec”, “Ex tb” or “Ex tc” are however included in the scope of this regulation)<sup>11</sup>;
- Motors with an integrated brake which forms an integral part of the inner motor construction and can neither be removed nor supplied by a separate power source during the testing of the motor efficiency;
- Motors for special requirements of the driven machine beyond the requirements of the IEC 60034 series of standards (such as motors for heavy starting duty, special torque stiffness and/or breakdown torque characteristics, large number of start/stop cycles, very low rotor inertia);
- Motors for special characteristics of the grid supply beyond the requirements of the IEC 60034 series of standards (such as motors with limited starting current, increased tolerances of voltage and/or frequency);
- Motors that will be exported to other countries, provided that these meet with the alternative requirements of the importing countries, if any;
- Motors covered by International Customs HS codes other than 850152 and 850153.

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<sup>10</sup> However, smoke extraction motors with a temperature class of up to and including 300 °C are covered by this regulation.

<sup>11</sup> It is intended to include “Ex eb” increased safety motors within the scope of this regulation at a later date (to be announced) as well, albeit at an IE level which is one step lower than the current MEPS for other motors.

## Article 2. Terms and Definitions

- (a) 'arithmetical mean' means the average of a set of numerical values, calculated by adding them together and dividing by the number of terms in the set.
- (b) 'compliance' means conforming to a rule, such as a law, policy, specification or standard. Also, fulfilment by countries/businesses/individuals of emission reduction and reporting commitments under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol.
- (c) 'Conformity Assessment Report' (CAR) means the documentation prepared by the manufacturer or importer of the electric motor which contains the compliance declaration, the evidence, and the test reports to demonstrate that the product is fully compliant with all applicable regulatory requirements.
- (d) 'Cooling' stands for a procedure by means of which heat resulting from losses occurring in a motor is given up to a primary coolant, which may be continuously replaced or may itself be cooled by a secondary coolant in a heat exchanger.
- (e) 'Direct efficiency determination' means a method by which the determination of efficiency is made by measuring the input power and the output power directly.
- (f) 'Duty' means the statement of the load(s) to which the motor is subjected, including, if applicable, starting, electric braking, no-load and rest and de-energised periods, and including their durations and sequence in time.
- (g) 'Duty type' means a continuous, short time or periodic duty, comprising one or more loads remaining constant for the duration specified, or a non-periodic duty in which load, and speed vary within the permissible operating range.
- (h) 'Efficiency' means the ratio of output power to input power expressed as a percentage.
- (i) 'Full load' means the load that causes a motor to operate at its rating.
- (j) 'Full load value' means a quantity value for a motor operating at full power, torque, current or speed.
- (k) 'IE Class' means the 'International Efficiency' classification of motors and other components of a motor system defined by the respective IEC Standards.
- (l) 'IEC Standard' means an international standard that is published by the International Electrotechnical Commission denoted by the letters "IEC" and identifying number and/or letters.
- (m) 'Indirect efficiency determination' means a method by which the determination of efficiency is made by measuring the input power or the output power and

determining the total losses. Those losses are added to the output power, thus giving the input power, or subtracted from the input power, thus giving the output power.

