UN environment programme

Energy efficiency requirements for general purpose electric motors

Accelerating the global adoption of energy efficient electric motors

Model Regulation Guidelines

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Glossary

Compliance: 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 UNFCCC and the Kyoto Protocol. (UNFCCC)

Conformité Européenne Marking (CE Marking): states that a product is assessed before being placed on the market and meets European Union safety, health and environmental protection requirements. Used in the European Economic Area (EEA), consisting of the 28 European Union Member States, and the European Free Trade Association (EFTA) countries i.e. Iceland, Liechtenstein and Norway. Per decision No 768/2008/ EC of the European Parliament and of the Council of 9 July 2008 on a common framework for the marketing of products, and repealing Council Decision 93/465/EEC.

Direct Efficiency Determination: method by which the determination of efficiency is made by measuring directly the input power and the output power.

Duty: 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.

Duty Type: 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 generally load and speed vary within the permissible operating range. Duty type S1 – Continuous-running duty: Operation at a constant load maintained for sufficient time to allow the motor to reach thermal equilibrium.

Full Load: the load that causes a motor to operate at its rating.

Full Load Value: a quantity value for a motor operating at full power, torque, current or speed.

Indirect Efficiency Determination: 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.

Inherent speed: means the rotation speed of the fan, when the fan is operated at nominal or rated supply conditions of the motor;

Load: 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.

Minimum Energy Performance Standard (MEPS): a mandatory minimum performance level that applies to all products sold in a market, whether imported or manufactured domestically.

Motor System: the electric motor system includes an electric motor and equipment for supplying power, starting the motor and varying its speed, mechanically transmitting motion to drive equipment (e.g. pumps, fans, compressors, production machines), and additional controls and subsequent equipment or process components like ducting etc.

Power Factor: the ratio of 'active' or 'real' power (i.e. useful power) to 'apparent' power drawn by a motor from the mains.

Rated Output: the value of the output included in the rating.

Rated Value: a quantity value assigned, generally by a manufacturer, for a specified operating condition.

Rating: the set of rated values and operating conditions.

Registration Verification: process of confirming that registered products meet the requirements of a programme's entry conditions.

Routine Test: a test to which each individual motor is subjected during or after manufacture to ascertain whether it complies with certain criteria.

SI Unit: any of the units adopted for international use under the Système International d'Unités.

Tolerance: the permitted deviation between the declared value of a quantity and the measured value.

Type Test: a test of one or more products made to a certain design to show that the design meets certain specifications.

Abbreviations

AC	Alternating Current
BEP	Best efficiency point
CAR	Conformity Assessment Report
CDM	Complete Drive Module
CEN	European Committee for Standardization
DSA	Designated Surveillance Authority
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
MEPS	Minimum Energy Performance Standards
PDS	Power Drive System
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
UNDP	United Nations Development Programme
U4E	United for Efficiency
ESOB	End suction own bearing
ESCC	end suction close coupled
ESCCi	end suction close coupled inline
MS-V	vertical multistage
MS-H	horizontal multistage
MSS	submersible multistage
BS	booster sets
EEI	Energy Efficiency Index
MEI	Minimum Efficiency Index
Rpm	revolutions per minute
PL	part load
OL	over load
Gt	Giga tonne
TWh	TeraWatthour
IE1	International Efficiency 1
kW	KiloWatt
kVA	kiloVoltAmpere
N	efficiency grade N for specific fan type
l/s	liter per second
d	proportional loss factor
C value	a constant for each specific water pump type quantifying the differences in efficiency for different pump types;

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About United for Efficiency

U4E (united4efficiency.org/) is a global initiative led by UNEP, which accelerates the transition to energy-efficient and climate friendly lighting, appliances and equipment.

Our integrated approach targets:

- Standards and regulations;
- Awareness raising and capacity building;
- Market monitoring, verification and enforcement;
- Funding and financial delivery mechanisms; and
- Environmentally sound management and health.

U4E provides tailored technical support through in-house experts and specialized partners to get the most out of countries´ energy resources. Enhancing efficiency unlocks savings on consumer electricity bills, helps businesses thrive through greater productivity, improves resiliency of power utilities to meet growing demands for electricity, and assists governments in realizing sustainable development ambitions.

The initiative is active in developing and emerging economies worldwide. U4E provides technical assistance by pursuing solutions for lighting, refrigeration and holistic cold-chain, space conditioning, electric motor systems, distribution power transformers, and system-scale improvements across these and other technologies. The product areas utilize well over half of the world's electricity.

U4E has a proven set of tools, assessments and guides developed with a diverse array of experts across many leading organizations which reflect international best practices. The contents are practically applied in market transformation projects at the regional, national and local scales.

This growing suite of resources equips policymakers to understand the significant opportunities and steps needed to start transforming their markets to eco-efficient appliances and equipment.

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Introduction

Global electricity use is expected to rise by 25 per cent to 30 per cent by 2030, mostly in emerging markets and developing economies. More than 50 per cent of all electrical energy i.e., 12,400 TWh (2021) is used by electric motor systems globally giving rise to 6.5 Gt of carbon dioxide emissions[1]. Policy actions to greatly increase the efficiency of new industrial motor systems and accelerate the replacement of existing industrial motor systems stock by 2030 could mitigate 3.4 Gt CO2 emissions by 2040 and 5.1 Gt by 20502.

Electric motor systems (figure 1) comprise power supply equipment, motor controls, electric motor, mechanical transmission equipment, driven equipment (e.g., pumps, fans, and compressors), and downstream process components. A fraction of the energy drawn by a motor system from the power supply is lost at each stage of energy transmission and conversion, with the remaining energy being delivered to the application for productive use. These energy losses can be reduced by improving the energy efficiency of the individual components as well as from optimising the efficiency of the system as a whole. The classical metric for energy performance of equipment is component level energy-efficiency, but for any user (and policymaker) the key performance indicator is the total energy used over a defined period. In optimising motor systems both criteria must be applied.

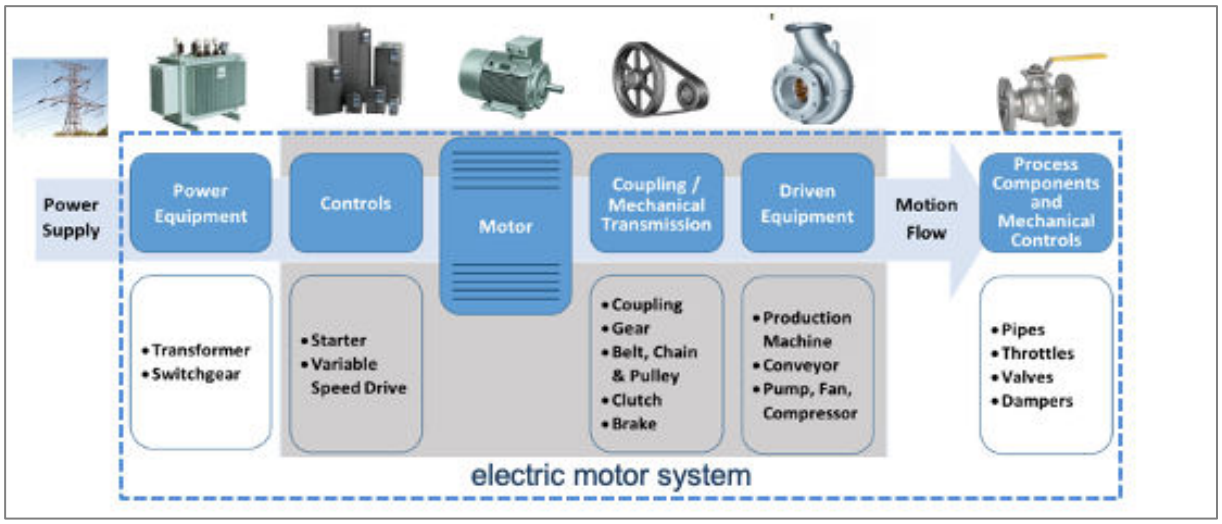


Figure 1: Components of an electric motor system[3]

Mandatory Minimum Energy Performance Standards (MEPS) regulate the new equipment that is permitted to enter the market. MEPS regulations are evolving towards a larger 'system border', including the motor, the Variable Speed Drive and the driven equipment. However, a regulation that covers the efficiency of a complete system is more challenging as the full system is often built at the end user's premises.

Implementation of MEPS allows countries to keep abreast of technology developments, eliminate poor-performing products and attain energy, financial and environmental savings in a cost-effective manner.

As a result of their large electricity consumption and their usage in multiple applications, relatively small improvements in motor system energy efficiency lead to very large absolute savings, becoming an important avenue to reach a country´s ambitious energy and environmental goals.

In response to these challenges and opportunities, UNEP's United for Efficiency (U4E) initiative has developed the *Model Regulation Guidelines for Electric Motor Systems*, which provide guidelines and templates for use by regulatory authorities in emerging markets and developing economies that are considering a legislative framework to promote energy-efficient electric motors, variable speed drives and driven applications such as fans, pumps, and air compressors, or those that have a legislative framework but have not yet developed relevant regulations.

[1] IEA World Energy Outlook 2022, plus IEA World Energy Outlook 2016 and U4E analysis.

[2] CLASP Net Zero Heroes, Nov 2023.

[3] Modified from the original figure created for the 2017 edition of the U4E Motors Policy Guide jointly with the Institute of Systems and Robotics, University of Coimbra.

The U4E Electric Motor Systems Model Regulation[4] Guidelines are a supplement to the *U4E Electric Motor Systems Policy[5] Guide*, a comprehensive document that provides an overview of all the key elements for transforming a national motor systems market towards higher efficiency through the Integrated Policy Approach. These Guidelines were developed in a consultative process meant to reflect current global best practices, with an understanding that the contents need to be adapted to specific local circumstances and not utilized verbatim based on these generalized recommendations, after due assessment of local conditions and consultations with stakeholders. Additionally, it is recognised that markets and technologies are dynamic, so adaptations would be necessary over time to keep pace with developments.

The endorsing organizations encourage regulatory authorities in developing and emerging economies to review their existing regulations for electric motors and motors systems if any and consider updating these to the global best practice levels described in these Model Regulation Guidelines to realise the potential energy, environmental and financial savings that are technically feasible and economically justifiable to the maximum extent.

[4] "Regulations" are specific rules or directives made and maintained by a governmental authority, typically enforceable by law.

[5] "Policies" are plans and actions adopted by a government to achieve its objectives.

Methodology and Approach

The Model Regulation Guidelines are structured as building blocks that may be issued individually or combined into a composite regulation for electric motor systems based on each country or region's market structure and practices. These offer recommendations in line with international best practices and address requirements for:

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

The Guidelines adopt a differentiated approach towards economies that have significant domestic manufacturing capacities for the respective motor system component and those almost entirely reliant on imports, recognising that the former may prefer a more gradual transition to the international best practice MEPS levels to provide their domestic manufacturing industry a (limited) transitory time for upgrading technology and manufacturing practices, while the latter have no barriers to immediately adopt international best practises. Thus, one or two "Bridging Starting MEPS levels" and an "Advanced MEPS level" have been defined for each component.

The Advanced MEPS level has largely been benchmarked on the latest European Union and United States of America regulations as applicable as below:

In the case of Electric Motors and Variable Speed Drives: in particular the European Union Regulation 2019/1781 for Electric Motors and Variable Speed Drives and the European Union Regulation 2021/341 amendment.

In the case of Fans Driven by Motors: in particular the European Union Regulation 2024/1834 for Fans driven by motors with an electric input power between 125 W and 500 kW.

In the case of Rotodynamic Water Pumps and Water Pump Units: in particular the European Union Working Document on Water pumps and Water pump units 2019-10.

In the case of Air Compressor units: in particular the European Union Working Document on Standard Air Compressor Packages 2019-07.

These guidelines do not cover requirements on mechanical construction, functional performance, safety, hazardous substances, product longevity, or warranty since such requirements are not primarily related to energy performance and are typically covered by the relevant International Electrotechnical Commission (IEC) or International Organization for Standardization (ISO) standards[6] and their corresponding mirror national standards, and/or parallel regulations on these same products. When drafting energy-efficiency regulations, countries should investigate and confirm that these supplementary requirements are indeed covered in parallel standards and regulations; if not, some of these could also be considered for inclusion in the energy-efficiency regulations.

These model regulation guidelines represent the best available information at the time of publication; however, the authors recognise that the IEC and ISO 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 adoption.

[6] "Standards" are technical requirements on equipment quality, safety, energy performance etc. set by standardisation bodies such as IEC/ISO and industry bodies such as NEMA.

Recommended Coverage and MEPS Levels

U4E recommends the following MEPS options, where an economic and environmental impact analysis will provide the principal basis for determining the scope and level of regulations:

SECTION	PRODUCT GROUP	RECOMMENDED COVERAGE & MEPS LEVELS
I	INDUCTION MOTORS	OPTION A - Advanced Level with the broadest coverage of motor types and sizes designed to enable countries leapfrog directly to the current international best practice regulations. This is suitable for countries that either do not have a significant domestic motor manufacturing industry, or already have MEPS for motors covering a narrower scope and/or at a lower efficiency level and are ready to adopt the advanced level: a. IE4 efficiency class for a three-phase motors of 75 - 200 kW, which are not brake motors, Ex eb increased safety motors or other explosion-protected motors; b. IE3 efficiency class for all other three-phase motors of 0.75 - 1000 kW; c. IE2 efficiency class for three-phase motors in the range of smaller 0.12 - 0.75 kW motors; single-phase motors rated above 0.12 kW; and an Ex eb motors for explosive atmospheres of 0.12 - 1000 kW. OPTION B - Bridging Starting Level at IE3-level Countries that do have a significant domestic motor manufacturing industry may choose to start at IE3-level "premium energy-efficiency" for a basic range of 0.75 – 1000 kW for three-phase motors. OPTION C - Bridging Starting Level with limited time at IE2-level and transitioning to IE3-level Countries that do have a significant domestic motor manufacturing industry can alternatively choose a more gradual transition by starting at IE2-level "high energy-efficiency", for a basic range of 0.75 – 1000 kW for three -phase motors, to provide themselves with (limited) transitory time for upgrading technology with the objective of transitioning in steps to Level B and Level A eventually[1].
II	VARIABLE SPEED DRIVES	Coverage: Variable Speed Drives (VSDs) with a rated motor power output between 0.12 kW-1000 kW (equivalent VSD rating 0.278 kVA – 1209 kVA) and a rated AC input voltage between 100 V - 1000 V. Recommended MEPS Level: IE2
III	FANS DRIVEN BY MOTORS	Coverage: axial fans, centrifugal fans, cross flow fans, mixed flow fans and jet fans, with an electric input power between 125 W and 500 kW. Minimum fan energy efficiencies are defined by an efficiency grade N specific for each fan type. OPTION A - Advanced Level Countries may choose to start directly at the advanced level. The efficiency grades N are at a 'premium level', ranging from N50 to N67 and include information requirements on partial load. OPTION B - Bridging Starting Level The bridging level includes lower efficiency grades, providing domestic manufacturers with a (limited) transitory time for upgrading technology—the efficiency grades N range from N45 to N65.
IV	ROTODYNAMIC WATER PUMPS	Coverage: Rotodynamic pumps for clean water of the following types: end suction own bearing (ESOB), end suction close coupled (ESCC), end suction close coupled

	AND WATER PUMP UNITS	inline (ESCCi), vertical multistage (MS-V), horizontal multistage (MS-H), submersible multistage (MSS) and booster sets (BS). OPTION A - Advanced Level Countries may start at the advanced level directly, the current international best practice level. The efficiency levels include - for water pumps, a Minimum Efficiency Index of 0.4 and - for water pump units, ESOB, ESCC, and ESCCi end suction units up to 45 kW shaft power, an Energy Efficiency Index of not more than 0.62, and for booster sets, an Energy Efficiency Index of not more than 0.5. OPTION B - Bridging starting level The optional bridging level includes a lower Minimum Efficiency Index for pumps only (the hydraulic efficiency) of MEI = 0.1 providing domestic manufacturers a (limited) transitory time for upgrading technology. These exclude the booster sets.
V	AIR COMPRESSORS	Coverage: Rotary standard air compressor packages with a maximum volume flow rate of between 5 to 1280 l/s when supplying air at discharge pressure(s) equal to or higher than 7 bar(a) and not exceeding 15 bar(a). Recommended MEPS Level: OPTION A - Current international best practice, defining a proportional loss factor value of d = -10 for rotary standard air compressor packages. OPTION B - Transitory bridging level, defining a proportional loss factor value of d = -15 for rotary standard air compressor packages, as an optional bridging level to provide domestic manufacturers with a (limited) transitory time for upgrading technology.

SECTION I

Model Regulation Guidelines for Induction Motors

OPTION A - advanced level with the broadest coverage of motor types and sizes

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[7] 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 60034-1:2022[8] or the comparable NEMA MG1 Standard; and
- have frame sizes according to IEC 60072-1:2022[9] or comparable NEMA frame sizes; and
- are rated for direct-on-line operation on a three-phase or single-phase[10] sinusoidal voltage supply; and
- have a rated shaft power from 0.12 kW to 1000 kW; and
- have 2, 4, 6 or 8 poles[11]; and
- have a rated voltage of 50 volts and above, up to and including 1000 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 for duty types S1, S3 >=80 per cent or S6 >=80 per cent as defined in the standard IEC 60034-1:2022; and
- are designed to operate in any ambient temperature within the range of -30°C to + 60°C[12]; and
- are designed to operate at any altitude up to 4000 m above mean sea level[13].

[7] The motors within the scope of this regulation fall within International Customs HS codes 850152 and 850153 (this is a necessary, but not a sufficient condition).
[8] 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.
[9] It is not necessary for the motors to have flanges, feet and/or shafts with mechanical dimensions conforming to IEC 60072-1:2022. Geared motors including those incorporating non-standard shafts and flanges are also covered by this regulation.
[10] This regulation may be implemented in up to three stages with a clear future timeline depending upon the availability of compliant products in the market. In the first stage, three phase motors between 0.12 kW-1000 kW may be covered with a MEPS of IE3. In the second stage single phase AC motors as well as ex eb motors for explosive atmospheres may be included. In the third stage, the MEPS requirement for 75 kW – 200 kW may be raised to IE4. Stages two and three are interchangeable.
[11] The power range differs for different pole configurations.
[12] The rated efficiency and efficiency classes are based on 25 °C ambient temperature according to IEC 60034-2-1:2024
[13] The rated efficiency and efficiency class are based on a rating for altitudes up to 1000 m above sea level.

Motors which are rated for both fixed speed operation (i.e. direct-on-line) and variable speed operation (e.g. through a variable speed drive), are within the scope of this regulation, but shall bear the IE efficiency class (in accordance with IEC 60034-30-1:2014) for fixed speed operation only.

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

1.2 Exemptions

This regulation does not apply to:

- Motors other than induction motors;
- 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[14];
- 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 60034-6:1991);
- 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 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, high frequency 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 the alternative requirements of the importing countries, if any;
- Motors placed on the market before <dd-mmm-YYYY> as substitutes for identical motors integrated in products placed on the market before <dd-mmm-YYYY>, and specifically marketed as such.

Article 2. Terms and Definitions

(a) *The 'Arithmetical mean'* is 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.

(c) *'Conformity Assessment Report' (CAR)* means the documentation prepared by the electric motor manufacturer or importer, which contains the compliance declaration, evidence, and test reports to demonstrate that the product is fully compliant with all applicable regulatory requirements.

(d) *'Cooling'* refers to a procedure by which heat resulting from losses 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 efficiency is determined 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.

[14] However, smoke extraction fan motors with a temperature class of up to and including 300 °C are covered by this regulation.

(g) *'Duty type'* means a continuous, short-term, 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 as defined in IEC 60034-1:2022.

(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 the quantity value of 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 the International Electrotechnical Commission publishes denoted by the letters "IEC" and identifying numbers and/or letters.

(m) *'Indirect efficiency determination'* means a method by which efficiency is determined 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 electrical and mechanical quantities values 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, specifically 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) '*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.

(r) '*Power factor'* means the ratio of 'active' or 'real' power (i.e. useful power) to 'apparent' power drawn by a motor from the mains.

(s) *'Rated output'* means the mechanical output power of the motor shaft at rated voltage and frequency. It is expressed in kilowatts (kW) in countries following the metric system, and in horsepower (hp) in other countries.

(t) *'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 power lines at the electric terminals.

(u) *'Rating'* means the set of assigned or declared values and operating conditions and indicated on the rating plate as rated values.

