

WORKING DOCUMENT ON

Possible requirements for electric motors and variable speed drives

DRAFT ECODESIGN REGULATION

COMMISSION WORKING DOCUMENT

implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for electric motors and variable speed drives and repealing Regulation 640/2009/EC

THE COMMISSION OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products¹ and in particular Article 15(1) thereof,

Having regard to Commission Regulation 640/2009/EC of 22 July 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for electric motors²,

After consulting the Ecodesign Consultation Forum,

Whereas:

- (1) Under Directive 2009/125/EC ecodesign requirements should be set by the Commission for energy-related products representing significant volumes of sales and trade, having a significant environmental impact and presenting significant potential for improvement through design in terms of their environmental impact without entailing excessive costs.
- (2) Article 16(2)(a) of Directive 2009/125/EC provides, that in accordance with the procedure referred to in Article 19(3) and the criteria set out in Article 15(2), and after consulting the Ecodesign Consultation Forum, the Commission should, as appropriate, introduce implementing measures for products offering a high potential for cost-effective reduction of greenhouse gas emissions, such as for electric motors and variable speed drives.
- (3) Clarity and transparency regarding the applicable requirements for different electric motors needs to be ensured. Regulation 640/2009/EC is repealed and its requirements are incorporated in this Regulation in order to have only one ecodesign Regulation on electric motors.
- (4) Electric motors are the most important type of electric load in industries within the Community where motors are used in the production processes. The systems in which these motors are operated account for about 70% of the electricity consumed by the industry. There is a total potential for cost-effective improvement of the energy efficiency of these motor systems by about 20% to 30%. One of the major factors in such improvements is the use of energy efficient motors. Consequently, motors in electric motor systems represent a priority product for which ecodesign requirements should be established.
- (5) Electric motor systems include a number of energy-using products, such as motors, drives, pumps or fans. Motors and variable speed drives are an important part of these

¹ OJ L 285, 31.10.2009, p. 10.

² OJ L 191, 23.7.2009, p. 26.

products. This is why this Regulation requires that certain types of motors be equipped with variable speed drives.

- (6) Many motors are integrated in other products without being separately placed on the market or put into service in the meaning of Article 3 of Directive 2009/125/EC. To achieve the full cost-efficient energy saving potential, motors integrated in other products where the efficiency can be tested separately should be subject to the provisions of this Regulation.
- (7) The Commission has carried out a preparatory study covering the technical, environmental and economic aspects of electric motors and variable speed drives typically used in the Union. The study was devised together with stakeholders and interested parties from the Union and third countries, and the results have been made publicly available.
- (8) Electric motors converted 1300 TWh of electricity into mechanical energy in 2012; this corresponds to corresponding to 520 Mt of CO₂ emissions. This value is expected to increase to around 1500 TWh in 2020 and 1800 TWh in 2030.
- (9) The preparatory study shows that electric motors are placed on the Community market in large quantities, with their use-phase energy consumption being the most significant environmental aspect of all life cycle phases.
- (10) Variable speed drives converted 400 TWh of electricity with a given wave form into electricity with another wave form in 2012; this corresponds to corresponding to 160 Mt of CO₂ emissions. This value is expected to increase to around 500 TWh by 2020 and 540 TWh in 2030.
- (11) The preparatory study shows that variable speed drives are placed on the Community market in large quantities, with their use-phase energy consumption being the most significant environmental aspect of all life cycle phases
- (12) The internal losses in electric motors have been estimated to amount to 134 TWh in 2012. Other systems losses are not included in this number.
- (13) The internal losses in variable speed drives have been estimated to amount to 31 TWh in 2012. Other system losses are not included in this number.
- (14) It has been concluded that the life-cycle energy consumption and the use-phase electricity consumption of electric motors and variable speed drives can be improved significantly.
- (15) The energy efficiency of motor driven systems can be improved if motors in variable speed and load applications are equipped with drives. The best way for addressing the complete motor driven system is through the extended product approach.
- (16) The environmental aspect of electric motors and variable speed drives that has been identified as significant for the purposes of this Regulation is energy consumption.
- (17) The preparatory study shows that requirements regarding the other ecodesign parameters referred to in Annex I, Part 1 to Directive 2009/125/EC are not necessary in the case of electric motors or variable speed drives.
- (18) Improvements in the electricity consumption of electric motors and variable speed drives should be achieved by applying existing non-proprietary cost-effective technologies that can reduce the total combined costs of purchasing and operating them.