- (n) 'Load' means all the values of the electrical and mechanical quantities that signify the demand made on a rotating machine by an electrical circuit or a mechanism at a given instant.
- (o) 'Losses' means the difference between the input power and the output power, comprising of various components viz. core losses, stator and rotor losses, friction and windage losses and stray load losses.
- (p) 'Minimum energy performance standard (MEPS)' means a mandatory minimum energy performance level that applies to all products sold in a market, whether imported or manufactured domestically.
- (q) 'Motor-Driven Unit' includes the aggregate of the motor, elements for transmitting its motion such as a coupling, belt, gear, clutch, brake etc., the driven equipment such as a pump, fan, compressor, conveyor etc., and a soft-starter or electronic speed control device.
- (r) 'Nominal energy efficiency' of a motor design is a representative value that is less than or equal to the average full-load efficiency of a statistically significant population of motors of the same design.
- (s) 'Power factor' means the ratio of 'active' or 'real' power (i.e. useful power) to 'apparent' power drawn by a motor from the mains.
- (t) 'Rated output' means the value of the output included in the rating. For a motor it means the mechanical power available at the motor shaft under rated operating conditions. It is expressed in kilo-Watts (kW) in countries following the metric system, and in horsepower (hp) in other countries.
- (u) 'Rated value' means a quantity value assigned, generally by a manufacturer, for a specified operating condition of a motor. NOTE The rated voltage or voltage range is the rated voltage or voltage range between lines at the terminals.
- (v) 'Rating' means the set of rated values and operating conditions.
- (w) 'Registration verification' means a process of confirming that registered products meet the requirements of a programme's entry conditions.
- (x) 'Routine test' means a test to which each individual motor is subjected during or after manufacture to ascertain whether it complies with certain criteria.
- (y) 'Self-certification' means a practice of submitting information about one's product in a formal statement rather than being obliged to ask a third party to do so.

- (z) 'Single-speed motor' means a motor rated for 50 Hz and/or 60 Hz on-line operation.
- (aa) 'SI unit' means any of the units adopted for international use under the *Système International d'Unités*.
- (bb) 'Tolerance' means the permitted deviation between the declared value of a quantity and the measured value.
- (cc) '*Type test*' means a test of one or more motors made to a certain design to show that the design meets certain specifications.

## Article 3. Requirements [OPTION A – INTERNATIONAL EFFICIENCY MOTORS CLASS IE3]

All electric induction motors in the scope of this regulation as defined in Article 1, that are manufactured in, or imported into the country/region, shall meet the minimum energy efficiency requirements of Article 3.1, the product information requirements of Article 3.2, and shall be assessed according to the compliance criteria and the referenced standards of Article 3.3.

### 3.1 Energy Efficiency Requirements

The nominal energy efficiency<sup>12</sup> of a motor included in the scope of this regulation must not be less than the value specified in Table 1 (50 Hz) and Table 2 (60 Hz) for the specified rated output power and number of poles, at full load and under rated operating conditions. For motors with a rated output power other than the values specified in Table 1, but within the range of 0.75 kW-375 kW, the efficiency value determined in accordance with the interpolation method specified in clause 5.4.5 of IEC 60034-30-1 shall apply.

The full-load energy efficiency of any individual motor, when tested at rated voltage and rated frequency in accordance with IEC 60034-2-1, shall not be less than the nominal efficiency declared by the manufacturer in technical documentation as well as on the rating plate, after allowing for the tolerance on the total losses according to IEC 60034-1.

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<sup>12</sup> The energy efficiency rating of a given motor design is not a unique value, but rather a band of values due to variations in materials, manufacturing processes and testing. Therefore, each motor design is assigned a nominal efficiency rating, which is a representative value that is less than or equal to the average full-load efficiency of a statistically significant population of motors of the given design. Individual motors are permitted a positive tolerance on total losses according to IEC 60034-1 viz. 15% for motors below 150 kW, and 10% for motors above 150 kW. This tolerance relates only to the verification of the measured parameters by the competent authorities and shall not be used by the manufacturer, or importer or authorised representative as an allowed tolerance to establish the values in the technical documentation or in interpreting these values with a view to achieving compliance or to communicate better performance by any means.