(v) '*Registration verification*' means a process of confirming that registered products comply with the requirements of a programme's entry conditions.

(w) '*Routine test'* means a test to which each individual motor is subjected during or after manufacture to ascertain whether it complies with certain criteria.

(x) '*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.

(y) '*Single-speed motor'* means a motor rated for 50 Hz and/or 60 Hz on-line operation.

(z) *'SI unit'* means any of the units adopted for international use under the Système International d'Unités.

(aa) *'Tolerance*' means the permitted deviation between the declared value of a quantity and the actual (measured or determined) value.

(bb) '*Type test*' means a test of one or more motors made to a specifc design to show that the design meets certain specifications.

Article 3. Requirements

All electric induction motors in the scope of this regulation, as defined in Article 1, that are that are manufactured in or imported into the country/region shall comply with 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.

3.1 Energy Efficiency Requirements

Motors shall conform to the following energy efficiency requirements:

a) The nominal energy efficiency[15] of a three-phase motor in the power range equal to or above 0.12 kW and below 0.75 kW ; a single-phase motor rated above 0.12 kW ; and an Ex eb motor for explosive atmospheres equal to or above 0.12 kW and equal to or below 1000 kW must not be less than the value specified in Table 1 (50 Hz) and Table 2 (60 Hz) as appropriate [IE2 efficiency class] for the specified rated output power and number of poles, at full load and under rated operating conditions.

b) The nominal energy efficiency of a three-phase motor in the power range equal to or above 75 kW and equal to or below 200 kW with 2-, 4- or 6- poles which are not brake motors, Ex eb increased safety motors, or other explosion-protected motors must not be less than the value specified in Table 5 (50 Hz) and Table 6 (60 Hz) as appropriate [IE4 efficiency class] for the specified rated output power and number of poles, at full load and under rated operating conditions.

c) The nominal energy efficiency of all other three-phase motors included in the scope of this regulation in the power range equal to or above 0.75 kW and equal to or below 1000 kW with 2-, 4-,6- or 8- poles must not be less than the value specified in Table 3 (50 Hz) and Table 4 (60 Hz) [IE3 efficiency class] for the specified rated output power and number of poles, at full load and under rated operating conditions.

Tables 1 to 6 show motors' energy efficiency, expressed in International Energy Efficiency classes (IE), for different motor-rated output power PN values at 50 Hz or 60 Hz. IE classes are determined at rated output power (PN) and rated voltage (UN) and based on a 25 °C ambient reference temperature.

For 50Hz or 60Hz motors the requirements above shall be met at the rated output power specified for 50 Hz or 60 Hz respectively.

For motors with a rated output power other than the values specified in the respective Tables, the efficiency value determined by the interpolation method specified in clauses 5.4.5 and 5.4.6 of IEC 60034-30-1:2014 shall apply.

When tested at rated voltage and rated frequency in accordance with IEC 60034-2-1:2024, the full-load energy efficiency of any individual motor shall not be less than the nominal efficiency declared by the manufacturer in technical documentation and on the rating plate, without any tolerance.

[15] 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 of 15 per cent on total losses according to IEC 60034-1:2022. This tolerance relates only to the verification of the actual 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 (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 2: 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 60034-30-1:2014 standard.

Table 3: 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 4: 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 3 and 4 correspond to the International Energy Efficiency class IE3 as per the IEC 60034-30-1:2014 standard.

Table 5: Nominal energy efficiency requirements for 50 Hz motors (IE4)

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	
75	95.6	96.0	95.4	
90	95.8	96.1	95.6	
110	96.0	96.3	95.8	
132	96.2	96.4	96.0	
160	96.3	96.6	96.2	
200	96.5	96.7	96.3	

Table 6: Nominal energy efficiency requirements for 60 Hz motors (IE4)

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	
75	95.0	96.2	95.8	
90	95.4	96.2	95.8	
110	95.4	96.2	96.2	
150	95.8	96.5	96.2	
185	96.2	96.5	96.2	
200#	96.2	96.5	96.2	
220	96.2	96.8	96.5	

values interpolated in accordance with clause 5.4.6 of IEC 60034-30-1:2014

The values in Tables 5 and 6 correspond to the International Energy Efficiency class IE4 as per the IEC 60034-30-1:2014 standard.

3.2 Product Information Requirements

The product information requirements set out in points (1) to (13) below shall be visibly displayed on:

(a) the technical data sheet or user manual supplied with the motor, unless an internet link to that information is supplied with the product. A QR code may in addition be supplied with a link to the information.;

(b) the technical documentation for the purposes of conformity assessment;

(c) free access websites of the manufacturer of the motor, its authorised representative, or the importer, and;

(d) the technical data sheet supplied with products in which the motor is incorporated.

Regarding the technical documentation, the information shall be provided in the order as set out in points (1) to (13). The exact wording used in the list does not need to be repeated. The information may be displayed using understandable graphs, figures, or symbols rather than text.

(1) rated efficiency (η_N) at the full, 75 per cent and 50 per cent rated load and voltage (U_N), determined based on operation at the relevant line frequency (50 or 60 Hz) and 25 °C ambient reference temperature, rounded to one decimal place;

(2) efficiency level: 'IE2' 'IE3' or 'IE4';

(3) manufacturer's name or trademark, commercial registration number and address;

(4) product's model identifier;

(5) number of poles of the motor;

(6) the rated power output(s) PN or range of rated power output (kW);

(7) the rated input frequency(s) of the motor (Hz);

(8) the rated voltage(s) or range of rated voltage (V);

(9) the rated speed(s) or range of rated speed (rpm);

(10) whether single-phase or three-phase;

(11) information on the range of operating conditions for which the motor is designed:

(a) altitudes above sea level (m);

(b) minimum and maximum ambient air temperatures, including for motors with air cooling (°C);

(c) water coolant temperature at the inlet to the product, where applicable (°C);

(d) maximum operating temperature (°C);

(e) potentially explosive atmospheres;

(12) if the motor is considered exempt from the efficiency requirement by Section 1.2 of this Regulation, what is the specific reason why it is considered exempt? For motors exempt from the efficiency requirements on account of being substitutes for identical motors integrated into products placed on the market before the coming into effect of this Regulation, the motor or its packaging and the documentation must indicate 'Motor to be used exclusively as spare part for' and the unique model identification of the product(s) for which it is intended.

(13) The power losses expressed in percentage (per cent) of the rated output power at the following different operating points for speed versus torque: (25;25) (25;100) (50;25) (50;50) (50;100) (90;50) (90;100) determined based on 25 °C ambient reference temperature, rounded to one decimal place; if the motor is not suited for operation at any of the operating points for speed versus torque above, then 'N.A.' or 'Not Applicable' should be indicated for such points.

The information referred to in points (1) and (2), as well as the year of manufacture, shall be durably marked on or near the motor's rating plate. Where the size of the rating plate makes it impossible to mark all the information referred to in point (1), only the rated efficiency at full rated load and voltage shall be marked.

The information listed in points (1) to (13) does not need to be published on free access websites for tailor-made motors with a special mechanical and electrical design manufactured based on a specific client request, if this information is included in the commercial offers provided to the clients.

Manufacturers shall provide information in the technical data sheet or user manual supplied with the motor on any specific precautions that must be taken when motors are assembled, installed, maintained, or used with variable speed drives.

3.3 Referenced Test Standards, Compliance Certification, Registration, And Surveillance Testing

The metrics, referenced standards, compliance certification, and surveillance testing criteria are set out in this section.

REFERENCED TEST STANDARDS[16]

Table 2. Reference Standards for Test Methods and Energy Efficiency Calculations

[16] IEC and other standards undergo revisions from time to time. The version of a standard referenced by this regulation shall be applicable for its implementation. Subsequent revisions in the standards, if any, shall be considered only when this regulation undergoes a revision, but not earlier.

Test method for determining motor energy efficiency.	IEC 60034-2-1:2024 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 60034-30-1:2014 Rotating electrical machines – Part 30-1: Efficiency classes of line operated AC motors (IE code).

COMPLIANCE CERTIFICATION

Test certificates are accepted from certified or accredited test laboratories, which may be either the 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 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 by submitting the complete product information as required under Article 3.2 and 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"[17] or equivalent may be registered by providing the registration certificate of the respective country.]

SURVEILLANCE TESTING

a) 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 efficiency of the motor at rated voltage and rated frequency and full- and partial-loads respectively is not less than the nominal efficiency according to Article 3.1, after allowing for the tolerance of 15 per cent on the total losses according to IEC 60034-1:2022.

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 15 per cent tolerance on the total losses according to IEC 60034-1:2022.

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

[17] 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.

b) The designated market surveillance authority shall verify compliance with the product information requirements according to clause 3.2 of this regulation for motors placed on the market by comparing the information provided by the importer and/or manufacturer with the requirements. The selection of motors shall be at the sole discretion of the surveillance authority. In the event of any deviations, a notice shall be issued for rectification within a reasonable period. This may be accompanied by enforcement actions in accordance with clause 6. If the rectification of the shortfall, if any, is not done within the notice period, the motor shall not comply with this regulation.

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

Article 4. Entry into Force

The product and information requirements set out in Article 3 shall take effect from <dd-mmm-yyyy>.

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) include test reports according to the specified standards;
(3) provide any other information required to be present in the technical documentation file;
(4) specify the reference settings and conditions that demonstrate compliance of the product with the conditions set by 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 and set in law. The supplier is obliged to check and update product conformity information, including informing the market surveillance authority of pertinent information related to product compliance as set in law by the authority without undue delay.

Article 6. Market Surveillance and Enforcement

The designated authority responsible for implementing this Regulation shall develop or designate an appropriate programme to check compliance with this standard and monitor the market for noncompliance. The programme(s) shall include details on sample size, lab accreditation requirements (to international standards such as ISO/IEC 17025:2017 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 market surveillance testing purposes shall follow 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 motors in the scope of this Regulation, which do not comply with the specified minimum energy performance requirements after the date of entry into force of this Regulation shall be liable for effective, proportionate and dissuasive sanctions, including, but not limited to warnings, fines, penalties, public naming, delisting etc. as may be determined by the designated authority.

An exception shall be allowed for motors that have been placed on the market (i.e., supplied by a manufacturer or importer for distribution and sale) before 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. Any person, other than an end-user, in possession of an electric induction motor in the scope of this Regulation that does not comply with the specified minimum energy performance requirements more than six months (if it a standalone product) or more than one year (if it is a component of a motor driven unit) after the date of entry into force of this Regulation, 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

This Regulation is anticipated to be reviewed no more than five years after its entry into force to consider technological progress, address any unforeseen loopholes being exploited, and consider any other relevant developments.

OPTION B - Bridging Starting Level (IE3)

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[18] 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 60034-1:2022[19] or the comparable NEMA MG1 Standard; and
- have frame sizes according to IEC 60072-1:2022[20] or comparable NEMA frame sizes; and
- are rated for direct-on-line operation on a three-phase sinusoidal voltage supply; and
- have a rated shaft power from 0.75 kW to 375 kW; and
- have 2, 4, 6 or 8 poles[21]; and
- have a rated voltage of 50 volts and above, up to and including 1000 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 for duty types S1, S3 >=80 per cent or S6 >=80 per cent as defined in the standards; and
- are designed to operate in any ambient temperature within the range of -30°C to + 60°C[22]; and
- are designed to operate at any altitude up to 4000 m above mean sea level[23].

Motors which are rated for both fixed speed operation (i.e. direct-on-line) and variable speed operation (e.g. through a variable speed drive), are within the scope of this regulation, but shall bear the IE efficiency class (in accordance with IEC 60034-30-1:2014) for fixed speed operation only.

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

1.2 Exemptions

Same as in OPTION A.

Article 2. Terms and Definitions

Same as in OPTION A.

[18] The motors within the scope of this regulation fall within International Customs HS codes 850152 and 850153 (this is a necessary, but not a sufficient condition).
[19] 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.
[20] It is not necessary for the motors to have flanges, feet and/or shafts with mechanical dimensions conforming to IEC 60072-1:2022. Geared motors, including those incorporating non-standard shafts and flanges, are also covered by this regulation.
[21] The power range differs for different pole configurations.
[22] The rated efficiency and efficiency classes are based on 25 °C ambient temperature according to IEC 60034-2-1:2024
[23] The rated efficiency and efficiency class are based on a rating for altitudes up to 1000 m above sea level.

Article 3. Requirements

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 comply with 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[24] 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 60034-30-1:2014 shall apply.

The full-load energy efficiency of any individual motor, when tested at rated voltage and rated frequency in accordance with IEC 60034-2-1:2024, 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 60034-1:2022.

[24] 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 of 15 per cent on total losses according to IEC 60034-1:2022. This tolerance relates only to the verification of the actual 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 60034-30-1:2014 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 covered in future (see OPTION A).

3.2 Product Information Requirements

Same as in OPTION A

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

Same as in OPTION A

Article 4. Entry into Force

Same as in Option A.

Article 5. Declaration of Conformity

Same as in Option A.

Article 6. Market Surveillance and Enforcement

Same as in Option A.

Article 7. Revision

Same as in Option A.

OPTION C - Bridging Starting Level, with limited time at IE2-level and transitioning to IE3-level

Article 1. Scope of Covered Products

Same as in OPTION B

Article 2. Terms and Definitions

Same as in OPTION A

Article 3. Requirements

[*Option C 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 three-phase electric induction motors in the power range 0.75 kW to 375 kW with 2-,4-,6- and 8- poles, that are manufactured in, or imported into the country/region, shall comply with 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[25] 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 60034-30-1:2014 shall apply.

The full-load energy efficiency of any individual motor, when tested at rated voltage and rated frequency in accordance with IEC 60034-2-1:2024, 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 60034-1:2022.

[25] 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: 2022specifically 15 per cent for motors below 150 kW, and 10 per cent for motors above 150 kW. This tolerance relates only to the verification of the actual 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 (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 2: 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 60034-30-1:2014 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.

3.2 Product Information Requirements

Same as in OPTION A.

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

Same as in OPTION A,

Article 4. Entry into Force

Same as in Option A.

Article 5. Declaration of Conformity

Same as in Option A.

Article 6. Market Surveillance and Enforcement

Same as in Option A.

Article 7. Revision

Same as in Option A.

SECTION II

Model Regulation Guidelines for Variable Speed Drives

Article 1. Scope of Covered Products

1.1 Scope

This Regulation covers VSDs with a 3-phase AC input that are manufactured in or imported into the country/region and are either sold as standalone equipment or as a component of a motor-driven unit and that:

(i) are rated for operating one motor with a rated output between 0.12 kW-1000 kW (equivalent VSD rating 0.278 kVA – 1209 kVA);

(ii) have a rated AC input voltage between 100 V - 1000 V;

(iii) and have only one AC output voltage.

1.2 Exemptions[26]

- VSDs with multiple AC outputs capable of driving more than one motor;
- VSDs with a single-phase AC input;
- VSDs integrated into a product and whose energy performance cannot be tested independently from the product, and an attempt to do so would render the VSD or the product inoperative;
- VSDs qualified specifically for the safety of nuclear installations;
- Regenerative drives;
- VSDs with sinusoidal input current;
- VSDs consisting of a single cabinet, comprising VSDs which are all in conformity with this Regulation.

Article 2. Terms and Definitions

Variable Speed Drive
'Variable speed drive' (VSD) means an electronic power converter that continuously adapts the electrical power supplied to a single motor to control the motor's mechanical power output according to the torque-speed characteristic of the load driven by the motor, by adjusting the power supply to a variable frequency and voltage supplied to the motor. It includes all protection devices and auxiliaries which are integrated into the VSD.

Variable Frequency Drive [same]
Inverter [same]
Drive [same]

CDM
complete drive module [same]

Drive Controller
drive module consisting of the electronic power converter connected between the electric supply and a motor as well as extensions such as protection devices, transformers, and auxiliaries.

[26] The list of exemptions is in accordance with current (2024.05) best practice international regulations based on IEC 61800-9-2, ed.1:2017 and the European Union regulation 2019/1781. These have been relaxed in IEC 61800-9-2. ed.2:2023 but this has not been adopted by any international regulations yet and is therefore not reflected in these model regulation guidelines.

RCDM
reference complete drive module
generic complete drive module defined by mathematical equations and/or power losses.
It is used as a basis for determining the IE class of an individual CDM.

Test load
the electrical device used for testing purposes that determines the output current and the output displacement power factor cos phi.

Article 3. Requirements

3.1 Energy Efficiency Requirements

A variable speed drive (VSD) within the scope of this regulation shall comply with the following requirements:
The power losses of the VSD shall not exceed the maximum power losses corresponding to the IE2 class as defined in IEC Standard 61800-9-2:2017, i.e. the maximum power losses are at least 25 per cent lower than the reference value referred to in Table 1:

Table 1: Losses of a Reference Variable Speed Drive, Efficiency Class IE1

Apparent Output Power of VSD $S_{r, equ}$	Rated power of motor (indicative)	Relative losses at 90% rated motor stator frequency and 100% rated torque-producing current $P_{l, RCDM (90,100)}$	Reference power losses (Absolute) at 90% rated motor stator frequency and 100% torque producing current $P_{L, RCDM (90,100)}$	Test load displacement power factor cos phi (+/- 0.08)
(kVA)	(kW)	%	(kW)	
0.278	0.12	35.85	0.100	0.73
0.381	0.18	27.30	0.104	0.73
0.500	0.25	21.80	0.109	0.73
0.697	0.37	16.84	0.117	0.73
0.977	0.55	13.21	0.129	0.73
1.29	0.75	11.02	0.142	0.79
1.71	1.1	9.51	0.163	0.79
2.29	1.5	8.21	0.188	0.79
3.30	2.2	7.20	0.237	0.79
4.44	3	6.72	0.299	0.79
5.85	4	6.39	0.374	0.79
7.94	5.5	6.01	0.477	0.85
9.95	7.5	5.84	0.581	0.85
14.4	11	5.43	0.781	0.85
19.5	15	5.18	1.01	0.85
23.9	18.5	5.05	1.21	0.85
28.3	22	4.97	1.41	0.85
38.2	30	4.87	1.86	0.85
47.0	37	4.79	2.25	0.85
56.9	45	4.75	2.70	0.86
68.4	55	4.74	3.24	0.86
92.8	75	4.69	4.35	0.86
111	90	4.66	5.17	0.86
135	110	4.11	5.55	0.86
162	132	4.10	6.65	0.86
196	160	4.09	8.02	0.86
245	200	4.07	10.0	0.87
302	250	4.10	12.4	0.87
381	315	4.09	15.6	0.87
429	355	4.09	17.5	0.87

483	400	4.09	19.8	0.87
604	500	4.08	24.7	0.87
677	560	4.08	27.6	0.87
761	630	4.08	31.1	0.87
858	710	4.08	35.0	0.87
967	800	4.08	39.4	0.87
1088	900	4.08	44.3	0.87
1209	1000	4.08	49.3	0.87

See application note[27]

Losses are determined in accordance with article 3.3.

If the apparent output power of a VSD is between two values in Table 1, the higher power loss value and the lower value of the test load displacement factor shall be used for the IE class determination.

Explanatory note:

IEC Standard 61800-9-2:2017 has defined the losses of a "Reference" Variable Speed Drive (termed as a "Reference Complete Drive Module" or "Reference CDM" in the standard) in the Table 1 and assigned it the Energy Efficiency class "IE1".

A VSD is classified as IE1 if its relative losses are within ±25 per cent of the values in the table i.e. 75 per cent to 125 per cent.

A VSD is classified as IE0 if its relative losses are higher than the values in the table by 25 per cent or more i.e. >125 per cent.

A VSD is classified as IE2 if its relative losses are at least 25 per cent lower than the values in the table i.e. <75 per cent.

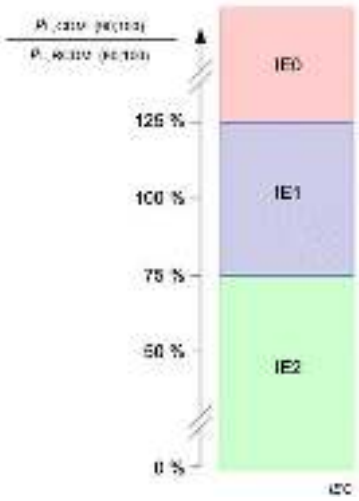


Figure 2: Illustration of IE classes for a VSD (CDM – Complete Drive Module)

3.2 Product Information Requirements

The product information on variable speed drives set out in points (1) to (11) shall be visibly displayed on:
(a) the technical data sheet or user manual supplied with the VSD, unless an internet link to that information is supplied with the product. A QR code may in addition be supplied with a link to the information;

(b) the technical documentation for the purposes of conformity assessment;

[27] The RCDM losses in Table 1 shall be used for all low voltage (above 200 V up and equal to 1000 V) CDMs. For a given apparent output power rating, CDMs with an input voltage up to and including 200V are expected to create higher losses than CDMs rated for higher input voltage. To take this into account, the values in Table shall be multiplied by a factor of 1.35 (reference IEC TS 61800-8:2010) when assessing the IE class for a CDM with a rated input voltage up to 200 V.