- (19) Ecodesign requirements should harmonise power consumption requirements for electric motors and variable speed drives throughout the Community, thus contributing to the functioning of the internal market and to the improvement of the environmental performance of these products.
- (20) An appropriate timeframe should be provided for manufacturers to redesign products. The timing should be such that negative impacts on the functionalities of electric motors or variable speed drives are avoided, and cost impacts for manufacturers, in particular small and medium-sized enterprises, are taken into account, while ensuring timely achievement of the objectives of this Regulation.
- (21) Measurements of the relevant product parameters should be performed through reliable, accurate and reproducible measurement methods, which take into account the recognised state of the art measurement methods including, where available, harmonised standards adopted by the European standardisation organisations, as listed in Annex I to Regulation (EU) 1025/2012 of the European Parliament and of the Council of 25 October 2012 on European standardisation³.
- (22) Regulation 640/2009 was estimated to save 135 TWh per year by 2020. As the provisions set out in such Regulation are maintained, such savings are also maintained.
- (23) The inclusion of new motor types in the scope of the Regulation should increase the market penetration of technologies that improve the life-cycle environmental impact of electric motors, leading to an additional estimated life-cycle electricity savings of 20 TWh by 2030, compared to the situation where no additional measures are taken.
- (24) This Regulation should increase the market penetration of technologies that improve the life-cycle environmental impact of electric motors and variable speed drives, leading to an estimated life-cycle electricity savings of 21.2 TWh by 2030, compared to the situation where no additional measures are taken.
- (25) The environmental impacts of medium voltage motors are relevant. At the time being no classification exists regarding the energy efficiency of electric motors with a rated voltage above 1 000 V. Such classification shall be developed and the possibility of setting minimum requirements for medium voltage motors shall be reassessed.
- (26) In accordance with Article 8(2) of Directive 2009/125/EC, this Regulation specifies which conformity assessment procedures apply.
- (27) In order to facilitate compliance checks, manufacturers should provide the information in the technical documentation referred to in Annexes IV and V to Directive 2009/125/EC insofar that information relates to the requirements laid down in this Regulation.
- (28) In order to further limit the environmental impact of motors manufacturers should provide relevant information on disassembly, recycling or disposal at end-of-life.
- (29) Benchmarks for currently available technologies with high energy efficiency should be identified. This will help to ensure the wide availability and easy accessibility of information, in particular for small and medium-sized enterprises and very small firms, which will further facilitate the integration of best design technologies for reducing energy consumption.
- (30) The measures provided for in this Regulation are in accordance with the opinion of the Committee established by Article 19(1) of Directive 2009/125/EC.

³ OJ L 316, 14.11.2012, p. 12.

HAS ADOPTED THE FOLLOWING REGULATION:

Article 1
Subject matter and scope

1. This Regulation establishes ecodesign requirements for the placing on the market and for the putting into service of motors, including where integrated in other products and variable speed drives.
2. This Regulation shall not apply to:
 - (a) motors designed to operate wholly immersed in a liquid;
 - (b) motors completely integrated into a product (for example gear, pump, fan or compressor) of which the energy performance cannot be tested independently from the product;
 - (c) motors with an integrated brake when the brake is an integral part of the inner motor construction and can neither be removed nor supplied by a separate power source during the testing of motor efficiency;
 - (d) motors specified to operate exclusively:
 - (i) at altitudes exceeding 4 000 metres above sea-level;
 - (ii) where ambient air temperatures exceed 60 °C;
 - (iii) in maximum operating temperature above 400°C;
 - (iv) where ambient air temperatures are less than –30 °C for any motor or less than 0 °C for a motor with water cooling;
 - (v) where the water coolant temperature at the inlet to a product is less than 0 °C or exceeding 32 °C;
 - (e) increased safety motors;
 - (f) motors in cordless or battery operated equipment;
 - (g) motors in hand-held equipment whose weight is supported by hand during operation;
 - (h) motors with mechanical commutators.except as regards the information requirements of Annex 1, Point 2: (3) to (6) and (12).