**Table 1 : Nominal energy efficiency requirements for 50 Hz motors (IE3)**

Rated output power (kW) (50 Hz)	Energy Efficiency (%) No of poles / Synchronous speed			
	2-pole 3000 RPM	4-pole 1500 RPM	6-pole 1000 RPM	8-pole 750 RPM
0.12	60.8	64.8	57.7	50.7
0.18	65.9	69.9	63.9	58.7
0.20	67.2	71.1	65.4	60.6
0.25	69.7	73.5	68.6	64.1
0.37	73.8	77.3	73.5	69.3
0.40	74.6	78.0	74.4	70.1
0.55	77.8	80.8	77.2	73.0
0.75	80.7	82.5	78.9	75.0
1.1	82.7	84.1	81.0	77.7
1.5	84.2	85.3	82.5	79.7
2.2	85.9	86.7	84.3	81.9
3	87.1	87.7	85.6	83.5
4	88.1	88.6	86.8	84.8
5.5	89.2	89.6	88.0	86.2
7.5	90.1	90.4	89.1	87.3
11	91.2	91.4	90.3	88.6
15	91.9	92.1	91.2	89.6
18.5	92.4	92.6	91.7	90.1
22	92.7	93.0	92.2	90.6
30	93.3	93.6	92.9	91.3
37	93.7	93.9	93.3	91.8
45	94.0	94.2	93.7	92.2
55	94.3	94.6	94.1	92.5
75	94.7	95.0	94.6	93.1
90	95.0	95.2	94.9	93.4
110	95.2	95.4	95.1	93.7
132	95.4	95.6	95.4	94.0
160	95.6	95.8	95.6	94.3
200 up to 375	95.8	96.0	95.8	94.6
375 up to 1000*	95.8	96.0	95.8	94.6

**Table 2: Nominal energy efficiency requirements for 60 Hz motors (IE3)**

Rated output power (kW)  (60 Hz)	Energy Efficiency (%) No of poles / Synchronous speed			
	2-pole 3600 RPM	4-pole 1800 RPM	6-pole 1200 RPM	8-pole 900 RPM
0.12	62.0	66.0	64.0	59.5
0.18	65.6	69.5	67.5	64.0
0.25	69.5	73.4	71.4	68.0
0.37	73.4	78.2	75.3	72.0
0.55	76.8	81.1	81.7	74.0
0.75	77.0	83.5	82.5	75.5
1.1	84.0	86.5	87.5	78.5
1.5	85.5	86.5	88.5	84.0
2.2	86.5	89.5	89.5	85.5
3.7	88.5	89.5	89.5	86.5
5.5	89.5	91.7	91.0	86.5
7.5	90.2	91.7	91.0	89.5
11	91.0	92.4	91.7	89.5
15	91.0	93.0	91.7	90.2
18.5	91.7	93.6	93.0	90.2
22	91.7	93.6	93.0	91.7
30	92.4	94.1	94.1	91.7
37	93.0	94.5	94.1	92.4
45	93.6	95.0	94.5	92.4
55	93.6	95.4	94.5	93.6
75	94.1	95.4	95.0	93.6
90	95.0	95.4	95.0	94.1
110	95.0	95.8	95.8	94.1
150	95.4	96.2	95.8	94.5
185 up to 375	95.8	96.2	95.8	95.0
375 up to 1000*	95.8	96.2	95.8	95.0

The values in Tables 1 and 2 correspond to the International Energy Efficiency class IE3 as per the IEC 60034-30-1 standard.

\*The efficiency figures for motor sizes below 0.75 kW and above 375 kW are included for information purposes only, as these are not covered by these efficiency regulation guidelines currently, but may be in future (and in line with new global best-practice regulations coming into effect such as those taking effect in the EU in July 2021).

### 3.2 Product Information Requirements

Manufacturers shall provide the following information for the motors covered by this regulation. either on one or more rating plates, in accordance with IEC 60034-1, in accompanying technical documentation and free access websites. Letter symbols for units and quantities shall be in accordance with IEC 60027-1 and IEC 60027-4.

If the manufacturer gives more information than specified below, this need not necessarily be marked on the rating plate(s).