(c) free access websites of the manufacturer, its authorised representative, or the importer and;

(d) the technical data sheet supplied with products in which the VSD is incorporated.

As regards to the technical documentation, the information shall be provided in the order as listed in points (1) to (11). The exact wording used in the list does not need to be repeated. It may be displayed using clearly understandable graphs, figures, or symbols rather than text:

(1) power losses in per cent of the rated apparent output power at the following different operating points for relative motor stator frequency versus relative torque-producing current (0;25) (0;50) (0;100) (50;25) (50;50) (50;100) (90;50) (90;100), as well as standby losses, generated when the VSD is powered up but is not providing current to the load, rounded to one decimal place;

(2) efficiency level: 'IE2'. (Note that VDSs with efficiency classes IE1 and IE0 are not permitted to enter the market under this regulation);

(3) manufacturer's name or trademark, commercial registration number and address;

(4) product's model identifier;

(5) apparent output power or range of apparent output power (kVA);

(6) indicative motor rated output power values(s) PN or range of rated output power (kW); (7) rated output current (A);

(8) maximum operating temperature (°C);

(9) rated supply frequency(s) (Hz);

(10) rated supply voltage(s) or range of rated supply voltage (V);

(11) if the VSD is considered exempt from the efficiency requirements in accordance with section 1.4 of this Regulation the specific reason why it is considered exempt.

The information listed above in points (1) to (11) does not need to be published on free access websites for tailor-made VSDs with special electrical design manufactured based on a specific client request if this information is included in the commercial offers provided to the clients.

The power losses in per cent of the rated apparent output power at (90;100) in point (1) ; the information in point (2); and the year of manufacture, shall be durably marked on or near the rating plate of the VSD.

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

The metrics, referenced standards, compliance certification, and surveillance testing criteria are set out in this section.

REFERENCED TEST STANDARDS[28]

Topic	Standard
Test method for determining VSD energy efficiency	IEC 61800-9-2 Ed. 1.0; 2017. Adjustable speed electrical power drive systems – Part 9-2: Ecodesign for power drive systems, motor starters, power electronics and their driven applications – Energy efficiency indicators for power drive systems and motor starters. Subclause 7.7, the input-output measurement method; or Subclause 7.8, the calorimetric measurement method.
VSD efficiency classes (IE codes)	IEC 61800-9-2 Ed. 1.0; 2017. Adjustable speed electrical power drive systems
Rating, performance, and tolerance	IEC 61800-9-2 Ed. 1.0; 2017. Adjustable speed electrical power drive systems

[28] IEC and other standards undergo revisions from time to time. The version of a standard referenced by this regulation shall be applicable for its implementation. Subsequent revisions in the standards, if any, shall be considered only when this regulation undergoes a revision, but not earlier.

For the determination of the IE class, the power losses of VSDs shall be determined at 100 per cent rated torque-producing current and 90 per cent rated motor stator frequency.

The losses shall be determined according to one of the following methods:

— the input-output method, or

— the calorimetric method.

The test switching frequency shall be 4 kHz for apparent power ratings of VSDs up to and including 111 kVA (rated motor power of 90 kW), and 2 kHz for higher ratings, alternatively at the default factory settings as defined by the manufacturer. It is acceptable to measure VSD losses at a frequency of up to 12 Hz instead of zero Hz.

Manufacturers or their authorised representatives can also use the single loss determination method. Calculations must be performed with respect to component manufacturer's data with typical values of power semiconductors at the actual VSD operating temperature or at the maximum operating temperature specified in the datasheet. When no component manufacturer data is available, losses shall be determined by measurement. Combinations of calculated and measured losses are allowed. The different individual losses are calculated or measured separately, and the total losses are determined as the sum of all individual losses.

COMPLIANCE CERTIFICATION

Test certificates are accepted from test laboratories that have been certified or accredited. These may be either manufacturer's in-house laboratories or third-party laboratories.

REGISTRATION

Importers and manufacturers of motors, VSDs, and motor-driven units, equipment, or systems covered by this Regulation must register with the designated authority following the prescribed procedure, accompanied by the required documents and information and the applicable fees.
VSD designs covered by this Regulation must be registered with the designated authority by submitting the full product information required under section 3.2, together with test certificates as required by the above Test Certificates clause.

SURVEILLANCE TESTING

To verify the claimed energy efficiency of a VSD design covered by this regulation, the designated market surveillance authority shall test any one VSD to be picked at any time directly from the market, at its sole discretion, according to the test method prescribed above.
At most, the determined value shall be the declared value by more than 10 per cent.
If the selected VSD fails this test, the market surveillance authority shall randomly test three additional VSDs of the same design, except for VSDs produced in lower quantities than five per year.
For three additional units tested as prescribed in point C, the arithmetical mean of the values determined for these three additional units shall not exceed the declared value by more than 10 per cent.

Article 4. Entry into Force

The product and information requirements set out in Article 3 shall take effect from <dd-mmm-yyyy>.

Article 5. Declaration of Conformity

Suppliers (i.e., importers and manufacturers) shall provide the information and technical documentation necessary for the market surveillance authority to assess conformity, verify compliance, and any additional optional claims. The supplier can provide this information and technical documentation as a Conformity Assessment Report (CAR) and/or enter it into the relevant product registration database and/or supply it 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) include test reports according to the specified standards;
(3) provide any other information required to be present in the technical documentation file;
(4) specify the reference settings and conditions that demonstrate compliance of the product with the conditions set by this Regulation.

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 17025:2017 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.

Article 7. Revision

It is anticipated that this Regulation shall be reviewed after not more than five years after its entry into force, to consider technological progress, to address any unforeseen loopholes being exploited and any other relevant developments.

SECTION III

Model Regulation Guidelines for Fans Driven by Motors with an Electric Input Power between 125 W and 500 KW

Article 1. Scope of Covered Products

1.1 Scope

This regulation applies to all fans, fans with an electric input power between 125 W and 500 kW (≥125 W and ≤500 kW) at their best efficiency point, that are manufactured in or imported into the country/region and are either sold as standalone equipment or integrated into other products.

1.2 Exemptions

1. This regulation does not apply to:
(a) fan impellers mounted on the shaft of electric motors with the sole purpose of cooling the motor itself;
(b) fans integrated into laundry and washer-dryers with maximum electric input power lower than or equal to 3 kW;
(c) fans integrated into kitchen hoods with total maximum electric input power attributable to the fan(s) lower than 280 W;
(d) fans with a best energy efficiency point at 8 000 revolutions per minute or more
(e) jet fans with maximum electric input power lower than 750 W.

2. This regulation shall not apply to fans that are specified to operate exclusively as follows and are specifically designed and marketed as such:
(a) in potentially explosive atmospheres;
(b) for emergency use only, capable of short-time duty operation of 1 hour or more at temperatures of 300 °C and above;
(c) where operating temperatures of the gas being moved can be higher than 100 °C, or lower than -40 °C, or both;
(d) where operating ambient air temperatures for the motor driving the fan, if located outside the gas stream, can be higher than 60 °C, or lower than -30 °C, or both;
(e) with a supply voltage higher than 1 000 V AC or higher than 1 500 V DC;
(f) in a toxic, highly corrosive or flammable environment;
(g) in an environment with abrasive substances;
(h) in cordless or battery-powered equipment;
(i) in handheld equipment whose weight is supported by hand during operation;
(j) in hand-guided mobile equipment moved while in operation.

Article 2. Terms and definitions

The following definitions apply:

1. 'fan' means a rotary-bladed machine that receives energy and utilises it by means of one or more impellers to maintain a continuous flow of air or other gas passing through it and, with a specific ratio lower than 1.1 and an output air velocity lower than 65 m/s, which can be of the following categories: axial, centrifugal,

cross-flow, mixed-flow or jet, and made of at least an impeller, a motor and a stator, and includes any other significant elements that are supplied with the fan;

2. 'Significant elements' means the elements of a fan that contribute to the continuous conversion of electric power into air volume flow rate and pressure, or that influence the efficiency of that conversion, namely:
    (a) impeller(s), including all rotating elements that have an aerodynamic influence;
    (b) electric motor;
    (c) stator;
    (d) other stationary aerodynamic elements that have an aerodynamic influence, including:
        i. inlet cone;
        ii. inlet or outlet guide vanes;
        iii. diffuser;
    (e) other stationary elements that have an aerodynamic influence, including:
        i. mechanical transmission (aerodynamic influence and influence on efficiency);
        ii. electrical transmission (aerodynamic influence and influence on efficiency), such as cable conduits, frequency inverter, variable speed drive, terminal box, AC/DC converter;
        iii. structural components that hold the assembly in place and may interfere with the airflow (such as brackets supporting the motor or the bearings);
3. 'Best efficiency point' (BEP) means the best energy efficiency point for fan operation, as declared by the manufacturer and specified by the fan speed, expressed in revolutions per minute (rpm);
4. 'impeller' means the rotating part of the fan that is imparting energy into the gas flow and is also known as the fan wheel;
5. 'Electric motor' or 'motor' means a device that converts electrical input power into mechanical output power in the form of a rotation with a rotational speed and torque that depends on factors including the frequency of the supply voltage and the number of poles of the motor as applicable;
6. 'Inlet cone', also known as venturi inlet, inlet bell, inlet radius, means a device that steers the air into the impeller and reduces the vena contracta and turbulence that would occur at the entrance of the impeller;
7. 'Inlet guide vanes' means vanes positioned before the impeller to guide the gas stream towards the impeller and which may or may not be adjustable;
8. 'Outlet guide vanes' means vanes positioned after the impeller to guide the gas stream from the impeller and which may or may not be adjustable;
9. 'diffuser' means a device that influences the fan performance through static recovery;
10. 'Protective guard' means a grid placed at fan inlet or outlet designed to prevent relatively large foreign bodies or human body elements from reaching the moving parts;
11. 'stator' means the stationary part of the fan that interacts with the air stream passing through the impeller and, within the geometrical air-stream envelope between defined fan inlet and outlet sections, includes any element that may increase, and excludes any non-fan element that may decrease, the fan efficiency;
12. 'Drive system' means electric motor, transmission or direct drive and a variable speed drive if supplied;
13. 'Direct drive' means a driving arrangement for a fan where the impeller is fixed to the motor shaft, either directly or with a coaxial coupling, and where the impeller speed is identical to the motor's rotational speed;
14. 'transmission' means a driving arrangement for a fan that is not direct drive, including using a belt drive, gearbox or slipping coupling;
15. 'variable speed drive' (VSD) means an electronic power converter, integrated or functioning as a separate unit, that continuously adapts the electric power supplied to a single motor, or multiple motors in order to control the motor's mechanical power output according to the torque-speed characteristic of the load driven by the motor, by adjusting the power supply to a variable frequency and voltage supplied to the motor,

including EC (electronically commutated) motors' internal controllers, excluding variable voltage controllers where only the supply voltage for the motor is varied, including all integrated protection devices and auxiliaries;

16. 'Specific ratio' means the stagnation pressure measured at the fan outlet divided by the stagnation pressure at the fan inlet at BEP;
17. 'Fan flow angle' means the angle between incoming and outgoing gas flow direction of the fan impeller, expressed in degrees, as set out in Article 3.1.3;
18. 'Axial fan' means a fan with a fan flow angle <20°, as set out in point 4 of Article 3.1.3;
19. 'Centrifugal fan' means a fan with a flow angle ≥70°, as set out in point 4 of Article 3.1.3;
20. 'Mixed flow fan' means a fan with a flow angle ≥20° and <70°, as set out in point 4 of Article 3.1.3;
21. 'Centrifugal blade angle' means the blade angle β2 of a centrifugal fan, expressed in degrees, as set out in point 5 of Article 3.1.3;
22. 'Forward curved fan' means a centrifugal fan with a fan blade angle β2 >90°, as set out in point 5 of Article 3.1.3;
23. 'Backward curved fan' means a centrifugal fan with a fan blade angle β2 where 0° < β2 <50°, as set out in point 5 of Article 3.1.3;
24. 'Backward inclined fan' means a centrifugal fan with a fan blade angle β2 where 50°< β2 ≤90°, as set out in point 5 of Article 3.1.3;
25. 'Cross-flow fan' means a fan in which the gas path through the impeller is in a direction essentially at right angles to its axis both entering and leaving the impeller at its periphery;
26. 'jet fan' means an axial, centrifugal or radial fan that produces a high velocity jet of air in a space (thrust), unconnected to any ducting, where the jet of air induces movement of the surrounding air, creating an overall air flow through the space, and that is designed for operation with open inlets, including radial and centrifugal jet fans with an angle entrance of ≤90° to the outlet, and outlets rather than operating against pressure;
27. 'Declared values' means the values provided by the manufacturer, importer or authorised representative for the stated, calculated or measured technical parameters in accordance with Article 5, for the verification of compliance by the Member State authorities;
28. 'Equivalent model' means a model that has the same technical characteristics relevant for the technical information to be provided, but which is placed on the market or put into service by the same manufacturer, importer or authorised representative as another model with a different model identifier;
29. 'Model identifier' means the code, usually alphanumeric, which distinguishes a specific product model from other models with the same trademark or the same manufacturer's, importer's or authorised representative's name;
30. 'Multiple speed motor' means a motor of which the rotating speed can be varied by energising different motor windings;
31. 'Air-circulating fan' means a fan that is unconnected to any ducting, without a stator or with a stator that cannot be connected to ducting, used for moving air within a space, such as a room or open-air area. There is no partition between inlet and outlet and the air circulates freely from outlet to inlet, it operates against zero external pressure and is not a jet fan and is not marketed as such. Its measurement arrangement is as per measurement category E. Fans for which performance information at any pressure different than zero Pa is provided on the manufacturer's website, catalogues, brochures, technical documentation, or other relevant means are not air circulating fans.

Article 3. Requirements

3.1 Energy Efficiency Requirements

The minimum efficiency requirements for fans are set out in Article 3.1.2.

Compliance with energy efficiency requirements shall be measured and calculated in accordance with requirements set out in Articles 3.1.2 and 3.1.3.

3.1.1 Definitions For The Purposes Of Energy Efficiency Requirements

(1) 'Measurement category' means a test, measurement or usage arrangement that defines the inlet and outlet conditions of the fan being tested;

(2) 'Measurement category A' means an arrangement where the fan is measured with free inlet and outlet conditions, and a partition between inlet and outlet zone;

(3) 'Measurement category B' means an arrangement where the fan is measured with free inlet and with a duct fitted to its outlet, and a partition between inlet and outlet zone;

(4) 'Measurement category C' means an arrangement where the fan is measured with a duct fitted to its inlet and free outlet conditions, and a partition between inlet and outlet zone;

(5) 'Measurement category D' means an arrangement where the fan is measured with a duct fitted to its inlet and outlet, and a partition between inlet and outlet zone;

(6) 'Measurement category E' means an arrangement where the fan is measured with free inlet and outlet conditions, and without a partition between inlet and outlet zone;

(7) 'Efficiency category' means the fan gas output energy form used to determine the fan energy efficiency, with a distinction for all fans except jet fans between 'static' or 'total' efficiency depending on whether the fan gas power has been determined with respectively the fan static pressure or fan pressure;

(8) 'fan efficiency' (η) means the ratio of the fan gas power output P_u and the electric input power P_e, both expressed in W and determined at BEP, multiplied with correction factors for power conversion C_p, part load compensation C_c and guard compensation C_{guard}, with a distinction between 'static' or 'total' efficiency depending on whether the fan gas power P_u has been determined with respect to the fan static pressure or fan pressure, in accordance with point 6.1 of Article 3.1.3;

(9) 'fan gas power' (P_u), in W, means the product of the volume flow rate q_v, in m³/s, and the applicable pressure difference between fan inlet and outlet Δp (fan pressure or fan static pressure), in Pa, both determined at BEP, with a distinction between 'static' or 'total' fan gas power depending on whether the fan gas power has been determined with, respectively, the fan static pressure or fan pressure;

(10) 'Electric input power' (P_e), in W, means the electric input power at BEP or T_m, measured at main terminals of motor or, when present, of variable speed drive;

(11) 'Power conversion correction' (C_p), means a correction factor for power conversion losses, as determined according to point 6 of Article 3.1.3;

(12) 'Part load compensation' (C_c) means a correction factor for part load, as determined according to point 6 of Article 3.1.3;

(13) 'Guard compensation' (C_{guard}) means a correction factor, as determined according to point 6 of Article 3.1.3, that may be applied when calculating fan efficiency where the fan is equipped with permanently fitted protective guards that cannot be removed without making the fan inoperable;

(14) 'Volume flow rate' (q_v), in m³/s, means the gas volume displaced per unit of time by the fan and is derived from the mass flow rate, typically with standard air with a density ρ at default 1'200 kg/m³;

(15) 'Total pressure' (p_{tot}), in Pa, means the pressure calculated from the absolute pressure and the dynamic pressure;

(16) 'Absolute pressure' (p), in Pa, means the pressure measured with respect to absolute zero pressure;

(17) 'Dynamic pressure' (p_d), in Pa, means the pressure calculated from the velocity and the density;

(18) 'Fan static pressure' (p_{fs}), in Pa, means the difference between the static pressure at the fan outlet and the stagnation pressure at the fan inlet or, when the compressibility phenomenon is not a factor, the difference between the static pressure at the fan outlet and the total pressure at the fan inlet. It is the omnidirectional force per unit surface area exerted at the fan outlet and is typically assessed by measuring the stagnation pressure in a (cylindrical) hole of appropriate geometry and dimensions, in duct wall or appropriate measurement instrument perpendicular to the direction of the gas flow;

(19) 'Fan pressure' (p_f), in Pa, means the difference between the stagnation pressures at the fan outlet and the fan inlet or, when compressibility phenomenon is not a factor, the difference between the total pressures at the fan outlet and the fan inlet. It is the directional force per unit surface area exerted at the fan outlet and is typically assessed by measuring the stagnation pressure in a (cylindrical) hole of appropriate geometry and dimensions facing the direction of the gas flow;

(20) 'Stagnation pressure' (p_{sg}), in Pa, means the pressure measured at a point in a flowing gas if it were brought to rest via a process where there is no transfer of heat or matter;

(21) 'Efficiency grade' means a parameter in the calculation of the minimum energy efficiency of a fan of specific electric input power at its BEP or at T_m (expressed as parameter '*N*' in the calculation of the fan energy efficiency);

(22) 'Minimum fan efficiency' (η_{min}) means the fan efficiency to be achieved in order to meet the requirements, calculated as the outcome of the appropriate equation in Article 3.1.2, using the applicable integer *N* of the efficiency grade and the electric input power P_e of the fan expressed in kW at its BEP;

(23) 'Minimum jet fan efficiency ($\eta_{r,min}$)' means fan efficiency to be achieved in order to meet the requirements, calculated as the outcome of the appropriate equation in Article 3.1.2, using the applicable integer N of the efficiency grade and the electric input power P_e of the fan expressed in kW at its measured thrust;

(24) 'Measured thrust *(T_m)'* is the jet fan thrust measured, in N, assessed according to measurement category E and converted to the density of 1.2;

(25) 'Jet-fan efficiency' $\eta_r(T)$ means the fan gas power output derived from the measured thrust of a jet fan divided by the electric input power P_e, multiplied with correction factors for power conversion C_p, part load compensation C_c and guard compensation C_{guard}, in accordance with point 6.2 of Article 3.1.3;

(26) 'Specific speed' (σ_{BEP}) means the ratio between volume flow rate and fan pressure as dimensionless characteristic number determined at BEP, in accordance with point 8 of Article 3.1.3;

(27) 'Low noise fan' means an axial fan with an electric input power of 10 kW or more with a maximum characteristic noise emission value L ≤32 dB(A) at BEP;

(28) 'Dual use fan' means a fan designed for both ventilation under normal conditions and emergency use as set out in Article 1.2 (2), point (b);

(29) 'Reversible fan' means a fan capable of reaching at least 80 per cent of the nominal forward volume flow rate in the reverse direction;

(30) 'Custom fan' means a fan having a custom design for a specific customer and/or contract with respect to one or more of the significant elements, and an operating point or range specified by the customer/contract. These fans are only supplied to that customer/contract. Details are not presented in catalogues, online media or general selection tools. The performance details are specific to the application and the customer/contract;

(31) 'Safety critical fan' means a fan that has been designed, verified, certified and manufactured under the scope of regulation relating to equipment and protective systems intended for use in potentially explosive atmospheres;

(32) 'Professional repairer' means an operator or undertaking which provides services of repair and professional maintenance of fans;

(33) 'Manufacturer-authorised professional repairer' means a professional repairer authorised by the manufacturer, importer or authorised representative to repair safety critical fans they place on the market.