Article 2
Definitions

In addition to the definitions set out in Directive 2009/125/EC, the following definitions shall apply:

- (1) ‘Motor’ means an electric single speed, 50 Hz or 50/60 Hz motor rated for operation on a sinusoidal voltage:
 - has 2,4, 6 or 8 poles;
 - has a rated voltage U_N up to 1 000 V;
 - has a rated output P_N from 0.12 kW to 1 000 kW;
 - is rated on the basis of continuous duty operation.

- (2) 'Variable Speed Drive' means an electronic power converter 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, by adjusting the three-phase 50 Hz power supply to a variable frequency and voltage supplied to the motor.
 - is specified to operate with a motor with a rated output equal or above 0.12 kW and equal or below 1 000 kW.
- (3) 'Squirrel cage motor' means an electric motor with no brushes, commutators, slip rings or electrical connections to the rotor.
- (4) 'Phase' means the type of configuration of the mains electrical supply;
- (5) 'Pole' means the total number of magnetic north and south poles produced by the rotating magnetic field of the motor. The number of poles determines the base speed of the motor.
- (6) 'Continuous duty operation' means the capability of an electric motor with an integrated cooling system to operate at nominal load without interruption below its rated maximum temperature rise.
- (6) 'Increased safety motor' means a motor designed and certified to operate in explosive atmospheres in increased safety enclosure
- (7) 'Motor with mechanical commutators' means a motor where the direction of the current is reversed by means of a mechanical device
- (8) 'Brake motor' means a motor equipped with an electromechanical brake unit operating directly on the motor shaft without couplings.

Article 3 ***Ecodesign requirements***

The ecodesign requirements for motors are set out in Annex I.

Each ecodesign requirement shall apply in accordance with the following timetable:

- (1) from the date of coming into force of this Regulation:
 - (a) squirrel cage motors with a rated output of equal or above 0.75 and below 7.5 kW that are not brake motors or motors specified to operate exclusively in potentially explosive atmospheres as defined in Directive 94/9/EC of the European parliament and of the Council⁴ shall not be less efficient than the IE2 efficiency level, as defined in Annex I, point 1;
 - (b) squirrel cage motors with a rated output of equal or above 7,5 and equal or below 375 kW that are not brake motors or motors specified to operate exclusively in potentially explosive atmospheres as defined in Directive 94/9/EC of the European parliament and of the Council shall not be less efficient than the IE3 efficiency level, as defined in Annex I, point 1, or meet the IE2 efficiency level, as defined in Annex I, point 1, and be equipped with a variable speed drive;
- (3) from 1 January 2017:

⁴ OJ L 100, 19.4.1994, p. 1.

- (a) squirrel cage motors with a rated output of equal or above 0.75 and equal or below 375 kW that are not brake motors or motors specified to operate exclusively in potentially explosive atmospheres as defined in Directive 94/9/EC of the European parliament and of the Council shall not be less efficient than the IE3 efficiency level, as defined in Annex I, point 1, or meet the IE2 efficiency level, as defined in Annex I, point 1, and be equipped with a variable speed drive;
- (4) from 1 January 2018:
- (a) all motors with a rated output of equal or above 0.12 and below 0.75 kW shall not be less efficient than the IE2 efficiency level, as defined in Annex I, point 1;
 - (b) brake motors or motors specified to operate exclusively in potentially explosive atmospheres as defined in Directive 94/9/EC of the European parliament and of the Council with a rated output of equal or above 0.75 and equal or below 375 kW shall not be less efficient than the IE3 efficiency level, as defined in Annex I, point 1, or meet the IE2 efficiency level, as defined in Annex I, point 1, and be equipped with a variable speed drive;
 - (c) all motors with a rated output of above 375 equal and below 1 000 kW shall not be less efficient than the IE3 efficiency level, as defined in Annex I, point 1;
 - (d) all variable speed drives shall not be less efficiency than the IE1 efficiency level, as defined in Annex I, point 2;
- (5) from 1 January 2020:
- (a) all motors with a rated output of equal or above 0.75 and equal or below 1 000 kW shall not be less efficient than the IE3 efficiency level defined in Annex I, point I.