- a) Year of manufacture
- b) Efficiency class (IE code) and
- c) nominal efficiency ( $\eta$ ) at 100%, 75 % and 50 % rated load and voltage ( $U_N$ ); rated efficiency class as specified in IEC 60034-30 -1 e.g. "IE3"  
[note: these first three shall be durably marked on or near the rating plate of the motor]
- d) Manufacturer's name
- e) Manufacturer's serial number, Manufacturer's machine code
- f) Number of phases, i.e. 3
- g) Number(s) of the rating and performance standard(s) which are applicable<sup>13</sup>
- h) Degree of protection (IP code) in accordance with IEC 60034-5
- i) Thermal class and the limit of temperature rise
- j) Class(es) of rating of the machine if designed for other than rating for continuous running duty S1
- k) Rated power output (kW).
- l) Rated voltage(s) or range of rated voltage (V).
- m) Rated frequency (Hz).
- n) Rated current(s) or range of rated current.
- o) Rated speed(s) or range of rated speed.
- p) Maximum safe operating speed if less than that specified in section 9.6 of IEC 60034-1
- q) Rated power factor(s).
- r) For wound-rotor induction machines, the rated open-circuit voltage between slip-rings and the rated slip-ring current.
- s) Maximum ambient air temperature, if other than 40 °C
- t) Minimum ambient air temperature if other than -15 °C
- u) The altitude for which the motor is designed (if exceeding 1 000 m above sea-level)
- v) The approximate total mass of the motor, if exceeding 30 kg.
- w) For motors suitable for operation in only one direction of rotation, the direction of

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<sup>13</sup> Two different rated values shall be indicated by X/Y and a range of rated values shall be indicated by X–Y (see IEC 61293).

rotation indicated by an arrow. This arrow need not be on the rating plate, but it shall be easily visible.

x) The connecting instructions in accordance with IEC 60034-8 by means of a diagram or text located near the terminals.

### 3.3 Referenced Test Standards, Compliance Certification and Surveillance Testing

The metrics, referenced standards, compliance certification, and surveillance testing criteria are set out in this section. IEC standards undergo revisions from time to time. The latest version of a standard as on the date of issuance of this regulation shall be referenced. Subsequent revisions if any, shall be ignored.

**Table 3: Reference Standards for Test Methods and Energy Efficiency Calculations**

Test method for determining motor energy efficiency.	IEC 60034-2-1 Ed. 2.0 (Bilingual 2014) Rotating electrical machines – Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles) subclause 6.1.3, Method 2-1-1B – Summation of losses, additional load losses according to the method of residual loss.
Motor efficiency classes (IE codes)	IEC 60034-30-1 Ed. 1.0 (Bilingual 2014) Rotating electrical machines – Part 30-1: Efficiency classes of line operated AC motors (IE code).

## COMPLIANCE CERTIFICATION

### TEST CERTIFICATES

Test certificates are accepted from test laboratories that have been accredited by their respective national accreditation bodies or by an International accreditation body. These may be either manufacturer’s in-house laboratories or third-party laboratories.

### REGISTRATION

Importers and manufacturers of motors and motor-driven units, equipment or systems covered by this regulation must register themselves with the designated authority, following the prescribed procedure, accompanied by the required documents and information and the applicable fees.

Motor designs covered by this regulation must be registered with the designated authority through the submission of the full product information as required under Article 3.2 together with test certificates as required by the Test Certificates clause above.

[Optional clause: Motor designs that are already registered with other countries that are members of a recognised official “Regional Energy Efficiency Certificate Mutual Recognition

Agreement”<sup>14</sup> or equivalent may be registered by providing the registration certificate of the respective country.]

## **SURVEILLANCE TESTING**

In order to verify the claimed energy efficiency of a motor design covered by this regulation, the designated market surveillance authority shall test any one single motor to be picked at any time directly from the market, at its sole discretion, according to the test method prescribed above.

The motor design shall be considered to comply with this regulation, if the measured full-load efficiency of the motor at rated voltage and rated frequency is not less than the nominal efficiency according to Article 3.1, after allowing for the tolerance on the total losses according to IEC 60034-1 i.e. 15 % on the power range 0.75-150 kW and 10 % on the power range 150-375 kW.

If the selected motor fails this test, the market surveillance authority shall randomly test three additional motors of the same design except for motors that are produced in lower quantities than five per year.

The motor design shall be considered to comply with the provisions set out in this regulation, if the arithmetic average of the measured full-load efficiency of the three test motors at rated voltage and rated frequency is not less than the nominal efficiency according to Article 3.1, after allowing for the tolerance on the total losses according to IEC 60034-1 i.e. 15 % on the power range 0.75-150 kW and 10 % on the power range 150-375 kW.