(34) 'Wearing parts (sacrificial elements)' means parts that are intentionally designed to wear, for the fan to meet the requirements of its intended use. For example, where a fan is used in an abrasive environment the fan can quickly become damaged by the abrasion. Some parts are designed as sacrificial elements to protect other critical areas and are designed to be replaced more frequently;

(35) 'Proprietary tool' means a tool that is not commonly available and is specifically designed for a function that cannot be safely and/or reliably achieved by a commonly available tool;

(36) 'Inherent speed' means the rotation speed of the fan, when the fan is operated at nominal or rated supply conditions of the motor;

(37) 'guarantee' means any undertaking by the manufacturer, importer or authorised representative to the consumer, to: (a) reimburse the price paid; or (b) replace, repair or handle fans in any way if they do not meet the specifications set out in the guaranteed statement or in the relevant advertising;

(38) 'Spare part' means a separate part that can replace a part with the same or similar function in a fan;

(39) 'Spare part fan' means a fan intended to replace a corresponding existing fan that is integrated into a product.

3.1.2 Minimum Fan Efficiency Requirements

The following rules shall apply:

1. Fans, except jet fans, cross flow fans and fans referred to in point 7, shall have a fan efficiency (η) equal to or larger than the minimum fan efficiency (η_{min}), which is a function of the electric input power P_e (in kW) and minimum efficiency grade N following the equations:

   — for fans with P_e <10 kW: $\eta_{min} = 4.56 \ln(P_e) - 10.5 + N$ *[%];*

   — for fans with P_e ≥10 kW: $\eta_{min} = 1.1 \ln(P_e) - 2.6 + N$ *[%];*

2. Jet fans shall have a fan efficiency (η_r) equal to or larger than the minimum jet fan efficiency ($\eta_{r,min}$), which is a function of the electric input power Pe (in kW) and minimum efficiency grade N following the equations:

   — for jet fans with P_e ≥750 W and <10 kW: $\eta_{r,min} = 7.32 \ln(P_e) - 21.25 + N$ *[%];*

   — for jet fans with P_e ≥10 kW: $\eta_{r,min} = 1.73 \ln(P_e) - 8.35 + N$ *[%];*

3. Cross flow fans shall have a minimum total fan efficiency (B,D) of at least 0.21 (21per cent) over the entire power range;

4. The fan efficiency shall be established in accordance with the measurement and calculations methods set in Article 3.1.3;

where, except for cross flow fans, values of efficiency grade N are set out in Table 1 below per fan type, efficiency category (static or total pressure) and measurement category (A to E) as appropriate, with the

- Tier 1 efficiency grades applicable from Date/Month/Year, and
- Tier 2 efficiency grades applicable from Date/Month/(Year+2).

Table 1. Minimum efficiency grades for fans, tier 1 and tier 2

Fan type	Measurement category	Efficiency category (pressure)	Minimum efficiency grades (N) Tier 1	Minimum efficiency grades (N) Tier 2
Axial fans	A,C	static	45	50
	B, D	total	61	64
Forward curved <5 kW and backward inclined centrifugal fans	A, C	static	48	52
	B, D	total	53	57
Other centrifugal fans	A, C	static	60	64
	B, D	total	64	67
Mixed flow fans	A, C	static	57+7*(α-45)/25	57+7*(α-45)/25
	B, D	total	65	67
Jet fans	E	total	-	50

5. The calculation of the minimum efficiency grade N for mixed flow fans involves the fan flow angle α, in degrees rounded to the nearest integer, established in accordance with point 4 of Article 3.1.3.

6. For fans having the following characteristics, the values of the minimum efficiency grades N set out in Table 1 shall be multiplied by the corresponding factor(s), as applicable:

Fan characteristics	Factor value
Dual use fans designed for both ventilation under normal conditions and emergency use as set out in Article 1.2, point 2(b)	0.9
Reversible fans	0.85
Low noise fans	0.9

7. For centrifugal fans with specific speed σ_{BEP} <0.12, electric input power P_e <10 kW, measurement category B or D and efficiency category 'total', the minimum fan efficiency (η_{min}) is a function of σ_{BEP} as follows: $\eta_{min} = 2.95 * \sigma BEP + 0.2$.

3.1.3 Measurements and Calculations

1. For the purposes of compliance and verification of compliance with the requirements of this Regulation, measurements and calculations shall be made using harmonised standards the reference numbers of which have been published in Article 3.1.3, or using other reliable, accurate and reproducible methods that take into account the generally recognised state-of-the-art methods, in line with provisions set out in points 2 to 8.

   In the absence of existing relevant standards and until the publication of the references of the relevant harmonised standards, the transitional testing methods set out in Table 2, or other reliable, accurate and reproducible methods, which take into account the generally recognised state-of-the-art methods, shall be used, in line with provisions sent out in points 2 to 8.

   Manufacturers, importers or authorised representatives shall use the declared values of the parameters referred to in Article 5, point (1) for the calculations in this Article.

2. For the purpose of assessing compliance with the requirements of this Regulation and provided that reliable, accurate and reproducible test- and calculation methods are used, the manufacturer:

   (a) may remove the elements that are not significant elements as defined in Article 5, point (1);

   (b) may conduct the tests with the geometrical equivalent of the stator inner surface;

(c) may conduct the tests with a scale model of the fan and calculate the results for the real-size fan if the fan has an impeller diameter above 1 m for jet fans or 0.5 m for other fans;

(d) may conduct the tests at customer's or manufacturer's site if the fan has an impeller diameter above 1 m for jet fans or 0.5 m for other fans.

3. The compliance of fans with multiple speed motors shall be determined at the power and speed corresponding to the highest speed made available to the customer.

   The compliance of fans of which the blade pitch angle can be adjusted to fulfil the customer's duty point shall be determined using the least favourable pitch configuration made available to the customer.

4. Fan flow angle

   The fan flow angle α is calculated as the average value of angles α1 and α2 following the formula:

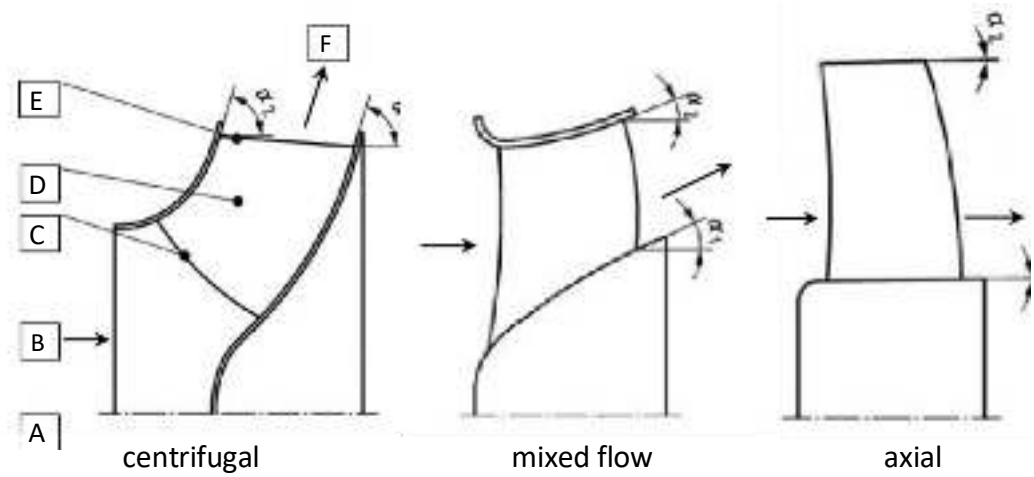
$$\alpha = \frac{\alpha_1 + \alpha_2}{2}$$

where:

α1 is the angle to the direction of the rotational axis of the tangent at the hub at the intersection of the blade trailing edge with the hub;

α2 is the angle to the direction of the rotational axis of the tangent at the shroud or at the outer diameter of the blade at the intersection of the blade trailing edge with the shroud or with the outer diameter of the blade, given that, if the hub and/or shroud are not axisymmetric, angles α1 and α2 are the average values in circumferential direction.

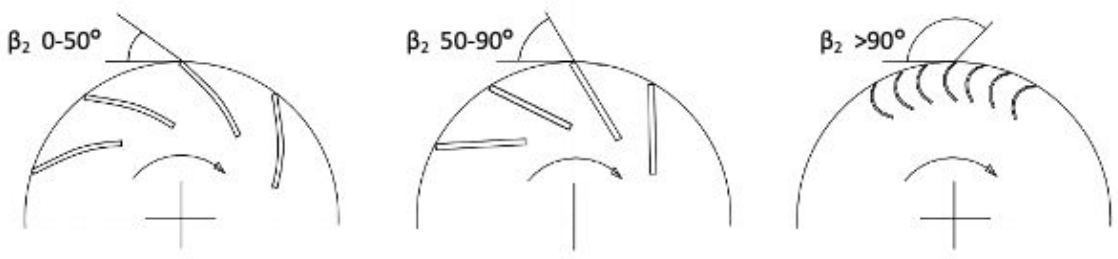
An impeller defined as 'axial' if α <20°, 'mixed-flow' if 20°≤ α <70° and 'centrifugal' if α ≥70°.



Where: A = rotation axis; B = inflow; C = leading edge; D = blade; E = trailing edge; F = outflow

5. Centrifugal blade angle

   Centrifugal blade angle β_2 means the angle between the tangent to the outer circumference of the outer circle, as defined by the trailing edge of the blades, and a line bisecting the trailing edge of the blade. To consider blade designs that have a rapid change of angle at the trailing edge, the angle is the arithmetic mean along 50 per cent of the trailing length of the blade. The trailing edge of the blade is the edge at the tip of the blade at the outlet of the impeller. A centrifugal impeller is defined as 'backward curved' if $0° < \beta_2 \leq 50°$, 'backward inclined' if $50° < \beta_2 \leq 90°$ and 'forward- curved' if $\beta_2 > 90°$.



Backward curved | Backward inclined | Forward curved

6. Fan efficiency

6.1 Fans, other than jet fans

The fan efficiency is calculated as follows:

$$\eta = C_p \cdot C_C \cdot C_{guard} \cdot P_u / P_e$$

where:

C_p is a correction factor for power conversion losses with a value of 0.9 for fans equipped with a DC motor with a rated voltage lower than 100 V when the converter transforming AC into DC is not part of the fan, and 1.0 otherwise;

C_C is a correction factor for part load compensation with one of the following values:

- C_C = 1 for a fan without a variable speed drive;
- C_C = 1.04 for a fan with a variable speed drive and P_e ≥5 kW and where this variable speed drive is included in the fan conformity assessment;
- $C_C = 1 + 0.0812 (P_e)^{-0.5}$ for a fan with a variable speed drive and P_e <5 kW and where this variable speed drive is included in the fan conformity assessment;

C_{guard} is a correction factor for guard compensation that may be applied when calculating fan efficiency in case the fan is equipped by permanently fitted protective guards that cannot be removed without making the fan inoperable. The value of C_{guard} is:

- 1 for a fan without a protective guard, with removable protective guard, or a protective guard with opening e > 30 mm;
- 1+(30-e)*0,004 for a fan equipped with a protective guard with opening 20 < e ≤ 30 mm;
- 1,04+(20-e)*0,0035 for a fan equipped with a protective guard with opening 10 < e ≤ 20 mm;
- 1,075+(10-e)*0,0375 for a fan equipped with a protective guard with opening 8 < e ≤ 10 mm;
- 1.15 for a fan equipped with a protective guard with opening e ≤ 8 mm,

where 'e' is the dimension of the opening, corresponding to the side of a square opening, the diameter of a round opening and the narrowest dimension of a slot opening, as defined in section 4.2.4.1 of standard ISO 13857:2019;

P_u, in W, is the product of the volume flow rate q_v, in m³/s, and the applicable pressure difference between fan in- and outlet Δp, in Pa, both determined at BEP, following the expression:

$$P_u = q_v \cdot \Delta p,$$

were q_v, in m³/s, is the gas volume displaced per unit of time by the fan and is derived from the mass flow rate, typically with standard air with a density ρ at default 1.200 kg/m³.

6.2 Jet-fans

The jet-fan efficiency $\eta_r(T)$ is calculated as:

$$\eta_r(T) = C_p \cdot C_c \cdot C_{guard} \cdot q_v(T) \cdot \Delta p(T)/P_a = C_p \cdot C_c \cdot C_{guard} \cdot 0.5 \cdot \sqrt{\frac{Tm}{\rho \cdot A2}} \cdot \frac{Tm}{Pe}$$

where:

$q_V(T)$ is volume flow rate at thrust T, in m³/s;

$\Delta p(T)$ is pressure difference at thrust T, in Pa;

Pe electric input power supplied to the fan, in W;

ρ is the standard air density (1.2 kg/m³);

$A2$ is the gross fan outlet area in m²;

Tm is the jet fan thrust as defined in Article 3.1.3 (24);

C_p, C_c and C_{guard} are correction factors as outlined in clause 6.1 above.

7. Characteristic noise emission value L

The characteristic noise emission value, in dB(A) is defined as

$$L = PWL_{impeller} - 30 \log u_{tip} - 10 \log (0.001 \cdot q_V \cdot p_{fs}) + 5 \log D_{impeller}$$

where:

$PWL_{impeller}$ is impeller sound power level at BEP, in dB(A);

u_{tip} is impeller tip speed at BEP, in m/s; q_V is volume flow rate at BEP, in m³/s;

p_{fs} is fan static pressure at BEP, in Pa;

$D_{impeller}$ is impeller diameter, in m.

8. Specific speed σ_{BEP}

The specific speed σ_{BEP} of centrifugal fans with electric input power P_e <10 kW, measurement category B or D and efficiency category 'total' is defined as:

$$\sigma_{BEP} = n \cdot \frac{2 \cdot \sqrt{\pi \cdot qv, BEP}}{(2 \cdot \frac{pf, BEP}{\rho})^{0,75}}$$

where:

σ_{BEP} is specific speed

n is fan speed in revolutions per second (rps);

ρ is air density 1.2 kg/m³;

$q_{V,BEP}$ is volume flow rate at BEP, in m³/s;

$p_{f,BEP}$ is fan pressure at BEP, in Pa;

π is the number pi (3.14…).

Table 2. References and qualifying notes for fans[29]

Parameter	Reference/Title	Notes and short description
	FprEN 17166:2020 Fans – Procedures and methods to determine the energy efficiency for the electric	

[29] The source of referenced standards is CEN (European Committee for Standardization) unless otherwise indicated

	input power range of 125 W up to 500 kW	
Measurement category	4.3 Identification of an appropriate measurement category.	The measurement category means a test, measurement or usage arrangement that defines the inlet and outlet conditions of the fan under test, used to determine the energy efficiency. Categories included are numbered A through E, according to ISO 13349:2010 and ISO 5801:2017 subclauses 6.2, 6.3, 6.4, 6.5 (categories A though D) and ISO 13350:2015 (category E – jet fans).
Efficiency category	3.15.1 and 3.15.3 Definitions of fan pressure and fan static pressure.	The fan gas output energy form used to determine the fan energy efficiency, defined by fan pressure or fan static pressure.
Efficiency grade	6.1 and 6.2 Method of comparison between efficiency grades.	The parameter in the calculation of the minimum fan energy efficiency is denoted in this Regulation as '*N*'. In FprEN 17166:2020 the minimum required efficiency grade is denoted N_g.
Fan efficiency	5.5.2.5 Testing of jet fans.	Jet fan overall efficiency is calculated following ISO 13350:2015.
Volume flow rate q_v	3.18 Volume flow rate.	Volume flow rate q_{v1} is the mass flow rate divided by the density at fan inlet: $q_{v1} = q_m / \rho_1$. ISO 5801:2017 subclause 11.2 and Annex A for mass flow rate measurement and calculation, whereby the volume flow rate can be calculated according to subclause 15.1.8.
Specific speed σBEP	3.15.1	The ratio between flow rate and fan pressure as dimensionless characteristic number determined at BEP, which can be calculated according to Article 3.1.3, 8. The needed fan pressure can be calculated according to FprEN 17166:2020 subclause 3.15.1.
	ISO 5801:2017 Fans –Performance testing using standardised airways	
Pressure difference Δp (in Pa) at BEP	12.8.9 Method of measurement.	Describes how to measure pressure difference between fan inlet and outlet, which following the Regulation must be measured at BEP.
Fan speed (rpm)	7.2 and 12.3 Rotational speed.	
Specific ratio	15.1.6 Fan pressure.	The stagnation pressure measured at the fan outlet divided by the stagnation pressure at the fan inlet at nominal flow rate. The specific ratio can be calculated from ISO 5801:2017 subclause 3.35 where it is defined as fan pressure ratio (r), where $r = p_{sg2} / p_{sg1}$.
	IEC 60034-2-1:2014 Rotating electrical machines - Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)	

Electric input power P_e (in kW)	6.1.2 Direct measurement of input (P_1) and output (P_2).	The electric input power at BEP, measured at main terminals of motor or, when present, variable speed drive. IEC 60034-2- 1:2014 for the electric input power of electric motors fed directly from the grid, IEC 61800-9-2:2017 for the electric input power of electric motors combined with and fed by a CDM).

3.2 Information Requirements on Fans

3.2.1 Product Information Requirements on Fans

1. With effect from Date/Month/(Year), the information on fans set out in points 2(a) to (o) shall be visibly displayed in:
   (a) the technical data sheet or user manual supplied with the fan, unless an internet link or a QR code linking to the free access website referred to in point (c) is supplied with the fan. A pictogram as in ISO 7000:2019 reference n°1641 is displayed next to the link or QR code;
   (b) the technical documentation for the purposes of conformity assessment pursuant to Article 5, in the order as listed in points 2(a) to (q), the exact wording does not need to be repeated, information may be displayed using graphs, figures or symbols rather than text;
   (c) free access websites of the manufacturer of the fan, its authorised representative or the importer for a period of at least 20 years after the placing on the market of the last unit of the model concerned.
2. The following information shall be displayed:
   (a) fan type: select one of the following types: axial fan, forward curved centrifugal fan, backward curved centrifugal fan, backward inclined centrifugal fan, cross flow fan, mixed flow fan, jet fan;
   (b) fan efficiency (η *or* η_r), either as a number rounded to the nearest third decimal, or as a percentage (with symbol '%') rounded to the nearest decimal;
   (c) whether the calculation of fan efficiency assumed use of a VSD and if so, whether the VSD is integrated in the fan or the VSD must be installed with the fan;
   (d) measurement category used to determine the fan efficiency (A-E);
   (e) efficiency category (static or total), except for jet fans;
   (f) efficiency grade *N* at BEP or T_m, except for cross flow fans;
   (g) the electric input power P_e (in kW, rounded to the nearest third decimal), volume flow rate q_v (in m³/h rounded to the nearest integer, or alternatively, when flow rate is ≥ 0.50 m^3/s in m³/s rounded to the nearest second decimal), and applicable pressure difference Δp (in Pa, rounded to the nearest integer) at BEP or T_m;
   (h) special characteristics: select one or more of the following: dual use fan, reversible fan, low noise fan.
   (i) DC voltage lower than 100 V, with answer 'yes' or 'no';
   (j) list of all significant elements supplied with the fan;
   (k) specific speed σ_{BEP}, only for centrifugal fans with specific speed σ_{BEP} <0.12, electric input power P_e < 10 kW, measurement category B or D and efficiency category 'total';
   (l) fan speed in revolutions per minute (in rpm, rounded to the nearest integer) at BEP or T_m;
   (m) the specific ratio, rounded to the nearest second decimal;
   (n) manufacturer's name, registered trade name or registered trademark, and the address at which the manufacturer can be contacted;
   (o) the model identifier and, where appropriate, other codes and marks sufficient for the product to be unequivocally and easily identified;

(p) information relevant for facilitating disassembly, recycling or disposal at end- of-life;

(q) information relevant to minimise impact on the environment and ensure optimal life expectancy as regards installation, use and maintenance of the fan.

For custom fans, the information listed in points (a) to (q) shall be provided with the commercial offers provided to the customers instead of on the free access websites.