The product information requirements on motors are as set out in Annex I. Compliance with ecodesign requirements shall be measured and calculated in accordance with requirements set out in Annex II.

Article 4 **Conformity assessment**

The conformity assessment procedure referred to in Article 8 of Directive 2005/32/EC shall be the internal design control system set out in Annex IV of that Directive or the management system for assessing conformity set out in Annex V of that Directive.

Article 5 **Verification procedure for market surveillance purposes**

When performing the market surveillance checks referred to in Article 3 (2) of Directive 2005/32/EC, the authorities of the Member States shall apply the verification procedure set out in Annex III to this Regulation.

Article 6 **Indicative Benchmarks**

The indicative benchmarks for the best-performing motors currently available on the market are identified in Annex IV.

Article 7

Repeal

Regulation 640/2009/EC is repealed from the date of entry into force of this Regulation.

Article 8

Revision

The Commission shall review this Regulation in the light of technological progress on both motors and drives no later than 1 January 2020 and present the result of this review to the Ecodesign Consultation Forum. The review shall include:

- (1) Resource efficiency, re-use and recycling and the level of measurement uncertainty;
- (2) The possibility of setting stricter requirements for electric motors and variable speed drives.

The Commission shall review this Regulation in the light of further developed standards for medium voltage motors no later than 1 January 2018 and present the result of this review to the Ecodesign Consultation Forum. The review shall include:

- (1) The possibility of setting minimum energy efficiency requirements to motors with a rated voltage U_N above 1 000 V.

Article 9

Entry into force

This Regulation shall enter into force on the twentieth day following that of its publication in the *Official Journal of the European Union*.

This Regulation shall be binding in its entirety and directly applicable in all Member States.

Done at Brussels,

For the Commission

Member of the Commission

ANNEX I
Ecodesign requirements for motors

1. MOTOR EFFICIENCY REQUIREMENTS

The nominal minimum efficiency requirements for motors are set out in Tables 1 and 2. Table 3 provides the nominal minimum efficiency to be achieved by a motor in order to be achieve an IE4 efficiency level.

Table 1: Nominal minimum efficiencies (η) for IE2 efficiency level (50 Hz)

Rated output power [kW]	Number of poles			
	2	4	6	8
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 1 000	95.0	95.1	95.0	93.5

Table 2: Nominal minimum efficiencies (η) for IE3 efficiency level (50 Hz)

Rated output power [kW]	Number of poles			
	2	4	6	8
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 1 000	95.8	96.0	95.8	94.6

Table 3: Nominal minimum efficiencies (η) for IE4 efficiency level (50 Hz)

Rated output power [kW]	Number of poles			
	2	4	6	8
0.12	66.5	69.8	64.9	62.3
0.18	70.8	74.7	70.1	97.2
0.20	71.9	75.8	71.4	98.4
0.25	74.3	77.9	74.1	70.8
0.37	78.1	81.1	78.0	74.3