If this result is not achieved, the motor design shall be considered to be not in compliance with this regulation.

If a decision of non-compliance is taken, the market surveillance authority may inform other government authorities to take consequential enforcement actions against the manufacturer and / or importer, as well as inform other authorities in the region of the decision being taken to help protect against the widespread sale of the same model.

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<sup>14</sup> It is suggested that countries should enter into such an agreement with neighbouring countries within the region for multiple equipment and appliances, including motors. Please refer to the U4E Guidance Notes on Registration.

## Article 3. Requirements [Option B – INTERNATIONAL Efficiency Motors CLASS IE2]

[Option B may be adopted by Countries/Regions with a significant domestic motor manufacturing industry for a temporary bridging period, to provide it with adequate time to adapt to the requirements of Option A, which is the international best practice currently, and must remain the goal].

All electric induction motors in the scope of this regulation as defined in Article 1, that are manufactured in, or imported into the country/region, shall meet the minimum energy efficiency requirements of Article 3.1, the product information requirements of Article 3.2, and shall be assessed according to the compliance criteria and the referenced standards of Article 3.3.

### 3.1 Energy Efficiency Requirements

The nominal energy efficiency<sup>15</sup> of a motor included in the scope of this regulation must not be less than the value specified in Table 1 (50 Hz) and Table 2 (60 Hz) for the specified rated output power and number of poles, at full load and under rated operating conditions. For motors with a rated output power other than the values specified in Table 1, but within the range of 0.75 kW-375 kW, the efficiency value determined in accordance with the interpolation method specified in clause 5.4.5 of IEC 60034-30-1 shall apply.

The full-load energy efficiency of any individual motor, when tested at rated voltage and rated frequency in accordance with IEC 60034-2-1, shall not be less than the nominal efficiency declared by the manufacturer in technical documentation as well as on the rating plate, after allowing for the tolerance on the total losses according to IEC 60034-1.

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<sup>15</sup> The energy efficiency rating of a given motor design is not a unique value, but rather a band of values due to variations in materials, manufacturing processes and testing. Therefore, each motor design is assigned a nominal efficiency rating, which is a representative value that is less than or equal to the average full-load efficiency of a statistically significant population of motors of the given design. Individual motors are permitted a positive tolerance on total losses according to IEC 60034-1 viz. 15% for motors below 150 kW, and 10% for motors above 150 kW. This tolerance relates only to the verification of the measured parameters by the competent authorities and shall not be used by the manufacturer, or importer or authorised representative as an allowed tolerance to establish the values in the technical documentation or in interpreting these values with a view to achieving compliance or to communicate better performance by any means.

**Table 4 : Nominal energy efficiency requirements for 50 Hz motors (IE2)**

Rated output power (kW)  (50 Hz)	Energy Efficiency (%) No of poles / Synchronous speed			
	2-pole 3000 RPM	4-pole 1500 RPM	6-pole 1000 RPM	8-pole 750 RPM
0.12	53.6	59.1	50.6	39.8
0.18	60.4	64.7	56.6	45.9
0.20	61.9	65.9	58.2	47.4
0.25	64.8	68.5	61.6	50.6
0.37	69.5	72.7	67.6	56.1
0.40	70.4	73.5	68.8	57.2
0.55	74.1	77.1	73.1	61.7
0.75	77.4	79.6	75.9	66.2
1.1	79.6	81.4	78.1	70.8
1.5	81.3	82.8	79.8	74.1
2.2	83.2	84.3	81.8	77.6
3	84.6	85.5	83.3	80.0
4	85.8	86.6	84.6	81.9
5.5	87.0	87.7	86.0	83.8
7.5	88.1	88.7	87.2	85.3
11	89.4	89.8	88.7	86.9
15	90.3	90.6	89.7	88.0
18.5	90.9	91.2	90.4	88.6
22	91.3	91.6	90.9	89.1
30	92.0	92.3	91.7	89.8
37	92.5	92.7	92.2	90.3
45	92.9	93.1	92.7	90.7
55	93.2	93.5	93.1	91.0
75	93.8	94.0	93.7	91.6
90	94.1	94.2	94.0	91.9
110	94.3	94.5	94.3	92.3
132	94.6	94.7	94.6	92.6
160	94.8	94.9	94.8	93.0
200 up to 375	95.0	95.1	95.0	93.5
375 up to 1000*	95.0	95.1	95.0	93.5