The information referred to in points 2(a), 2(b), 2(c), 2(d), 2(e) and 2(f) and year of manufacture shall be durably marked on or near the rating plate of the fan, and for point 2(c) one of the following forms of words must be used if applicable:

– 'A variable speed drive must be installed with this fan',

– 'A variable speed drive is integrated within the fan'.

Manufacturers shall provide information in the user manual on specific precautions to be taken when fans are assembled, installed or maintained, including cleaning.

3.2.1 Information Requirements on Partial Load or at Specified Duty

With effect from Date/Month/(Year+1), the following requirements shall apply:

1. For all fans, except custom fans, jet fans and fans with multiple speed motors:

   The partial-load operational performance of the fan shall be provided for fans, except custom fans, jet fans and fans with multiple speed motors. This shall be described by a minimum of three performance curves at different speeds: one at the stated inherent speed, one at a lower speed of between 40 per cent and 50 per cent of the inherent speed, plus an additional one in the middle (±10 percentage points) of the other two. More than three curves can be provided, including at any speeds including ones lower than 40 per cent.

   Performance curves shall comprise enough test points to permit the characteristic curve to be plotted over the normal operating range.

   The information on the curves can be in digital form such as selection software or online catalogue. The values of volume flow, pressure, electric power, fan rotation speed and efficiency shall be provided for the individual test points.

   This information shall be available in:

   (a) the technical data sheet or user manual supplied with the fan, unless an internet link or a QR code to that information is supplied with the fan. A pictogram as in ISO 7000:2019 reference n°1641 is displayed next to the link or QR code;

   (b) the technical documentation for the purposes of conformity assessment pursuant to Article 5;

   (c) the free access websites of the manufacturer of the fan, its authorised representative or the importer.

2. For custom fans, except jet fans:

   The performance or performance curve of custom fans at the specified operating point(s) or operating range(s) shall be provided. A performance curve shall comprise enough test points to permit the characteristic curve to be plotted over the normal operating range. The values of volume flow, pressure, electric power and efficiency shall be provided for the individual test points.

   This information shall be available in:

   (a) the commercial offers provided to the customers or the technical data sheet or user manual supplied with the fan, unless an internet link or a QR code to that information is supplied with the product. A pictogram as in ISO 7000:2019 reference n°1641 is displayed next to the link or QR code;

   (b) the technical documentation for the purposes of conformity assessment, pursuant to Article 5.

3. For jet fans:

The partial-load operational performance of the fan shall be provided for jet fans:

(a) for jet fans with a single speed motor there is no partial load operation, and no partial load information is required;

(b) for jet fans without variable speed drives or not intended to be used with variable speed drives, but fitted with a multiple fixed speed motor, the additional operating point is at the lower speed settings;

(c) for jet fans with a variable speed drive or intended to be used with a variable speed drive the additional data points shall be at 30 per cent and 50 per cent of the inherent speed.

For each operating point, the published data shall include thrust, electric input power, rotational speed and efficiency, as a minimum.

This information shall be available in:

(a) the technical data sheet or user manual supplied with the fan, unless an internet link or a QR code to that information is supplied with the fan. A pictogram as in ISO 7000:2019 reference n°1641 is displayed next to the link or QR code;

(b) the technical documentation for the purposes of conformity assessment pursuant to Article 5;

(c) the free access websites of the manufacturer of the fan, its authorised representative or the importer.

For custom jet fans, the information shall be provided with the commercial offers provided to the customers instead of on the free access websites.

4. For fans with multiple speed motors except jet fans, the curves shall be provided for the motor's inherent and minimum speed available to the customer in the same conditions as set out in points 1 and 2 depending on whether or not the fan is a custom fan.

3.3. Referenced Standards, Compliance Certification, Registration and Surveillance Testing

The metrics, referenced standards, compliance certification, and surveillance testing criteria are set out in this clause. IEC/ISO 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

Topic	*Standard*
Test method for determining fan performance	ISO 5801:2017, Fans — Performance testing using standardized airways ISO 13350:2015 Fans — Performance testing of jet fans FprEN 17166:2020 Fans – Procedures and methods to determine the energy efficiency for the electric input power range of 125 W up to 500 kW
Test method efficiency electric motors	IEC 60034-2-1:2014 Rotating electrical machines - Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)
Test method efficiency CDM	IEC 61800-9-2:2017 for the electric input power of electric motors combined with and fed by a CDM).

Fan efficiency classifications	ISO 12759-1:2023, Fans — Efficiency classification for fans — Part 1: General requirements. ISO 12759-2:2019 Fans — Efficiency classification for fans — Part 2: Standard losses for drive components. ISO 12759-4:2019 Fans — Efficiency classification for fans — Part 4: Driven fans at maximum operating speed. ISO 12759-5:2019 Fans — Efficiency classification for fans — Part 5: Jet fans.
Terms, definitions and tolerances	ISO 12499:2008 Industrial Fans - Mechanical safety of fans - Guarding ISO 13348:2007 Industrial fans — Tolerances, methods of conversion and technical data presentation ISO 13349-1;2022, Fans — Vocabulary and definitions of categories — Part 1: Vocabulary
Other	IEC 60704-2-7:2020 Household and similar electrical appliances - Test code for determination of airborne acoustical noise – Part 2-7: Particular requirements for fans. ISO 7000:2019 Graphical symbols for use on equipment — Registered symbols ISO 13857:2019 Safety of machinery - Safety distances to prevent hazard zones ISO/IEC 17025:2018 certification or equivalent

Compliance Certification and Surveillance Testing

TEST CERTIFICATES

Test certificates are accepted from test laboratories that have been certified or accredited. These may be either manufacturer's in-house laboratories or third-party laboratories.

REGISTRATION

Importers and manufacturers of fans covered by this regulation must register themselves with the designated registration authority (DRA), following the prescribed procedure, accompanied by the full product information as required under Article 3.2 together with test certificates and the applicable fees.

[Optional clause: Fans that are already registered with other countries that are members of a recognised official "Regional Energy Efficiency Certificate Mutual Recognition Agreement"[30] or equivalent may be registered by providing the registration certificate of the respective country.]

SURVEILLANCE TESTING - Verification procedure for market surveillance purposes

1. The verification tolerances defined in this article relate only to the verification by the Designated Surveillance Authority (DSA) of the declared values and shall not be used by the manufacturer, importer or authorised

[30] It is suggested that countries should enter into such an agreement with neighbouring countries within the region for multiple equipment and appliances, including fans. Please refer to the U4E Guidance Notes on Registration.

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.

2. Where a model is not in conformity with the requirements laid down in point (6), the model and all equivalent models shall be considered non-compliant.

3. As part of verifying the compliance of a product model with the requirements laid down in this Regulation the DSA shall apply the following procedure:

   (a) the DSA shall test one single unit of the model;

   (b) the model and all equivalent models shall be considered to comply with the requirements set out in this Regulation if all the following conditions are fulfilled:

      i. the declared values given in the technical documentation and, where applicable, the values used to calculate these values, are not more favourable for the manufacturer, importer or authorised representative than the results of the corresponding measurements;

      ii. the declared values meet any requirements laid down in this Regulation and any required product information published by the manufacturer, importer or authorised representative does not contain values that are more favourable for the manufacturer, importer or authorised representative than the declared values;

      iii. when the designated authority checks the unit of the model, it complies with the product information requirements in points 2, 3, 5 and 6 , as applicable;

      iv. when the designated authority tests the unit of the model, the determined values (the values of the relevant parameters as measured in testing and the values calculated from these measurements), comply with the respective verification tolerances set out in Table 3;

      v. the fan type determined following the application of points 8 (a) (b) or (c) is the same as the declared fan type.

4. Where the results referred to in points 3(b), (i), (ii) and (iii) are not achieved, the model and all equivalent models shall be considered not to comply with this Regulation.

5. Where the result referred to in point 3(b)(iv) or (v) is not achieved:

   (a) for models that are produced in quantities of less than 25 per calendar year including equivalent models, the model and all equivalent models shall be considered not to comply with this Regulation;

   (b) for models that are produced in quantities of 25 or more per calendar year including equivalent models, the DSA shall select three additional units of the same model for testing. As an alternative, the three additional units selected may be one or more of equivalent models.

6. The model shall be considered to comply with the applicable requirements if, for the three units referred to in point 5(b), the arithmetical mean of the determined values, complies with the respective verification tolerances set out in Table 3, and if the fan type determined following the application of points 8 (a) (b) or (c) is the same as the declared fan type, where the determined value of α and/or β_2 means the arithmetical mean of the values determined for those three additional units.

7. Where the result referred to in point 6 is not achieved, the model and all equivalent models shall be considered not in compliance with this Regulation.

8. When the DSA verifies the correspondence between fan type, centrifugal blade angle β_2 and/or fan flow angle α and the minimum efficiency grade (N) specified in table 1, they shall, for the purpose of this Article:

   (a) <u>for centrifugal fans declared as backward inclined fans, or as forward curved fans and driven by a motor with an electric input power < 5 kW:</u> use the fan type and N value corresponding to 'other centrifugal fan' if the determined value of β_2 is less than 47°;

(b) for centrifugal fans declared as backward inclined fans and driven by a motor with an electric input power Pe >= 5 kW: use the fan type and N value corresponding to 'other centrifugal fan' if the determined value of β_2 is more than 93°;

(c) for fans declared as axial fans, efficiency category 'total': use the fan type and N Value corresponding to 'mixed flow fans' if the determined value of α is more than 23°;

(d) for fans declared as axial fans or mixed flow fans, efficiency category 'static': use the N Value directly resulting from the determined value of α.

9. (Optional clause if applicable) The DSA shall, without delay, provide all relevant information to the authorities of the other regional partner countries after a decision is taken on the non-compliance of the model according to points 2, 4, 5(a), 7 or 11.)
10. The DSA shall use the measurement and calculation methods set out in Article 3.1.3.
11. When the DSA verifies the performance curves referred to in point 3 of Article 3.2.2, a minimum of two declared test points for each of the characteristic curves shall be tested, in line with points 3 to 10 above, taking into account points 12 to 14 below. If one of the declared test points is found non-compliant, the model and all equivalent models shall be considered non-compliant with this Regulation.
12. (Optional clause if applicable) The authorities in the regional partner countries may decide to undertake the verification procedure of fans with an impeller diameter above 1 m for jet fans or 0.5 m for other fans at the premises of manufacturers, authorised representatives or importers before the products are put into service. The regional partner country authority can do this verification using its own testing equipment.
13. If factory acceptance tests are planned for such fans, which will test parameters laid down in Article 3.2 of this Regulation, the DSA may decide to use witnessed testing during these factory acceptance tests to gather test results which can be used to verify compliance of the fan under investigation. The DSA may request a manufacturer, authorised representative or importer to disclose information on any planned factory acceptance tests relevant for witnessed testing.
14. In the cases mentioned in points 12 and 13, the DSA only needs to verify one single unit of the model. If the results referred to in point 3(b)(iv) and 3(b)(v) are not achieved, the model and all equivalent models shall be considered not to comply with this Regulation.
15. When testing fans at partial load, the DSA shall use a variable speed drive without filters, with a view to minimising VSD energy losses.
16. The DSA shall only apply the verification tolerances set out in Table 3 and shall only use the procedure described in this Article for the requirements referred to in this Article. For the parameters in Table 3, no other tolerances such as those set out in harmonised standards or in any other measurement method shall be applied.

Table 4. Verification tolerances

Parameters	*Verification tolerances*
Fan efficiency (η)	The determined value* shall not be lower than the value representing 93 per cent of the corresponding declared value at BEP or T_m, and not be lower than the value representing 85 per cent of the corresponding declared value at partial load.
Electric input power (P_e)	The determined value* shall not be higher than the value representing 107 per cent of the corresponding declared value at BEP or T_m, and not be higher than the value representing 110 per cent of the corresponding declared value at partial load.

Volume flow rate (q_V)	The determined value* shall not differ by more than 5 per cent from the corresponding declared value at BEP or T_m, and not more than 10 per cent than the corresponding declared value at partial load.
Pressure difference (Δp), 'fan static pressure' (p_{fs}) or 'fan pressure' (pf)	The determined value* shall not differ by more than 5 per cent from the corresponding declared value at BEP, and not more than 10 per cent than the corresponding declared value at partial load.
Fan speed (rpm)	The determined value* shall not differ by more than 2 per cent from the corresponding declared value.
Characteristic noise emission value (L)	For fan declared as low noise fans: the determined value* shall not exceed the declared value of 32 dB by more than 3 dB with respect to 1 pW.

*Note: * Where three additional units are tested in accordance with point 5(b), the determined value means the arithmetical mean of the values determined for those three additional units.*

3.4 Indicative Benchmark

The maximum values relate to the achievable efficiency grade N (minimum efficiency formulas are set out in Article 3.1.2) with clean air and no space and/or noise restrictions. The minimum values apply to contaminated air (some dust load) and space, noise and/or other operational restrictions at the limit of what is still in scope according to the exemptions in Article 1.

Table 5. Indicative benchmarks for fans

Fan type	Measurement category	Pressure	*N* minimum	*N* maximum
Axial fans	A, C	static	50	75
	B, D	total	64	85
Forward curved <5 kW and backward inclined fans	A, C	static	52	65
	B, D	total	57	70
Forward curved ≥5 kW, backward curved fans	A, C	static	64	80
	B, D	total	67	85
Mixed flow fans	A, C	static	57+7·(α −45)/25	77
	B, D	total	67	85
Jet fans	E		50	60

Cross flow fans: 21 per cent efficiency.

Article 4. Entry into Force

This regulation shall enter into force from DD-MM-YY, and the countries' regulatory authorities should decide on the appropriate date on a case-by-case basis.

Article 5. Declaration of Conformity – Conformity assessment

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.

1. For the purposes of the conformity assessment, the technical documentation shall contain a copy of the declared values of parameters in point 2 of Article 3.2.1, of the declared values of the parameters of the test points in Article 3.2.2, and the details and results of calculations set out in Article 3.1.3.
2. Where the information included in the technical documentation for a particular model has been obtained by either of the following means, the technical documentation shall include the details of the calculation, the assessment undertaken by the manufacturer to verify the accuracy of the calculation and, where appropriate, the declaration of identity between the models of different manufacturers:
    a. from a model that has the same technical characteristics relevant for the technical information to be provided but is produced by a different manufacturer;
    b. by calculation on the basis of design or extrapolation from another model of the same or a different manufacturer, or both.
3. The technical documentation shall include a list of all equivalent models, including the model identifiers.
4. Where the manufacturer has used the compliance assessment options set out in point 2 of Article 3.1.3, non-significant elements removed, model scaling, test conditions and calculations and the place where the testing is conducted shall be duly reported in the technical documentation.
5. Where this Regulation requires the provision of performance curves at different speeds pursuant to Article 3.1.3, the technical documentation shall indicate the characteristics of the speed regulation device used, and the speed used (as a percentage of the inherent speed) for those curves.
6. A fan to which a VSD is added shall not be considered a new fan model requiring a new conformity assessment if:
    a. the VSD is physically located so as not to interfere with the air stream;
    b. the VSD can be removed from the fan for verification without damaging the fan and the VSD.

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, Enforcement, and Circumvention

Market surveillance

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.

Enforcement

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 industrial fans in the scope of this regulation, which do not comply with 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 industrial fans 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 industrial fans 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 industrial fans are exhausted, whichever is earlier.

Further, any person, other than an end-user, in possession of an industrial fan in the scope of this regulation after the date of entry into force of this regulation, that does not comply with 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.

Circumvention

1. Manufacturers, importers or authorised representatives shall not place on the market or put into service products designed to alter their behaviour or properties when being tested so as to achieve a more favourable result for any declared value of the parameters regulated in this Regulation. That includes, but is not limited to, products designed to detect they are being tested by recognising the test conditions or test cycle and to automatically alter their behaviour or properties in response, and products preset to alter their behaviour or properties at the time of testing.
2. Manufacturers, importers or authorised representatives shall not prescribe specific test instructions that alter the behaviour or the properties of products to achieve a more favourable result for any of the declared values of the parameters regulated in this Regulation. That includes, but is not limited to, prescribing a manual alteration of a product in preparation for the test that alters the product's behaviour, or properties compared with when it is in normal use and operated by the end-user.
3. Manufacturers, importers or authorised representatives shall not place on the market or put into service products designed to alter their behaviour or properties within a short period of being put into service in a way that worsens any declared value for the parameters regulated in this Regulation.

Article 7. Revision

It is anticipated that this Regulation shall be reviewed after not more than five years after its entry into force, so as to take into account technological progress. The review shall in particular address,

- whether it is appropriate to revise the metrics with an extended and technology- neutral product approach, including part load performance;
- whether it is appropriate to revise the efficiency limits in line with the new metrics and technological progress;
- the relevance of regulating fans below 125 W electric power, air circulating fans and large comfort fans;
- the relevance of regulating jet fans below 750 W;

- resource efficiency, repairability, reuse and recycling, recycled content and durability
- the relevance of the exemptions laid down in Article 1;
- the relevance of the circumvention provisions laid down in Article 6;
- the potential of 3D printing of elements;
- whether it is appropriate to revise the requirements on the storage of product information due to the possible introduction of a digital product passport;
- the relevance of requiring an energy label.

SECTION IV

Model Regulation Guidelines for Water Pumps and Water Pumps units

Article 1. Scope of Products

1.1 Scope

This regulation applies to:

- all rotodynamic water pumps for pumping clean water, excepting those exempted in clause 1.2, whether manufactured in, or imported into the country/region and that are placed on the market either as a standalone product or as a component of a water pump unit, or included in other products;

and

- all rotodynamic water pump units for pumping clean water, excepting those exempted in clause 1.2, that include such rotodynamic water pumps as a component, whether manufactured in, or imported into the country/region and irrespective of whether these are placed on the market as an assembled unit, or are assembled on-site by the pump supplier, or by the end-user or by a third-party.

1.2 Exemptions

This Regulation shall not apply to:

a. water pumps and water pump units designed specifically for pumping clean water at temperatures below – 10°C or above 120°C, except with regard to the information requirements of Article 4, points (11) to (13);

b. water pumps and water pump units designed only for fire-fighting applications;

c. displacement water pumps and displacement water pump units;

d. self-priming water pumps and self-priming water pump units.

Article 2. Terms and definitions

The following definitions apply:

(1) 'Water pump' is the hydraulic part of a device that moves clean water by physical or mechanical action and is of one of the following designs:

1. End suction own bearing (ESOB),
2. End suction close coupled (ESCC),
3. End suction close coupled inline (ESCCi),
4. Vertical multistage (MS-V),
5. Horizontal Multistage (MS-H),
6. Submersible multistage (MSS),
7. Booster sets (BS);

(2) 'Rotodynamic water pump' means a water pump that moves clean water by means of hydrodynamic forces;

(3) 'Water pump unit' means a water-pump equipped or supplied with an electric motor and with or without a variable speed drive;

(4) 'Electric motor' or 'motor' means a device that converts electrical input power into mechanical output power in the form of a rotation with a rotational speed and torque that depends on factors including the frequency of the supply voltage and number of poles of the motor;

(5) 'Variable speed drive' (VSD) means an electronic power converter that continuously adapts the electrical power supplied to a single motor to control the motor's mechanical power output according to the torque-speed characteristic of the load driven by the motor, by adjusting the power supply to a variable frequency and voltage supplied to the motor. It includes all electronics connected between the mains and the motor including extensions such as protection devices, transformers and auxiliaries;

(6) 'End suction water pump' means a glanded single stage end suction rotodynamic water pump designed for pressures up to 16 bar, with a specific speed n_s between 6 and 80 rpm, a minimum rated flow of 6 m^3/h (1,667·10–3 m^3/s), a maximum shaft power of 150 kW, a maximum head of 90 m at nominal speed of 1 450 rpm and a maximum head of 140 m at nominal speed of 2 900 rpm;

(7) 'Rated flow' means the head and flow that the manufacturer will guarantee under normal operating conditions;

(8) 'Glanded' means sealed shaft connection between the impeller in the pump body and the motor. The driving motor component remains dry;

(9) 'End suction own bearing water pump' (ESOB) is an end suction water pump with own bearings;

(10) 'End suction close coupled water pump' (ESCC) is an end suction water pump of which the motor shaft is extended to become also the pump shaft;

(11) 'End suction close coupled inline water pump' (ESCCi) means a water pump of which the water inlet of the pump is on the same axis as the water outlet of the pump;

(12) 'Vertical multistage water pump' (MS-V) means a glanded multistage (i > 1) rotodynamic water pump in which the impellers are assembled on a vertical rotating shaft, which is designed for pressures up to 25 bar, with a nominal speed of 2 900 rpm and a maximum flow of 100 m3/h (27,78·10–3 m3/s);

(13) 'Horizontal multistage water pump' (MS-H) means a glanded multistage (i > 1) rotodynamic water pump in which the impellers are assembled on a horizontally rotating shaft, which is designed for pressures up to 25 bar, and a maximum flow of 100 m³/h (27,78·10^{-3} m³/s);

(14) 'Submersible multistage water pump' (MSS) means a multistage (i > 1) rotodynamic water pump with a nominal outer diameter of 2.5" (63.5 mm) or 6" (152.4 mm) designed to be operated submersed, , at operating temperatures within a range of 0 °C and 90 °C, with a nominal flow rate >1.75 m3/h;

(15) 'booster set' means either a single water-pump unit, or an assembly of water-pump units connected in parallel, with a maximum hydraulic power of 150 kW, a minimum rated flow of 6 m³/h (0,001667 m³/s), to be operated with backflow prevention and additional components influencing hydraulic performance and with components necessary to control pressure or provide flow in open loops inside buildings and which is placed on the market and/or put into service as one single product and its intended use is to pump clean water;

(16) 'Displacement water pump' means a water pump that moves clean water by enclosing a volume of clean water and forcing this volume to the outlet of the pump;

(17) 'self-priming water pump' means a water pump that moves clean water, and which can start and/or operate also when only partly filled with water;

(18) 'Clean water' means water with a maximum non-absorbent free solid content of 0,25 kg/m3, and with a maximum dissolved solid content of 50 kg/m3, provided that the total gas content of the water does not exceed the saturation volume. Any additives that are needed to avoid water freezing down to – 10 °C shall not be taken into account;

(19) hydraulic power (Phyd) means the power delivered by the water pump to the fluid pumped at the specified point of operation (in kW).