0.40	78.9	81.7	78.7	74.9
0.55	81.5	83.9	80.9	77.0
0.75	83.5	85.7	82.7	78.4
1.1	85.2	87.2	84.5	80.8
1.5	86.5	88.2	85.9	82.6
2.2	88.0	89.5	87.4	84.5
3	89.1	90.4	88.6	85.9
4	90.0	91.1	89.5	87.1
5.5	90.9	91.9	90.5	88.3
7.5	91.7	92.6	91.3	89.3
11	92.6	93.3	92.3	90.4
15	93.3	93.9	92.9	91.2
18.5	93.7	94.2	93.4	91.7
22	94.0	94.5	93.7	92.1
30	94.5	94.9	94.2	92.7
37	94.8	95.2	94.5	93.1
45	95.0	95.4	94.8	93.4
55	95.3	95.7	95.1	93.7
75	95.6	96.0	95.4	94.2
90	95.8	96.1	95.6	94.4
110	96.0	96.3	95.8	94.7
132	96.2	96.4	96.0	94.9
160	96.3	96.6	96.2	95.1
200	96.5	96.7	96.3	95.4
250	96.5	96.7	9.5	95.4
315 up to 1 000	96.5	96.7	96.6	95.4

The nominal efficiencies for IE5 level are 20% above the nominal efficiencies in Table 3.

To determine the nominal efficiency of motors with rated power outputs of 0,12 – 200 kW not given in Tables 1, 2 and 3 the following formula shall be applied:

$$\eta_s = A \cdot [\log_{10}(P_N)]^3 + B \cdot [\log_{10}(P_N)]^2 + C \cdot \log_{10}(P_N) + D$$

A, B, C and D are interpolation coefficients to be determined according to Table 4.

Table 4: Interpolation coefficients for motors with rated power output of 0,12 – 200 kW

IE code	Coefficients	2 poles	4 poles	6 poles	8 poles
IE2	A	22.4864	17.2751	-15.9218	6.4855
	B	27.7603	23.978	-30.2580	9.4748
	C	37.8091	35.5822	16.6861	36.8520
	D	82.4580	84.9935	79.1318	70.7620
IE3	A	6.8532	7.6356	-17.3610	-0.5896
	B	6.2006	4.8236	-44.5380	-25.5260
	C	25.1317	21.0903	-3.0554	4.2884
	D	84.0392	86.0998	79.1318	75.8310
IE4	A	- 8.8538	8.432	-13.0355	-4.9735
	B	- 20.3352	2.6888	-36.9497	-21.4530

	C	8.9002	14.6236	-4.3621	2.6653
	D	85.0641	87.6153	82.0009	79.0550

The nominal efficiencies for IE5 level are 20% below the nominal efficiencies for IE4 level.

2. VARIABLE SPEED DRIVE EFFICIENCY REQUIREMENTS

The nominal minimum efficiency requirements for variable speed drives are set out in Tables 5.

Table 5: Maximum variable speed drive losses for IE1

Rated output power [kW]	Maximum power losses at 90% of the maximum speed and 100% of the maximum torque [W]
0.12	100
0.18	104
0.25	109
0.37	118
0.55	129
0.75	142
1.1	163
1.5	188
2.2	238
3	299
4	375
5.5	479
7.5	583
11	784
15	1014
18.5	1212
22	1413
30	1866
37	2262
45	2712
55	3252
75	4370
90	5193
110	5582
132	6679
160	8058
200	10028
250	12445
315	15674
355	17628
400	19866

500	24794
560	27771
630	31224
710	35187
800	39637
900	44564
1000	49521

If the rated power of a power drive system is between two values in Table 5, the nearest higher power loss value shall be used for the IE class determination.

The reference power losses of IE2 level are 25% below the reference power losses of IE1 level.

3. PRODUCT INFORMATION REQUIREMENTS ON MOTORS

From the date of coming into force of this Regulation for motors with a rated output between 0.75 and 375 kW that are not brake motors or motors specified to operate exclusively in potentially explosive atmospheres as defined in Directive 94/9/EC of the European parliament and of the Council and from 1 January 2018 for motors with a rated output between 0.12 and 1 000 kW, the information on motors set out in points (1) to (12) shall be visibly displayed on:

- (a) the technical documentation of motors;
- (b) the technical documentation of products in which motors are incorporated;
- (c) free access websites of manufacturers of motors;
- (d) free access websites of manufacturers of products in which motors are incorporated.