**Table 5: Nominal energy efficiency requirements for 60 Hz motors (IE2)**

Rated output power (kW)  (60 Hz)	Energy Efficiency (%) No of poles / Synchronous speed			
	2-pole 3600 RPM	4-pole 1800 RPM	6-pole 1200 RPM	8-pole 900 RPM
0.12	59.5	64.0	50.5	40.0
0.18	64.0	68.0	55.0	46.0
0.25	68.0	70.0	59.5	52.0
0.37	72.0	72.0	64.0	58.0
0.55	74.0	75.5	68.0	62.0
0.75	75.5	78.0	73.0	66.0
1.1	82.5	84.0	85.5	75.5
1.5	84.0	84.0	86.5	82.5
2.2	85.5	87.5	87.5	84.0
3.7	87.5	87.5	87.5	85.5
5.5	88.5	89.5	89.5	85.5
7.5	89.5	89.5	89.5	88.5
11	90.2	91.0	90.2	88.5
15	90.2	91.0	90.2	89.5
18.5	91.0	92.4	91.7	89.5
22	91.0	92.4	91.7	91.0
30	91.7	93.0	93.0	91.0
37	92.4	93.0	93.0	91.7
45	93.0	93.6	93.6	91.7
55	93.0	94.1	93.6	93.0
75	93.6	94.5	94.1	93.0
90	94.5	94.5	94.1	93.6
110	94.5	95.0	95.0	93.6
150	95.0	95.0	95.0	93.6
185	95.4	95.0	95.0	93.6
220 up to 335	95.4	95.4	95.0	93.6
375 up to 1000*	95.4	95.8	95.0	94.1

The values in Tables 1 and 2 correspond to the International Energy Efficiency class IE2 as per the IEC 60034-30-1 standard.

\*The efficiency figures for motors below 0.75 kW and above 375 kW are included for information purposes only, as these are not covered by these efficiency regulation guidelines currently, but may be in future (in line with new global best-practice regulations coming into effect such as those taking effect in the EU in July 2021).

### 3.2 Product Information Requirements

Manufacturers shall provide the following information for the motors covered by this regulation, either on one or more rating plates, in accordance with IEC 60034-1, in accompanying technical documentation and free access websites. Letter symbols for units and quantities shall be in accordance with IEC 60027-1 and IEC 60027-4.

If the manufacturer gives more information than specified below, this need not necessarily be marked on the rating plate(s).

- a) Year of manufacture
- b) Efficiency class (IE code) and
- c) nominal efficiency ( $\eta$ ) at 100%, 75 % and 50 % rated load and voltage ( $U_N$ ); rated efficiency class as specified in IEC 60034-30 -1 e.g. "IE3"  
[note: these first three shall be durably marked on or near the rating plate of the motor]
- d) Manufacturer's name
- e) Manufacturer's serial number, Manufacturer's machine code
- f) Number of phases, i.e. 3
- g) Number(s) of the rating and performance standard(s) which are applicable<sup>16</sup>
- h) Degree of protection (IP code) in accordance with IEC 60034-5
- i) Thermal class and the limit of temperature rise
- j) Class(es) of rating of the machine if designed for other than rating for continuous running duty S1
- k) Rated power output (kW).
- l) Rated voltage(s) or range of rated voltage (V).
- m) Rated frequency (Hz).
- n) Rated current(s) or range of rated current.
- o) Rated speed(s) or range of rated speed.
- p) Maximum safe operating speed if less than that specified in section 9.6 of IEC 60034-1
- q) Rated power factor(s).
- r) For wound-rotor induction machines, the rated open-circuit voltage between slip-rings and the rated slip-ring current.
- s) Maximum ambient air temperature, if other than 40 °C
- t) Minimum ambient air temperature if other than -15 °C
- u) The altitude for which the motor is designed (if exceeding 1 000 m above sea-level)
- v) The approximate total mass of the motor, if exceeding 30 kg.
- w) For motors suitable for operation in only one direction of rotation, the direction of