(20) 'Equivalent model' means a model which has the same technical characteristics relevant for the technical information to be provided, but which is placed on the market or put into service by the same manufacturer, importer or authorised representative as another model with a different model identifier;

(21) 'Model identifier' means the code, usually alphanumeric, which distinguishes a specific product model from other models with the same trademark or the same manufacturer's, importer's or authorised representative's name.

Article 3. Requirements

3.1 Energy Efficiency Requirements

The minimum efficiency requirements for rotodynamic water pumps and water pump units are set out in Article 3.1.2.

The definitions for the purpose of Articles 3.1.2 to Article 3.3 are set out in Article 3.1.1.

3.1.1 Definitions for the purposes of energy efficiency Requirements, measurements and calculations

For the purpose of Articles 3.1.2 and Article 3.1.3, the following definitions apply:

(1) 'Impeller' means the rotating component of a rotodynamic pump which transfers energy to the water;

(2) 'Full impeller' means the impeller with the maximum diameter for which performance characteristics are given for a pump size in the catalogues of a water pump manufacturer;

(3) 'Specific speed' (n_s) means a dimensional value characterising the shape of the water pump impeller by head, flow and speed (n):

$$n_s = n \cdot \frac{\sqrt{Q_{BEP}/3600}}{(H_{BEP}/i)^{3/4}}$$ [rptablem]

Where

— 'Head' (H) means the increase in the hydraulic energy of water in meters [m], produced by the water pump at the specified point of operation,

— 'Rotational speed' (n) means the number of revolutions per minute [rpm] of the shaft,

— 'Flow' (Q) means the volume flow rate [m^3/s] of water through the water pump,

— 'Stage' (i) means the number of series impellers in the water pump,

— 'Best efficiency point' (BEP) means the operating point of the water pump at which it is at the maximum hydraulic pump efficiency measured with clean cold water,

(4) Hydraulic pump efficiency' (η) is the ratio between the mechanical power transferred to the liquid during its passage through the water pump and the mechanical input power transmitted to the pump at its shaft;

(5) 'Clean cold water' means clean water to be used for pump testing, with a maximum kinematic viscosity of 1,5 × 10–6 m^2/s, a maximum density of 1 050 kg/m^3 and a maximum temperature of 40 °C;

(6) 'Part load' (PL) means the operating point of the water pump at 75 per cent of the flow at BEP;

(7) 'Overload' (OL) means the operating point of the water pump at 110 per cent of the flow at BEP;

(8) 'Minimum Efficiency Index' (MEI) means the dimensionless scale unit for hydraulic pump efficiency at BEP, PL and OL;

(9) 'C' means a constant for each specific water pump type quantifying the differences in efficiency for different pump types;

(10) 'Energy Efficiency Index' (EEIv) means the dimensionless scale unit for an average pump unit electric power input according to a flow-time profile and reference control curve divided by a reference power input;

(11) 'Flow-time profile' means a pattern of percentiles of time where the pump unit runs at a given flow rate;

(12) 'Average power input' ($P_{1,avg}$) is the weighted average of measured electric input power of a pump unit over a number of operating points as defined in a flow-time profile;

(13) 'Reference power input' ($P_{1,ref}$) is the nominal electric power input of a reference pump unit;

For pumps units that are not a booster set, the pump is:

- is operated with clean cold water at Q_{BEP} and H_{BEP} and at n = 2900 rpm or n = 1450 rpm, whichever rotational speed n is closest to the actual pump speed under test,
- has an efficiency at the best efficiency point (BEP) of at least $(\eta_{BEP})_{min\ requ}$ when measured according to Article 3.1.3 and calculated with the C-value for MEI = 0,4, according to Article 3.1.3.
- is driven by a (fictitious) 3-phase induction motor which is directly fed by an electric grid with a frequency of 50 Hz, which:
  - is of the 2-pole type for n = 2900 rpm or is of the 4-pole type for n = 1450 rpm
  - has a nominal power output which exactly equals the shaft power of the pump at its nominal operating conditions,
  - performs at exactly the motor efficiency which is required as minimum value for motors of efficiency class IE3 according to IEC 60034-30-1:2014.

For booster sets, the fictious booster set:

- is equipped with two (virtual) fixed speed pumps of the vertical multistage type (MS-V),
- is operated with clean cold water at point of maximum hydraulic output power of the booster (with flow and head $Q_{100\%}$ and $H_{100\%}$),
- has at this operating point a total internal hydraulic loss (caused by piping and valves) of 2 m,
- has no auxiliary electric losses,
- The (virtual) pumps have a specific speed of n_s = 45 rpm and an efficiency of at least $(\eta_{BEP})_{min\ requ}$ when measured according to Article 3.1.3 and calculated with the C-value for MEI = 0,4, according to Article 3.1.3;
- Each pump is driven by a fictitious 3-phase induction motor which is of the 2-pole type and is directly fed by an electric grid with a frequency of 50 Hz,
  - has a nominal power output which exactly equals the shaft power of the driven pump at its defined operating condition,
  - performs at exactly the motor efficiency which is required as minimum value for motors of efficiency class IE3 according to IEC 60034-30-1.

3.1.2 Energy Efficiency Requirements for Water Pumps and Water Pump Units

A. ENERGY EFFICIENCY REQUIREMENTS FOR WATER PUMPS

Each water pump energy efficiency requirement shall apply in accordance with the following timetable – and definitions as specified in Article 3.1.1:

1. first tier: from Date/Month/Year, water pumps shall have a minimum efficiency:

   - at the best efficiency point (BEP) of at least $(\eta_{BEP})_{\ min\ requ}$ when measured as required under Article 3.3 and calculated with the C-value for MEI = 0.1, according to Article 3.1.3,
   - at part load (PL) of at least $(\eta_{PL})_{\ min\ requ}$ when measured as required under Article 3.1.3 and calculated with the C-value for MEI = 0.1, according to Article 3.1.3,

- at overload (OL) of at least $(\eta_{OL})_{\text{min requ}}$ when measured as required under Article 3.1.3 and calculated with the C-value for MEI = 0.1, according to Article 3.1.3.

2. second tier: from Date/Month/(Year+1), water pumps shall have a minimum efficiency:

- at the best efficiency point (BEP) of at least $(\eta_{BEP})_{\text{min requ}}$ when measured as required under Article 3.3 and calculated with the C-value for MEI = 0.4, according to Article 3.1.3,
- at part load (PL) of at least $(\eta_{PL})_{\text{min requ}}$ when measured as required under Article 3.1.3 and calculated with the C-value for MEI = 0.4, according to Article 3.1.3,
- at overload (OL) of at least $(\eta_{OL})_{\text{min requ}}$ when measured as required under Article 3.1.3 and calculated with the C-value for MEI = 0.4, according to Article 3.1.3.

Compliance with energy efficiency requirements shall be measured and calculated in accordance with requirements set out in Article 3.1.3.

B. ENERGY EFFICIENCY REQUIREMENTS FOR WATER PUMPS UNITS

Each water pump unit energy efficiency requirement shall apply in accordance with the following timetable – and definitions as specified in Article 3.1.1:

(a) From Date/Month/(Year+1), ESOB, ESCC and ESCCi end suction water pump units up to 45 kW shaft power shall have: an Energy Efficiency Index EEIv according to Article 3.1.3 of not more than 0.62.

(b) From Date/Month/(Year+1), booster sets shall have an Energy Efficiency Index EEIv according to Article 3.1.3 of not more than 0.50.

Compliance with energy efficiency requirements shall be measured and calculated in accordance with requirements set out in Article 3.1.3.

3.1.3 Measurements and Calculation method

For the purposes of compliance and verification of compliance with the requirements of this Regulation, measurements and calculations shall be made using harmonised standards as referenced in Article 5. Or using other reliable, accurate and reproducible methods, which take into account the generally recognised state of the art, and produce results deemed to be of low uncertainty. They shall fulfil all of the following technical parameters.

A. DETERMINATION OF THE MEI FOR WATER PUMPS

The hydraulic pump efficiency (η), as defined in Article 3.1.1, is measured at the head and flow corresponding to the best efficiency point (BEP), part load (PL) and over load (OL) for full impeller diameter with clean cold water.

The formula for calculating the required minimum efficiency at best efficiency point (BEP) is as follows:

$$(\eta_{BEP})_{\text{min requ}} = 88{,}59\ x + 13{,}46\ y - 11{,}48\ x^2 - 0{,}85\ y^2 - 0{,}38\ x\ y - C_{\text{Pump Type,rpm}}$$

where

$x = \ln(n_s)$; $y = \ln(Q_{BEP})$ and ln = natural logarithm and Q_{BEP} = flow at BEP in [m^3/h]; n_s = specific speed in [rpm]; C = value found in Table 1.

The value of C depends on the pump type and nominal speed, and also the MEI value.

Table 1. Minimum Efficiency Index (MEI) and its corresponding C-value depending on the pump type and speed

$C_{PumpType,rpm}$	C-value MEI = 0.10	C-value MEI = 0.40
C (ESOB, 1450)	132.58	128.07
C (ESOB, 2900)	135.60	130.27
C (ESCC, 1450)	132.74	128.46
C (ESCC, 2900)	135.93	130.77
C (ESCCi, 1450)	136.67	132.30
C (ESCCi, 2900)	139.45	133.69
C (MS-V, 2900)	138.19	133.95
C (MS-H, 2900)	138.19	133.95
C (MSS, 2900)	134.31	128.79

The requirements for part load (PL) and over load (OL) conditions are set at slightly lower values than those for 100 per cent flow (η_{BEP}).

$$(\eta_{PL})_{min,\ requ} = 0{,}947 \cdot (\eta_{BEP})_{min,\ requ}$$

$$(\eta_{OL})_{min,\ requ} = 0{,}985 \cdot (\eta_{BEP})_{min,\ requ}$$

All efficiencies are based on full (untrimmed) impeller. Vertical multistage water pumps are to be tested with a 3 stage (i = 3) version. Submersible multistage water pumps are to be tested with a 9 stage (i = 9) version. If this number of stages is not offered within the specific product range the next higher number of stages within the product range is to be chosen for testing.

B. DETERMINATION OF THE EEI_V FOR SINGLE STAGE ESOB, ESCC AND $ESCC_I$ WATER PUMPS UNITS

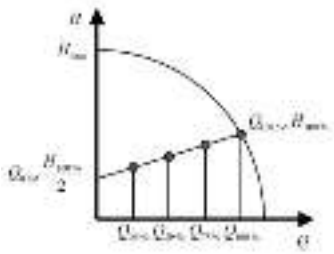
The energy efficiency index (EEI_V) is the ratio of the average measured power input of the pump unit P1,avg (in kW) and the reference power input P1,ref (in kW). It is determined is as follows:

1. Where a water pump unit has more than one setting of head and flow, measure the power consumption of the water pump at the maximum setting (highest pump curve).
2. Determine the average electric power input $P_{1,avg}$ as follows:

2.1. For a pump unit with a VSD, the electric power consumption of the water pump unit $P_{1,meas,i}$ is measured at the load points i (Q_i, H_i) of the control curve:

Table 2. Control curve and flow-time profile for single stage ESOB, ESCC, and ESCCi pump units

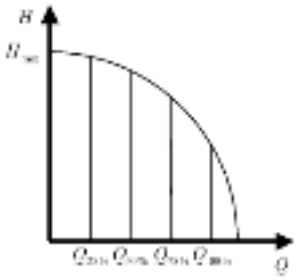
i	1	2	3	4
Flow Q_i in % of Q_{BEP} (= $Q_{100\%}$)	25	50	75	100
Head H_i in % of H_{BEP} (= $H_{100\%}$), for vsd pumps units	62,5	75	87,5	100
Time t_i in % of total operating time	44	35	15	6



The measured pump head $H_{meas,i}$ is compared to the target value H_i. The measured electric power $P_{1,meas,i}$ at the flow rate Q_i is corrected as such :

$$P_{1,corr,i} = \left(\frac{H_i}{H_{meas,i}}\right).P_{1,meas,i}$$

2.2. For a pump unit without VSD, the electric power consumption of the water pump unit $P_{1,meas,i}$ is measured at the head H resulting from the flows Q_i defined in table 2 above.



In this case, no correction applies:
$P_{1,corr,i} = P_{1,meas,i}$

2.3. Calculate the weighted average power $P_{1,avg}$ as:

$$P_{1,avg} = \sum_{i=1}^{4}[\frac{t_i}{100}.P_{1,corr,i}]$$

Using the time t_i specified in the flow-time profile in table 2 above.

3. Calculate the reference power input $P_{1,ref}$ in the following way:

3.1. Calculate the reference hydraulic power $P_{hyd,ref}$ as follows:

$$P_{hyd,ref} = \frac{\left(\rho.g.\left({}^{Q_{BEP}}/_{3600}\right).H_{BEP}\right)}{1000} \quad [kW]$$

where:
- The density of clean cold water ρ is 1000 kg/m^3,
- and the gravitational constant g is 9.81 m/s^2.

3.2. Calculate the reference pump efficiency η_{ref} as:

$$\eta_{ref} = 88{,}59\ x + 13{,}46\ y - 11{,}48\ x^2 - 0{,}85\ y^2 - 0{,}38\ x\ y - C$$

where
$x = \ln(n_s)$; $y = \ln(Q_{BEP})$ and ln = natural logarithm and Q_{BEP} = flow at BEP in [m^3/h]; n_s = specific speed in [rpm] defined in Article 3.1.1; C = C-value for the relevant pump type and rotational speed according to Table 1 above.

3.3. Calculate the reference shaft power $P_{2,ref}$ of the pump unit [kW] as:

$$P_{2,ref} = \frac{P_{hyd,ref}}{\frac{1}{100}.\eta_{ref}} \quad [kW]$$

3.4. Calculate the reference motor efficiency $\eta_{ref,M}$ as:

$$\eta\, ref, M = a \cdot \left[\log_{10}\left(\frac{P2, ref}{1kW}\right)\right]^3 + b \cdot \left[\log_{10}\left(\frac{P2, ref}{1kW}\right)\right]^2 + c \cdot \log_{10}\left(\frac{P2, ref}{1kW}\right) + d[\%]$$

with coefficients a, b, c and d determined as per table 3 below:

Table 3. Coefficients for determining efficiency of motors of the IE 3 efficiency class

	Case 1: motor $P_{2,ref}$ > 0.75kW		**Case 2: motor $P_{2,ref}$ < 0.55kW**	
Coefficient	**2-pole**	**4-pole**	**2-pole**	**4-pole**
a	0.356 9	0.077 3	6.853 2	7.635 6
b	- 3.307 6	- 1.895 1	6.200 6	4.823 6
c	11.610 8	9.298 4	25.131 7	21.090 3
d	82.250 3	83.702 5	84.039 2	86.099 8
Efficiency values for motors with 0.55kW < $P_{2,ref}$ < 0.75kW have to be linearly interpolated between the resulting values of Case 1 at 0.75kW and of Case 2 at 0.55kW				

3.5. The reference electric power input is calculated as:

$$P1, ref = \frac{P2, ref}{\frac{1}{100} \cdot \eta\, ref, M} \; [kW]$$

4. Calculate the energy efficiency index EEIv [31]as:

$$EEI_v = \frac{P_{1,avg}}{P_{1,ref}}$$

C. DETERMINATION OF THE EEIV FOR BOOSTER SETS (BS)

The energy efficiency index (EEI_V) is the ratio of the average measured power input of the booster set $P_{1,avg}$ (in kW) and the reference power input $P_{1,ref}$ (in kW). It is determined as follows:

1. If an expansion tank and/or a "jockey pump" is integrated in the booster set, they shall not affect the EEI value and therefore shall be deactivated during tests to determine EEI_v, except an expansion tank of a volume $V_{tank} \leq 10\ l + (Q_{100\%}/1m^3/h)$.

2. Determine the point of maximum hydraulic output power of the booster set and establish the flow and head at this point as: $Q_{100\%}$ and $H_{100\%}$.

3. Determine the average electric power input $P_{1,avg}$ as follows:

   3.1. The electric power consumption of the booster set $P_{1,meas,i}$ is measured at the load points i (Q_i, H_i) of the control curve in table 4, for increasing flow rate as well as for decreasing flow rate:

Table 4.Control curve and flow-time profile for booster sets

[31] The EN 17038 standard will have a supplementary excel calculation tool for calculation of the EEI.

Booster sets (BS)										
i	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Flow Q_i in % of $Q_{100\,\%}$	10	20	30	40	50	60	70	80	90	100
Head H_i in % of $H_{100\,\%}$	77.5	80	82.5	85	87.5	90	92.5	95	97.5	100
Time t_i in % of total operating time	6	21	26	19	12	6	4	3	2	1

3.2. For the case that the given head from the reference control curve at a load point from the flow-time profile is not reached, the following penalty must be added to the measured value, for each measurement sample:

$$P1, pen(Qi) = 2 \cdot \frac{Href(Qi) - Hmeas(Qi)}{Hmeas(Qi)} \cdot P1.meas(Qi)$$

3.3. Calculate the weighted average of the electric power $P_{1,avg}$ for increasing flow rate as well as for decreasing flow rate by the equation:

$$P_{1,avg} = \sum_{i=1}^{10} [\frac{t_i}{100} . P_{1,meas,i}]$$

Using the time t_i specified in the flow-time profile in table 4 above.

3.4. The weighted average of the electric power $P_{1,avg}$ is then given by the arithmetic mean of the two values $P_{1,avg,inc}$ and $P_{1,avg,dec,}$ for increasing and decreasing flow rates:

$$P1, avg = \frac{P1, avg, inc + P1, avg, dec}{2}$$

4. $P_{1,ref}$ is calculated assuming that the reference booster set is made of (virtual) fixed speed pumps of the vertical multistage type (MS-V):

4.1. The reference hydraulic power $P_{hyd,ref}$ of each of the 2 pumps is:

$$(Phyd, ref) per\ pump = \frac{\left[\rho \cdot g \cdot \left(\frac{1}{2} \cdot \frac{Q100\%}{3600}\right) \cdot (H100\% + 2m)\right]}{1000} [kW]$$

with ρ = 1000 kg/m³, g = 9.81 m/s^2 and $Q_{100\%}$ in [m^3/h]

4.2. The reference pump efficiency η_{ref} is given by the equation:

η_{ref} = 88,59 x + 13,46 y -11,48 x^2 – 0,85 y^2 – 0,38 x y — $C_{Pump\ Type,rpm}$

where,

x = ln (n_s); y = ln ($Q_{100\%}$/2) and ln = natural logarithm and $Q_{100\%}$ = flow at maximum hydraulic output power of the booster set in [m^3/h]; n_s = specific speed = 45 rpm; C = C-value = 133,95.

4.3. Calculate the reference shaft power $P_{2,ref}$ for each of the (virtual) pumps:

$$(P_{2,ref}) = \frac{P_{hyd,ref}}{\frac{1}{100}\eta_{ref}} \quad [kW]$$

4.4. The reference motor efficiency $\eta_{ref,M}$ is calculated as:

$$\eta\, ref, M = a \cdot \left[\log_{10}\left(\frac{P2, ref}{1kW}\right)\right]^3 + b \cdot \left[\log_{10}\left(\frac{P2, ref}{1kW}\right)\right]^2 + c \cdot \log_{10}\left(\frac{P2, ref}{1kW}\right) + d[\%]$$

with coefficients a, b, c and d determined as per table 3 above.

4.5. Calculate $P_{1,ref}$ of the booster set as:

$$P1, ref = 100 \cdot \frac{2 \cdot (P2, ref) per\ pump}{\eta ref, M}\ [kW]s$$

5. Calculate the energy efficiency index EEI_v for booster sets as[32]:

$$EEI_{v,booster\ sets} = \frac{P_{1,avg}}{P_{1,ref}}$$

3.2 Product Information Requirements

3.2.1. Product Information Requirements of Water Pumps

1. From Date/Month/Year, the information on water pumps set out in points 2(a) to (p) shall be visibly displayed in:
   (a) the technical data sheet or user manual supplied with the water pump; unless an internet link or a QR code linking to the free access website referred to in point (c) is supplied with the pump. A pictogram as in ISO 7000:2019 reference n°1641 is displayed next to the link or QR code;
   (b) for water pumps integrated in products: the technical data sheet or user manual supplied with products in which the water pump is incorporated;
   (c) the technical documentation for the purposes of conformity assessment pursuant to Article 5, in the order as listed in points 2(a) to (p), the exact wording does not need to be repeated, information may be displayed using graphs, figures or symbols rather than text;
   (d) free access websites of manufacturer of the water pump, its authorised representative or the importer for a period of at least 20 years after the placing on the market of the last unit of the model concerned;

   Letter symbols for units and quantities shall be in accordance with ISO 17769-1 and 17769-2.

2. The information shall be provided in the order as presented in points (a) to (p).
   (a) Minimum efficiency index: MEI ≥ [*x,xx*];
   (b) Standard text: 'The benchmark for most efficient water pumps is MEI ≥ 0,70', or, alternatively, the indication 'Benchmark MEI ≥ 0,70';
   (c) Manufacturer's name or trademark, commercial registration number and address;
   (d) Model identifier;
   (e) Category (i.e. one of the designs specified in article 2: ESOB, ESCC, ESCCi, MS-V, MS-H, MSS etc.) and size identifier (rated power and nominal speed);
   (f) Hydraulic pump efficiency (%) with trimmed impeller [*xx,x*], or, alternatively, the indication [–.-];
   (g) Pump performance curves for the pump, including efficiency characteristics;
   (h) Standard text: 'The efficiency of a pump with a trimmed impeller is usually lower than that of a pump with the full impeller diameter. The trimming of the impeller will adapt the pump to a fixed duty point, leading to reduced energy consumption. The minimum efficiency index (MEI) is based on the full impeller diameter.';

[32] The EN 17038 standard will have a supplementary excel calculation tool for calculation of the EEI.

(i) Standard text: 'The operation of this water pump with variable duty points may be more efficient and economic when controlled, for example, by the use of a variable speed drive that matches the pump duty to the system';

(j) Information relevant for disassembly, recycling or disposal at end-of-life;

(k) Standard text for water pumps designed only for pumping clean water at temperatures below – 10 °C: '*Designed for use below – 10 °C only*';

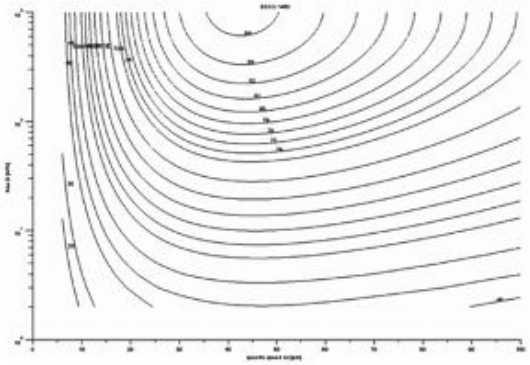
(l) Standard text for water pumps designed only for pumping clean water at temperatures above 120 °C: '*Designed for use above 120 °C only*';

(m) For pumps designed specifically for pumping clean water at temperatures below – 10 °C or above 120 °C, manufacturer must describe the relevant technical parameters and characteristics used;

(n) Standard text: 'information on benchmark efficiency is available at [*www.xxxxxxxxx.xxx*]';

(o) Benchmark efficiency graph for MEI = 0,7 for the pump based on the model shown in the Figure. Similar efficiency graph shall be provided for MEI = 0,4.

Example of a benchmark efficiency graph for ESOB 2900¶



Further information may be added and may be complemented by graphs, figures or symbols.

(p) if the water pump is considered exempt from efficiency requirement in accordance with Article 1(2) of this Regulation, the specific reason why it is considered exempt.

The information referred to in points (a) and (c) to (f) as well as the year of manufacture shall be durably marked on or near the rating plate of the water pump.

Manufacturers shall provide information on how to install, use and maintain the water pump in order to minimise its impact on the environment.

3.2.2 Product Information Requirements of Water Pump Units

1. From Date/Month/Year, the product information requirements on water pump units set out in points 2(a) to (e) below shall be visibly displayed on:

   (a) the technical data sheet or user manual supplied with the water pump unit; unless an internet link or a QR code linking to the free access website referred to in point (c) is supplied with the water pump unit. A pictogram as in ISO 7000:2019 reference n°1641 is displayed next to the link or QR code;

   (b) for water pumps units integrated in products: the technical data sheet or user manual supplied with products in which the water pump unit is incorporated;

   (c) the technical documentation for the purposes of conformity assessment pursuant to Article 5, in the order as listed in points 2(a) to (e), the exact wording does not need to be repeated, information may be displayed using graphs, figures or symbols rather than text.

(d) free access websites of the manufacturer of the water pump unit, its authorised representative or the importer;

2. The information shall be provided in the order as presented in points (a) to (e).
   (a) Energy efficiency index of the water pump unit: EEIv <= [x,xx];
   (b) Pump performance curves for the pump unit, including efficiency characteristics, including the data points needed for calculation of the EEIv
   (c) Manufacturer's name or trademark, commercial registration number and address;
   (d) Model identifier;
   (e) Information relevant for disassembly, recycling or disposal at end-of-life;
   (f) if the water pump unit is considered exempt from efficiency requirement in accordance with Article 1(2) of this Regulation, the specific reason why it is considered exempt.

3.3 Referenced Standards, Compliance Certification, Registration and Surveillance Testing

The metrics, referenced standards, compliance certification, and surveillance testing criteria are set out in this section. ISO and 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 5. Reference Standards for Test Methods and Energy Efficiency Calculations

Topic	*Standard*
Test method for determining pump performance	ISO 9906;2012 Ed. 2 Rotodynamic pumps — Hydraulic performance acceptance tests — Grades 1, 2 and 3
Pump Minimum Efficiency Index (MEI)	EN 16480:2021 - Pumps - Rotodynamic pumps - Minimum required efficiency of water pumps and determination of Minimum Efficiency Index (MEI)
Pump Energy Efficiency Index (EEI)	EN17038-1,-2,-3,-4;2019 - Pumps - Methods of qualification of the Energy Efficiency Index (EEI) for rotodynamic pump units Part 1 – General requirements and procedures for testing and calculation of Energy Efficiency Index (EEI) Part 2: Testing and calculation of Energy Efficiency Index (EEI) of single pump units Part 3: Testing and calculation of energy efficiency index (EEI) of booster sets Part 4: Testing and calculation of energy efficiency index (EEI) of submersible multistage pump units
Terms, definitions and tolerances	ISO 9906;2012 Ed. 2 Rotodynamic pumps — Hydraulic performance acceptance tests — Grades 1, 2 and 3

Compliance Certification, Registration and Surveillance Testing

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 pumps and, 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.

Pump designs covered by this regulation must be registered with the designated authority through the submission of the full product information as required under Article 4 together with test certificates as required by the above Test Certificates clause.

SURVEILLANCE TESTING

The verification tolerances defined in this Article relate only to the verification of the measured parameters by authorities and shall not be used by the manufacturer, 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.

Where a model has been designed to be able to detect it is being tested (e.g. by recognizing the test conditions or test cycle), and to react specifically by automatically altering its performance during the test with the objective of reaching a more favourable level for any of the parameters specified in this Regulation or included in the technical documentation or included in any of the documentation provided, the model and all equivalent models shall be considered not compliant

When verifying that a product model complies with the requirements laid down in this Regulation the authorities shall apply the following procedure for the requirements referred to in Article 3.

1) The designated market surveillance authority shall test any one single unit per model to be picked at any time directly from the market, at its sole discretion, following verification procedure for the requirements set out in Article 3.2 and the test method set out in Article 3.3.

2) The model shall be considered to comply with this regulation, if

    (a) the values given in the technical documentation and, where applicable, the values used to calculate these values are not more favourable for the manufacturer, importer or authorised representative than the results of the corresponding measurements; and
    (b) the declared values meet any requirements laid down in this Regulation and any required product information published by the manufacturer, importer or authorised representative does not contain values that are more favourable for the manufacturer, importer or authorised representative than the declared values; and
    (c) when the designated authority checks the unit of the model, it complies with the product information requirements, as specified in Article 3.2;
    (d) when the designated authority tests the unit of the model, the determined values (the values of the relevant parameters as measured in testing and the values calculated from these measurements) comply with the respective verification tolerances as set out in Table 6.

3) If the results referred to in points (2)(a) or (2)(c) are not achieved the model and all equivalent models shall be considered not to comply with this Regulation.

4) If the result referred to in point (2)(d) is not achieved;

    (a) for models that are produced in quantities of less than five per year including equivalent models, the model and all equivalent models shall be considered not to comply with this Regulation;

    (b) for models that are produced in quantities of five or more per year including equivalent models, the market surveillance authority shall select three additional units of the same model for testing. As an alternative, the three additional units selected may be one or more of equivalent models.

5) The model shall be considered to comply, with the applicable requirements if for these three units the arithmetical mean of the determined values complies with the respective verification tolerances given in Table 6.

6) If the result referred to in point (5) is not achieved, the model and all equivalent models shall be considered not to comply with this Regulation.

7) The designated authority shall provide all relevant information to [any other involved authority] without delay after a decision is taken on the non-compliance of the model according to points (3) or (6).

The market surveillance authority shall use the measurement and calculation methods set out in Article 3.3.

The market surveillance authority shall only apply the tolerances set out in Table 6 and shall only use the procedure described in points (1) to (7) for the requirements referred to in this Article. For the parameters in Table 6, no other tolerances such as those set out in harmonised standards or in any other measurement method shall be applied.

Table 6. Verification tolerances

Parameters	**Verification tolerances**
Efficiency at BEP (η_{BEP})	The determined value* shall not be lower than the declared value by more than 5 %.
Efficiency at PL (η_{PL})	The determined value* shall not be lower than the declared value by more than 5 %.
Efficiency at OL (η_{OL})	The determined value* shall not be lower than the declared value by more than 5 %.

** In the case of three additional units tested as prescribed in point 4 (b), the determined value means the arithmetical mean of the values determined for these three additional units.*

3.4 Indicative Benchmark

The indicative benchmark for the best-performing water pumps based on the best available technology on the market for water pumps is a minimum efficiency index (MEI) ≥ 0,70.

Article 4. Entry into Force

This regulation shall enter into force from DD-MM-YY, and the countries' regulatory authorities should decide on the appropriate date on a case-by-case basis.

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:

(5) demonstrate that the product model fulfils the requirements of this Regulation;
(6) include test reports according to the specified standards;
(7) provide any other information required to be present in the technical documentation file;
(8) 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 industrial fans in the scope of this regulation, which do not comply with the specified minimum energy performance requirements after the date of entry into force of this regulation shall be liable for effective, proportionate and dissuasive sanction, including, but not limited to warnings, fines, penalties, public naming, delisting etc. as may be determined by the designated authority.

An exception shall be allowed for rotodynamic water pumps 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 pumps 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 pumps are exhausted, whichever is earlier.

Further, any person, other than an end-user, in possession of a pump in the scope of this regulation after the date of entry into force of this regulation, that does not comply with the specified minimum energy performance requirements more than six months (if it a standalone product) or more than one year (if it is a component of a motor driven unit) after the date of entry into force of this regulation, 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 five years after its entry into force, to take into account technological progress, to address any unforeseen loopholes being exploited and any other relevant matters. The review shall aim at adopting an extended product approach.

SECTION V

Model Regulation Guidelines for Standard Air Compressor Packages

Article 1. Scope of Covered Products

1.1 Scope

This regulation applies to all *rotary standard air compressor packages* with a maximum volume flow rate between 5 to 1280 l/s when supplying air at discharge pressure(s) equal to or higher than 7 bar(a) and not exceeding 15 bar(a), that are manufactured in or imported into the country/region and are either sold as standalone equipment or integrated in a motor-driven unit.

1.2 Exemptions

This Regulation shall not apply to *rotary standard air compressor packages*:

(k) the stages of which is/are driven by single-phase electric motors;

(l) designed and specified to function in potentially explosive atmospheres;

(m) designed and specified to function at inlet air temperatures, the daily average value of which is below 15°C or above 50°C;

(n) designed and specified to function at ambient pressures prevailing at altitudes exceeding 1000 metres above sea-level.

Article 2. Terms and definitions

The following definitions apply:

32. 'Rotary standard air compressor package' means a standard air compressor package in which air admission, forced expansion, and diminution of its successive volumes or its forced discharge are performed cyclically by rotation of one or more working members (such as rotors) and associated parts;

33. 'Standard air compressor package' means an air compressor specified and capable to supply air, drawn in from the ambient, at discharge pressures between 7 bar(a) and 15 bar(a), and in which the air that is compressed comes into contact with one or more intentionally added substances for sealing, cooling and/or lubrication (of moving members and/or the enclosure they move within) except water;

34. 'Air compressor' means a machine or apparatus that converts electric energy into the potential energy of air pressure, for displacement and compression of air to any higher-pressure values above atmospheric pressure with a pressure ratio exceeding 1.1;

35. 'Stage' means the smallest discernible section of an air compressor in which the pressure of the air drawn in is increased by mechanical motions of one or more working members;

36. 'Pressure ratio' means the rated discharge pressure divided by the inlet pressure (p_{2rated}/p_1);

37. 'Rated discharge pressure' (p_{2rated}) means any discharge pressure at which the compressor package can typically be operated as specified by the manufacturer, expressed in bar(a). Since multiple rated discharge pressures can be specified for the same compressor package, the symbol can include a subscript allowing identification of the different rated discharge pressures e.g. ($p_{2rated,I}$, for i=2 to n);

38. 'Discharge pressure' (p_2) means the absolute pressure of air measured at the discharge port of the product when supplying air, expressed in bar(a);
39. 'Inlet pressure' (p_1) means the absolute pressure of aspirated air at the inlet of the product, expressed in bar(a);
40. 'Maximum volume flow rate' (V_{1max}) means the highest inlet volume flow rate that can be supplied safe, continuously and reliably by the compressor package, for any rated discharge pressure, expressed in l/sec or as '100 per cent ' when expressed as percentage points of maximum volume flow rate for that same discharge pressure;
41. 'Inlet volume flow rate' (V_1) means the volume of compressed air per unit of time supplied by the compressor package to a connected system, with inlet air at standard inlet conditions and expressed in l/s;
42. 'Standard inlet conditions' means the air aspirated by the compressor package is assumed to have an inlet pressure of 1 bar(a) (100 kPa), a temperature of 20°C and a relative water vapour pressure of 0 (zero), and the cooling water (if applicable) supplied to the compressor package has a supply temperature of 20°C and a temperature difference between inlet and outlet not exceeding 25 K (see also Table 3, Article 3.1.3 D);
43. 'Equivalent model' means a model which has the same technical characteristics relevant for the technical information to be provided, but which is placed on the market or put into service by the same manufacturer, importer or authorised representative as another model with a different model identifier;
44. 'Model identifier' means the code, usually alphanumeric, which distinguishes a specific product model from other models with the same trademark or the same manufacturer's, importers or authorised representative's name;

Article 3. Requirements

3.1 Energy Efficiency Requirements

The minimum efficiency requirements for rotary standard air compressor packages are set out in Article 3.1.2.

Compliance with energy efficiency requirements shall be measured and calculated in accordance with requirements set out in Articles 3.1.3 – 3.1.6.

3.1.1 Definitions for the purposes of energy efficiency Requirements

(40) Compressor package means a basic package or a feature package;

(41) Basic package means an air compressor that contains not more than the minimum number of components required for safe, continuous and reliable operation and is used for verification of its performance. The minimum number of components shall include those indicated in point 4 of Article 3.1.3.E. Basic package configuration and measurement;

(42) Feature package means an air compressor that comprises a basic package and any number of additional components, for instance for drying or filtering of compressed air and/or noise attenuation etc.;

(43) Fixed speed rotary standard air compressor package means a rotary standard air compressor package which is not equipped with a variable speed drive when placed on the market, and/or the minimum volume flow rate of which is (at any discharge pressure) higher than 55 per cent of the rated maximum volume flow rate (a that same discharge pressure);

(44) Variable speed rotary standard air compressor package means a rotary standard air compressor package which is equipped with a variable speed drive when placed on the market and the minimum volume flow rate of which is 55 or less of the rated maximum volume flow rate;

(45) Minimum volume flow rate (V_{1min}) means the lowest inlet volume flow rate that can be supplied safe, continuously and reliably by the compressor package, for a given discharge pressure, expressed in l/s or in percentage of the maximum volume flow rate for that same discharge pressure;

(46) Variable speed drive means an electronic power converter integrated, or functioning as one system, with the motor(s) driving the stage(s) that continuously adapts the electrical power supplied to the electric motor in order to control the mechanical power output of the motor according to the torque-speed characteristic of the load being driven by the motor, excluding variable voltage controllers where only the supply voltage for the motor is varied;

(47) Package efficiency means the fixed speed isentropic efficiency or the variable speed isentropic efficiency;

(48) Fixed speed isentropic efficiency means the representative energy efficiency of the fixed speed rotary standard air compressor package, calculated for the discharge pressure(s) specified, expressed in percentages (%);

(49) Variable speed isentropic efficiency means the representative energy efficiency of the variable speed rotary standard air compressor package, calculated for discharge pressure(s) specified, expressed in percentages (%);

(50) Isentropic efficiency means the division of the power that is theoretically required to compress under constant entropy a given inlet volume flow rate of air (treated as an ideal gas), from a given inlet pressure and temperature to a given discharge pressure, by the actual electric input power to the basic package of the standard air compressor package compressing the same inlet volume flow rate of air from the same inlet pressure and temperature to the same discharge pressure, established for any required combination of discharge pressure and inlet volume flow rate, expressed as percentage;

(51) Ideal gas means a hypothetical gas whose molecules occupy negligible space and have no interactions, and which consequently obeys the gas laws exactly;

(52) Entropy means a quantitative measure of disorder in a thermodynamic system;

(53) Proportional loss factor (d) means the factor to be used to express or calculate a target for a package efficiency relative to the average of package efficiencies of the product group the compressor package belongs to (defined by curve and constants) and proportional to the difference in the average efficiency of that group and the (theoretical) optimum package efficiency of that group (100 per cent) when assessed for the maximum inlet volume flow rate;

(54) Maximum discharge pressure (p_{2max}) means a discharge pressure of 15 bar(a) if at least one rated discharge pressures exceeds 15 bar(a) or the highest of rated discharge pressure(s) between 7 bar(a) and 15 bar(a), that can be supplied safe, continuously (without interruption of air delivery or unloading) and reliably by the compressor package, and the realisation of which involves no active reduction of the inlet volume flow rate (for instance through inlet throttling, etc.), with air at standard inlet conditions, expressed in bar(a);

Note: If only one rated discharge pressure within 7 bar(a) to 15 bar(a) is specified, the maximum discharge pressure, the minimum discharge pressure and the rated discharge pressure are identical;

(55) Minimum discharge pressure (p_{2min}) means a discharge pressure of 7 bar(a) if at least one rated discharge pressure(s) is less than 7 bar(a) or the lowest of rated discharge pressure(s) between 7 bar(a) and 15 bar(a), that can be supplied safe, continuously (without interruption of air delivery or unloading) and reliably by the compressor package and with air at standard inlet conditions, expressed in bar(a);

Note: If only one rated discharge pressure within 7 bar(a) to 15 bar(a) is specified, the maximum discharge pressure, the minimum discharge pressure and the rated discharge pressure are identical;

(56) Input power (P_{real}) means the electric input power supplied to the compressor package, when running loaded and delivering compressed air, expressed in kW;

(57) Full load power ($P_{full\ load}$) is the input power of the compressor package while supplying the maximum volume flow rate at the maximum discharge pressure(s), expressed in kW;

(58) Idle power (P_{idle}) means the input power of the compressor package, with the electric motor running but the internal pressure vented (unloaded condition), expressed in kW;

(59) Cycle energy requirement means the energy consumption of a compressor package when completing an operating cycle from standstill over start-up to full load and back via venting and idling to standstill, expressed in seconds of full load power (s) ;

(60) Cooling method means the method applied to cool the stage(s) within the rotary standard air compressor package;

(61) Compression stages mean the number of successive compression stages within the rotary standard air compressor package;

(62) Sound pressure level means the sound pressure emitted by the rotary standard air compressor package, expressed in (dB);

(63) Heat recovery option means a technical solution for the recovery of heat produced by the compressor package with the aim of energy saving within the compressor package (i.e. heat-driven drying processes, etc.) or in processes to which the recovered heat is delivered (i.e. space and/or water heating or (pre)heating of various media, etc.);

(64) Customer means a natural or legal person who buys, hires or receives a product for own use whether acting for purposes which are outside its trade, business, craft or profession or not;

(65) 'Witnessed testing' means actively observing the physical testing of the product under investigation by another party, to draw conclusions on the validity of the test and the test results. This may include conclusions on the compliance of testing and calculations methods used with applicable standards and legislation;

(66) 'Factory acceptance test' means a test on an ordered product where the customer uses witnessed testing to verify the product's full accordance with contractual requirements, before they are accepted or put into service.