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<sup>16</sup> Two different rated values shall be indicated by X/Y and a range of rated values shall be indicated by X–Y (see IEC 61293).

rotation indicated by an arrow. This arrow need not be on the rating plate, but it shall be easily visible.

x) The connecting instructions in accordance with IEC 60034-8 by means of a diagram or text located near the terminals.

### 3.3 Referenced Test Standards, Compliance Certification and Surveillance Testing

The metrics, referenced standards, compliance certification, and surveillance testing criteria are set out in this section. IEC standards undergo revisions from time to time. The latest version of a standard as on the date of issuance of this regulation shall be referenced. Subsequent revisions if any, shall be ignored.

**Table 6: Reference Standards for Test Methods and Energy Efficiency Calculations**

Test method for determining motor energy efficiency.	IEC 60034-2-1 Ed. 2.0 (Bilingual 2014) Rotating electrical machines – Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles) subclause 6.1.3, Method 2-1-1B – Summation of losses, additional load losses according to the method of residual loss.
Motor efficiency classes (IE codes)	IEC 60034-30-1 Ed. 1.0 (Bilingual 2014) Rotating electrical machines – Part 30-1: Efficiency classes of line operated AC motors (IE code).

## COMPLIANCE CERTIFICATION

### TEST CERTIFICATES

Test certificates are accepted from test laboratories that have been accredited by their respective national accreditation bodies or by an International accreditation body. These may be either manufacturer’s in-house laboratories or third-party laboratories.

### REGISTRATION

Importers and manufacturers of motors and motor-driven units, equipment or systems covered by this regulation must register themselves with the designated authority, following the prescribed procedure, accompanied by the required documents and information and the applicable fees.

Motor designs covered by this regulation must be registered with the designated authority through the submission of the full product information as required under Article 3.2 together with test certificates as required by the Test Certificates clause above.

[Optional clause: Motor designs that are already registered with other countries that are members of a recognized official “Regional Energy Efficiency Certificate Mutual Recognition

Agreement”<sup>17</sup> or equivalent may be registered by providing the registration certificate of the respective country.]

## **SURVEILLANCE TESTING**

In order to verify the claimed energy efficiency of a motor design covered by this regulation, the designated market surveillance authority shall test any one single motor to be picked at any time from any place directly from the market, at its sole discretion, according to the test method prescribed above.

The motor design shall be considered to comply with this regulation, if the measured full-load efficiency of the motor at rated voltage and rated frequency is not less than the nominal efficiency according to Article 3.1, after allowing for the tolerance on the total losses according to IEC 60034-1 i.e. 15 % on the power range 0.75-150 kW and 10 % on the power range 150-375 kW.

If the selected motor fails this test, the market surveillance authority shall randomly test three additional motors of the same design except for motors that are produced in lower quantities than five per year.

The motor design shall be considered to comply with the provisions set out in this regulation, if the arithmetic average of the measured full-load efficiency of the three test motors at rated voltage and rated frequency is not less than the nominal efficiency according to Article 3.1, after allowing for the tolerance on the total losses according to IEC 60034-1 i.e. 15 % on the power range 0.75-150 kW and 10 % on the power range 150-375 kW.

If this result is not achieved, the motor design shall be considered to be not in compliance with this regulation.

If a decision of non-compliance is taken, the market surveillance authority may inform other government authorities to take consequential enforcement actions against the manufacturer and / or importer, as well as inform other authorities in the region of the decision being taken to help protect against the widespread sale of the same model.

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<sup>17</sup> It is suggested that countries should enter into such an agreement with neighbouring countries within the region for multiple equipment and appliances, including motors. Please refer to the U4E Guidance Notes on Registration.