3.1.2 Minimum Energy Efficiency Requirements

The target efficiency for rotary air compressor packages shall be calculated using the equation below.

Equation 1

$$\eta_{target} = a*\ln^2(V_{1max}) + b*\ln(V_{1max}) + c + \{100 - (a*\ln^2(V_{1max}) + b*\ln(V_{1max}) + c)\}*d/100$$

Where:

η_{target} means the isentropic efficiency that the product shall achieve.

ln means the natural logarithm of the value indicated in brackets (..)

a, b and c are coefficients given in Table 1 for fixed speed rotary air compressor packages and variable speed rotary air compressor packages.

V_{1max} means the maximum volume flow rate per discharge pressure (minimum discharge pressure, maximum discharge pressure and rated discharge pressures higher than 7 bar(a) and less than 15 bar(a)

d is the proportional loss factor

Table 1. Coefficients for calculation of the isentropic efficiency of ACP

Standard air compressor type	**Coefficients of the formula to calculate the <u>minimum</u> isentropic efficiency, depending on flow rate (V_{1max})**		
	a	b	c
Fixed speed rotary standard air compressor	-0.928	13.911	27.110
Variable speed rotary standard air compressor	-1.549	21.573	0.905

3. first tier: from Date/Month/Year, the fixed speed isentropic efficiency of a fixed speed rotary compressor package and the variable speed isentropic efficiency of a variable speed rotary compressor package at:
    - the *minimum discharge pressure*;
    - the *maximum discharge pressure* and;
    - any other *rated discharge pressure* less than 15 bar(a) but exceeding 7 bar(a);

shall be equal to or exceed the corresponding *target efficiency* calculated based on the same *maximum volume flow rate* specified for that same *discharge pressure* and for
a proportional loss factor value of d = -15

4. first tier: from Date/Month/(Year +2), the fixed speed isentropic efficiency of a fixed speed rotary compressor package and the variable speed isentropic efficiency of a variable speed rotary compressor package at:
    - the *minimum discharge pressure*;
    - the *maximum discharge pressure* and;
    - any other *rated discharge pressure* less than 15 bar(a) but exceeding 7 bar(a);

    shall be equal to or exceed the corresponding *target efficiency* calculated based on the same *maximum volume flow rate* specified for that same *discharge pressure* and for
    a proportional loss factor value of d = -10

3.1.3 Measurement methods and Calculations

For the purposes of compliance and verification of compliance with the requirements of this Regulation, measurements and calculations shall be made using harmonised standards as referenced in Article 5. Or using other reliable, accurate and reproducible methods, which take into account the generally recognised state-of-the-art, and in line ith the following provisions:

3.1.3 A Calculation of fixed speed isentropic efficiency

The *fixed speed isentropic efficiency* for each *discharge pressure* specified in Article 3.1.2 when supplying the *maximum volume flow rate* for that same *discharge pressure* is calculated using the equation below.

Equation 2

$$\eta_{isen,fixed} = \frac{V_{1max} * p_1 * \frac{\kappa}{(\kappa - 1)} * [(p_2/p_1)^{\frac{\kappa - 1}{\kappa}} - 1]}{(P_{real} * 10)}$$

Where:

$\eta_{isen,\ fixed}$ = *isentropic efficiency* of the compressor package when supplying the *inlet volume flow rate* for the applicable *discharge pressure*, multiplied by 100 gives percentages (%);

V_{1max} = *maximum volume flow rate* (l/s) for the applicable *discharge pressure* p_2, at standard inlet conditions;

p_1 = *inlet pressure* in bar(a), by default 1 bar(a);

p_2 = *discharge pressure* in bar(a), at standard inlet conditions;

P_{real} = *electric input power* (kW) of the *basic package* for the applicable working point;

κ = isentropic exponent of air is 1.4 by convention.

Where only one *rated discharge pressure* higher than 7 bar(a) but less than 15 bar(a) is specified, the calculation of *fixed speed isentropic efficiency* shall be done for just this rated discharge pressure.

3.1.3.B Calculation of variable speed isentropic efficiency

The *variable speed isentropic efficiency* is calculated using the equation below, where *i* is the designation for an *inlet volume flow rate* of either 100 per cent, 70 per cent or 40 per cent of the *maximum volume flow rate*.

Equation 3

$$\eta_{isen,var} = \sum_{i=1}^{n} (\eta_{isen,i} * f_i)$$

Where:

$\eta_{isen,var}$ = *variable speed isentropic efficiency* of the compressor package, based on the *isentropic efficiency* when supplying either 100 per cent, 70 per cent or 40 per cent of the *maximum volume flow rate* (l/s) for the applicable *discharge pressure*, weighted by factor f_i, multiplied by 100 gives percentages (%);

f_i = weighing factor, according to table 2.

The isentropic efficiency for test condition *i* is calculated using the equation below

Equation 4

$$\eta\ isen,i = \frac{V1,i*p1*\frac{x}{(x-1)}*\left[\left({}^{p2,i}/_{p1}\right)^{\frac{x-1}{x}}-1\right]}{(Preal,1*10)}$$

Where, for each indent *i* referring to either 100 per cent, 70 per cent and 40 per cent of the *maximum volume flow rate*:

$\eta_{isen,i}$ = the *isentropic efficiency* when supplying either 100 per cent, 70 per cent or 40 per cent of the *maximum volume flow rate* (l/s) for the applicable *discharge pressure*, multiplied by 100 gives percentages (%);

$V_{1,i}$ = *inlet volume flow rate* (l/s) set at i is 100 per cent, 70 per cent or 40 per cent of the *maximum volume flow rate* at the applicable *discharge pressure*, at standard inlet conditions;

p_1 = *inlet pressure* in bar(a), by default 1 bar(a);

$p_{2,i}$ = *discharge pressure* in bar(a) at 100 per cent, 70 per cent or 40 per cent of maximum volume flow rate, at standard inlet conditions;

$P_{real,i}$ = *electric input power* (kW) of the *basic package* for the applicable working point (*i* is 100 per cent, 70 per cent or 40 per cent of the maximum volume flow rate);

κ = isentropic exponent of air is 1.4 by convention.

The weighing factors f_i for the specified inlet volume flow rates are presented in table 2.

Table 2. Weighing factors for variable speed rotary standard air compressors

Inlet volume flow rate ($V_{1,i}$ expressed as % of maximum volume flow $V_{i,max}$)	**Weighing factor (f_i)**
100%	25%
70%	50%
40%	25%

General methodology

The calculation of the *fixed speed isentropic efficiency* at each required *discharge pressure* follows from the calculation of the isentropic efficiency at 100 per cent, 70 per cent and 40 per cent of the *maximum volume flow rate*, resulting in $\eta_{isen,100\%}$, $\eta_{isen,70\%}$ and $\eta_{isen,40\%}$

For each of the required *discharge pressures* p_2 the *variable speed isentropic efficiency* $\eta_{isen,var}$ is the summation of $\eta_{isen,100\%}$ multiplied by $f_i = 0.25$, $\eta_{isen,70\%}$ multiplied by $f_i = 0.5$, and $\eta_{isen,40\%}$ multiplied by $f_i = 0.25$.

Where only one *rated discharge pressure* higher than 7 bar(a) but less than 15 bar(a) is specified, the calculation of *variable speed isentropic efficiency* shall be done for just this rated discharge pressure.

3.1.3.C Calculation of package efficiency at 40 per cent of maximum volume flow rate if the minimum volume flow rate is > 40 per cent and < 55 per cent

If the *minimum volume flow rate* of a *rotary standard air compressor package* any *rated discharge pressure* between or equal to 7 bar(a) and 15 bar(a) is higher than 40 per cent but less than 55 per cent of the *maximum volume flow rate*

the isentropic efficiency at 40 per cent inlet volume flow rate shall be calculated on the basis of an extrapolation of known values, as follows:

The efficiency of a *variable speed rotary standard air compressor package* at 40 per cent of *maximum volume flow rate* shall be established by the extrapolation of the parabolic function (2nd order polynomial) defined below, using and *isentropic efficiency* at 100 per cent and 70 per cent of *maximum volume flow rate* and the *minimum volume flow rate* and their *inlet volume flow rate* as anchor points.

Equation 5

$$y = ax^2 + \mathrm{bx} + \mathrm{c}$$

Where:

y = the extrapolated value for the *isentropic efficiency* at 40 per cent of *maximum volume flow rate*

x = the *inlet volume flow rate* at 40 per cent of *maximum volume flow rate*

a, b and c = constants, defined by the extrapolation, at sufficient

The extrapolated *isentropic efficiency* at 40 per cent of *maximum volume flow rate* shall not exceed the *isentropic efficiency* at the *minimum volume flow rate* (between 40 per cent and 55 per cent of *maximum volume flow rate*) of the *variable speed rotary standard air compressor package*.

3.1.3.D Standard inlet conditions

The *isentropic efficiency* of the *basic package* shall be calculated assuming *standard inlet conditions*, which means that inlet air pressure, inlet air temperature and water vapour pressure (and cooling water temperature if applicable) are as described inTable 3.

Table 3. Standard inlet conditions

Inlet condition parameter	**Value**
Inlet air pressure	1 bar(a) [100 kPa]
Inlet air temperature	20°C
Relative water vapour pressure	0
Cooling water temperature (if applicable)	20°C
Temperature difference inlet/outlet cooling water	<25 K

3.1.3.E Basic package configuration and measurement

The relevant parameters shall be measured for the *basic package of the rotary standard air compressor package* or using a *feature package* in which case the following measurement procedure shall be applied so that the final results match as closely as possible the results that could have been expected for a basic package of that product:

(1) All features not belonging to the *basic package* configuration (see Table 4) which have an additional electrical power consumption shall be switched off during measurement.

(2) All features not belonging to the *basic package* configuration (see Table 4) which have an additional compressed air consumption shall be closed off during measurement.

(3) All features not belonging to the *basic package* configuration (see Table 4) which produce an additional pressure drop shall be handled as follows:

   a) In case of pressure drop at the inlet/suction side or any intermediate level, the feature(s) not belonging to the *basic package* is/are allowed to be dismounted during the measurement, by replacing it with suitable piping if necessary.

   b) In case of a pressure drop at the discharge side due to feature(s) not belonging to the *basic package*, the *discharge pressure* p_2 is allowed to be measured upstream to the feature.

c) In case the procedure under b) is not feasible and the pressure drop caused by the feature(s) not belonging to the *basic package* is/are known, the *discharge pressure* p_2 of the package may be corrected for the given pressure drop by adding the known pressure drop of the feature(s) not belonging to the *basic package* to the *discharge pressure* p_2.

Table 4 gives a minimum configuration of the *basic package* for *fixed speed rotary standard air compressor packages* and *variable speed rotary standard air compressor packages*. If the absence of a component not listed in Table 4 hampers safe, reliable and continuous operation when the product is placed on the market and/or put into service, the component is considered part of the *basic package*.

Table 4. Components of the basic package of fixed speed rotary standard air compressor packages and variable speed rotary standard air compressor packages

Inlet filter
Inlet valve
Compression element
Minimum pressure check / backflow check valve
Electric/electronic motor control [2]
Electric motor, driving the stage(s)
Transmission (belt, gear, coupling) [1]
Compressor control device (pressure switch, pressure transducer etc…)
Cooling fan (incl. its controls)
Compressed air after-cooler
Oil separator
Oil pump (incl. its controls) [1]
Oil filter
Oil cooler
Thermostatic valve

[1] If the design of the *air compressor* requires the use of this component to function safe, continuous and reliable, then the component is part of the *basic package*. For *air compressors* designed to function safely, continuously and reliably without the use of this component (i.e. a transmission is not applied when the stage is driven by the electric motor directly, or oil is circulated without use of an oil pump), the component is not part of the basic package.

[2] The electric/electronic motor control controlling the electric motor driving the compressor stage(s) shall be included in the assessment of the *basic package*. For a f*ixed speed rotary standard air compressor package* this is assumed to be electric switchgear, for a *variable speed rotary standard air compressor package* this is assumed to be a *frequency converter*. Other motor controls (controlling electric motors in fans and/or pumps that are part of the basic package) are to be included in the assessment as well, regardless of type.

3.2 Product Information Requirements

a. From Date/Month/Year, the instruction manuals for installers and end-users, and free access websites of manufacturers importers and authorised representatives shall provide the following product information;
   i. Minimum pressure ($p_{2,min}$) [bar(a)];
   ii. Maximum pressure (p_{2max}) [bar(a)];
   iii. Rated pressure(s) (p_{2rated}) [bar(a)];
   iv. Maximum volume flow rate (V1max) at minimum, maximum and rated discharge pressure(s) [l/s] ;
   v. for variable speed rotary compressor packages only: Minimum volume flow rate (V_{1min}) of the basic package at minimum, maximum and rated discharge pressure(s) [l/s];
   vi. Package efficiency:

a. For fixed speed rotary standard air compressor packages the fixed speed isentropic efficiency of the basic package of the standard air compressor package for the minimum discharge pressure, the maximum discharge pressure and any other rated discharge pressure(s) ($p_{2,rated}$) specified, the value of which lies between 7 bar(a) and 15 bar(a) calculated in accordance with Article 3.1.3;

b. For variable speed rotary standard air compressor packages the variable speed isentropic efficiency of the basic package of the standard air compressor package for the minimum discharge pressure, the maximum discharge pressure and any other rated discharge pressure(s) ($p_{2,rated}$) specified, the value of which lies between 7 bar(a) and 15 bar(a) calculated in accordance with Article 3.1.3;

vii. Full load power ($P_{full\ load}$) of basic package [kW];

viii. Idle Power (P_{idle}) of basic package [kW] ;

ix. Cycle energy of basic package [s] ;

x. Cooling method (water or air cooled);

xi. Description of at least one heat recovery option that can be applied in or in conjunction with the compressor package;

xii. Information relevant to improving resource efficiency:

a. Information relevant for facilitating disassembly, recycling or disposal at end- of-life;

b. Information relevant for the installation, use and maintenance of the compressor package.

b. Manufacturers, importers and authorised representatives of rotary standard air compressor packages shall provide to market surveillance authorities, upon request, the necessary information on the setting of the unit, as applied for the establishment of minimum, maximum and rated discharge pressures, maximum and minimum volume flow rate, and package efficiencies for each relevant combination of discharge pressure and inlet volume flow rate, and provide contact information for obtaining such information.

The exact wording used in the list does not need to be repeated. Where applicable it may be displayed using graphs, figures or symbols rather than text.

3.3 Referenced Standards Compliance Certification, Registration, 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 5. Reference Standards for Test Methods and Energy Efficiency Calculations

Topic	*Standard*
Test method for determining air compressor package performance	ISO 1217:2009, Displacement compressors — Acceptance tests ISO 1217:2009, Amendment 1: 2016, Calculation of isentropic efficiency and relationship with specific energy Uniform Test Method for Certain Air Compressors, by US Department of Energy [Appendix A to Subpart T of Part 431, Title 10, https://www.ecfr.gov/current/title-10/part-431/appendix-Appendix%20A%20to%20Subpart%20T%20of%20Part%20431], which incorporates additional

	instructions e.g. stabilization, test equipment, etc. in addition to the ISO 1217 standard.
Terms, definitions and tolerances	-

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 air compressor packages and, 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.

Air compressor package 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 above Test Certificates clause.

SURVEILLANCE TESTING
To verify the claimed energy efficiency of an air compressor package design covered by this regulation,

1. the designated market surveillance authority shall test any one single unit to be picked at any time directly from the market, at its sole discretion, according to the test method prescribed in Article 5.

2. The model shall be considered to comply with this regulation, if the overall efficiency of the air compressor package (η_e) is at least target energy efficiency*0,9 calculated using the formulas and the applicable efficiency grades from Article 3.

3. If the result referred to in point 2 is not achieved:
    i. for models that are produced in lower quantities than five per year, the model shall be considered not to comply with this regulation,
    ii. for models that are produced in quantities of five or more per year, the market surveillance authority shall randomly test three additional units.

4. The model shall be considered to comply, if the average of the overall efficiency (η_e) of the three units referred to in point 3 is at least target energy efficiency*0,9 using the formulas and the applicable efficiency grades from Article 3.

5. If the results of the additional tests are not achieved, the model shall be considered not to comply 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.

3.4 Indicative Benchmark

The indicative benchmark for the best available technology on the market for compressors, at the time of adoption of this Regulation, is as indicated in Table 6. These benchmarks may not always be achievable in all applications or for the *maximum volume flow rate range* and *discharge pressures* covered by the Regulation.

Table 6. Benchmarks of rotary standard air compressor packages

Rotary standard air compressor package type	Proportional loss factor (d) to be used for calculation of benchmark
Fixed speed rotary standard air compressor	+15
Variable speed rotary standard air compressor	+15

For the calculation of isentropic efficiencies, the calculation method described in Article 3.1.3, point 1 and/or 2 shall apply.

Article 4. Entry into Force

This regulation shall enter into force from DD-MM-YY, and the countries' regulatory authorities should decide on the appropriate date on a case-by-case basis.

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:

(9) demonstrate that the product model fulfils the requirements of this Regulation;
(10) include test reports according to the specified standards;
(11) provide any other information required to be present in the technical documentation file;
(12) 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 and set in law. The supplier is obliged to check and update product conformity information, including informing the market surveillance authority of pertinent information related to product compliance as set in law by the authority 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 air compressor packages in the scope of this regulation, which do not comply with 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 air compressor packages 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 air compressor packages 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 are exhausted, whichever is earlier.

Further, any person, other than an end-user, in possession of an air compressor package in the scope of this regulation after the date of entry into force of this regulation, that does not comply with 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 five years after its entry into force, to take into account technological progress, to address any unforeseen loopholes being exploited and any other relevant matters. The review shall aim at adopting an extended product approach.

Conclusions

In these U4E Model Regulation Guidelines, regulatory authorities in emerging markets and developing economies now have convenient and ready templates for designing Minimum Energy Performance Standards (MEPS) for Electric Motors, Variable Speed Drives, Fans, Rotodynamic Water Pumps and Water Pump Units, and Air Compressors at global best practice levels.
Those economies that have a Standards & Labelling program for other appliance groups like lighting and cooling products should consider widening the coverage to motors and motor systems.
Other economies that already have Minimum Energy Performance Standards for Motors at lower efficiency levels should consider updating these to the global best practice levels as well as widening the coverage to include other motor system components.

It is understood that these templates would have to be adapted to specific local circumstances after due assessment of local conditions and consultations with stakeholders. Doing so will enable emerging markets and developing economies realise the potential energy, environmental and financial savings that are technically feasible and economically justifiable to the fullest extent.

The regulations should be reviewed not more than five years after their entry into force, to take into account technological progress, address any unforeseen loopholes being exploited, and any other relevant matters.

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