## Article 4. Entry into Force

Option A: The product and information requirements set out in Article 3 shall take effect from 1 January 2020.

OPTION B: The product and information requirements set out in Article 3 shall take effect from 1 January 2020. Requirements set out in the table 3.2 will be upgraded by one IE – class on January 1st, 2023.

## Article 5. Declaration of Conformity

Compliance with the requirements of this regulation shall be demonstrated in accordance with the provisions of Article 3. Suppliers (i.e. importers and manufacturers) shall provide the information and technical documentation necessary for the market surveillance authority to assess conformity and verify compliance and any additional optional claims. This information and technical documentation can be provided by the supplier as a Conformity Assessment Report (CAR) and/or entered into the relevant product registration database or supplied in any other format as reasonably determined by the market surveillance authority. The conformity assessment information and documentation should:

- (1) demonstrate that the product model fulfils the requirements of this Regulation;
- (2) provide any other information required to be present in the technical documentation file;
- (3) specify the reference settings and conditions in which the product complies with this Regulation.

The information shall be submitted to the designated authority by the supplier for review prior to placing the product on the market. If the CAR or application for registration for the designated model is approved, which is confirmed by written correspondence from the designated authority and/or listing of the product on the relevant product registration system, the model may be placed on the market. If a CAR or application for registration is rejected, a written explanation shall be provided to the submitter. All aspects identified in the written explanation must be addressed in any revised CAR or application for registration. Until the CAR or application for registration is approved, the product is ineligible for placement on the market. The duration of product CAR or registration validity shall be as reasonably determined by the market surveillance authority. The supplier is obliged to check and update product conformity information, including informing the market surveillance authority of pertinent information as defined by the authority related to product compliance without undue delay.

## Article 6. Market Surveillance and Enforcement

The designated authority responsible for implementing this regulation shall develop or designate an appropriate programme or programmes to check compliance with this standard and to monitor the market for noncompliance. The programme(s) shall include details on sample size, lab accreditation requirements (to international standards such as ISO/IEC 17025 certification or equivalent), and a redress process that manufacturers or their authorised representatives can utilize if, following surveillance testing, their product is found to be out of compliance.

The designated authority will be responsible for enforcement activities in the country/region. The designated authority shall establish written policies that clearly spell out its authority, procedures, penalties including the publishing of test results and details of non-compliant suppliers. All testing carried out for compliance and for market surveillance testing purposes shall be in accordance with the measurement and calculation methods set out in this Regulation.

Any person, persons or firm manufacturing, importing, storing for sale, supplying, selling, or distributing electric induction motors in the scope of this regulation, which do not meet the specified minimum energy performance requirements after the date of entry into force of this regulation shall be liable for penal actions including, but not limited to warnings, sanctions, fines, penalties, public naming, delisting etc. as may be determined by the designated authority.

An exception shall be allowed for motors which have been placed on the market (i.e. supplied by a manufacturer or importer for distribution and sale) prior to the entry into force of this regulation. Existing stocks of such motors in the distribution chain may continue to be sold even after the entry into force of this regulation, up to a maximum period of two years or until the stocks of such motors are exhausted, whichever is earlier.

Further, any person, other than an end-user, in possession of an electric induction motor in the scope of this regulation after the date of entry into force of this regulation, that does not meet the specified minimum energy performance requirements shall ensure that it is rendered unusable and dispose of it as scrap within three months from the date that the non-conformance is first detected.

## Article 7. Revision

It is anticipated that this Regulation shall be reviewed after not more than 5 years after it's entry into force, so as to take into account technological progress, to address any unforeseen loopholes being exploited and any other relevant matters. It is recommended that any subsequent review or revision to this Regulation take into consideration the following topics:

- setting more stringent energy efficiency requirements for the motors within its current scope;
- extending the size range of induction motors to 1000 kW on the upper side;
- extending the size range of induction motors to 0.12 kW on the lower side (including single-phase motors);
- extending the coverage to motors for use with variable-speed drives;
- combining this regulation with other motor-related regulations;
- extending the scope to motor-driven units viz. pumps, fans and compressors.