As regards to the technical documentation, the information must be provided in the order as presented in points 1 to 12. The exact wording used in the list does not need to be repeated. It may be displayed using graphs, figures or symbols rather than text.

- (1) nominal efficiency (η) at the full, 75% and 50% rated load and voltage (U_N);
- (2) efficiency level: 'IE2', 'IE3', 'IE4' or , 'IE5';
- (3) the year of manufacture;
- (4) manufacturer's name or trade mark, commercial registration number and place of manufacturer;
- (5) product's model number;
- (6) number of poles of the motor;
- (7) the rated power output(s) or range of rated power output (kW);
- (8) the rated input frequency(s) of the motor (Hz);
- (9) the rated voltage(s) or range of rated voltage (V);
- (10) the rated speed(s) or range of rated speed (rpm);
- (11) information relevant for disassembly, recycling or disposal at end-of-life;

- (12) information on the range of operating conditions for which the motor is specifically designed:
- (i) altitudes above sea-level;
 - (ii) ambient air temperatures, including for motors with air cooling;
 - (iii) water coolant temperature at the inlet to the product;
 - (iv) maximum operating temperature;
 - (v) potentially explosive atmospheres.

The information referred to in points 1, 2 and 3 shall be durably marked on or near the rating plate of the motor.

Where the size of the rating plate makes it impossible to mark all the information referred to in point 1, only the nominal efficiency (η) at full rated load and voltage (U_N) shall be marked.

The information listed in points 1 - 12 does not need to be published on motor manufacturer's free access web site for tailor-made motors with special mechanical and electrical design manufactured on the basis of client request. Information on the mandatory requirement to equip motors, which do not meet the IE3 efficiency level with a variable speed drive, shall be visibly displayed on the rating plate, technical documentation of the motor:

- (a) from 1 January 2015 for motors with a rated output of 7,5 – 375 kW,
- (b) from 1 January 2017 for motors with a rated output of 0,75 – 375 kW.

Manufacturers shall provide information in the technical documentation on any specific precautions that must be taken when motors are assembled, installed, maintained or used with variable speed drives, including information on how to minimise electrical and magnetic fields from variable speed drives.

4. PRODUCT INFORMATION REQUIREMENTS ON VARIABLE SPEED DRIVES

From 1 January 2018 the information on variable speed drives set out in points (1) to (5) shall be visibly displayed on:

- (a) the technical documentation of variable speed drives;
- (b) free access websites of manufacturers of variable speed drives;

As regards to the technical documentation, the information must be provided in the order as presented in points 1 to 5. The exact wording used in the list does not need to be repeated. It may be displayed using graphs, figures or symbols rather than text.

- (1) power losses (W) at the following different operating points for speed versus torque (0;25), (0;50), (0;100), (50;25), (50;50), (50;100), (90;50), (90;100);
- (2) efficiency level: 'IE1', or 'IE2';
- (3) the year of manufacture;
- (4) manufacturer's name or trade mark, commercial registration number and place of manufacturer;
- (5) information relevant for disassembly, recycling or disposal at end-of-life;

ANNEX II

Measurements 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 the reference numbers of which have been published for this purpose in the Official Journal of the European Union, or other reliable, accurate and reproducible method, which takes into account the generally recognised state-of-the-art methods. They shall fulfil all of the following technical parameters.

1. FOR ELECTRIC MOTORS

The energy efficiency is the ratio of mechanical output power to the electrical input power.

The efficiency level of the motor, as specified in Annex I, shall be determined at rated output power (P_N), rated voltage (U_N), and rated frequency (f_N).

The difference between the output mechanical power and the input electrical power is due to losses occurring in the motor.

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

- measurement of total losses; or
- determination of separate losses for summation.

2. FOR VARIABLE SPEED DRIVES

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

- single component loss determination;
- input-output method; or
- calorimetric method.

ANNEX III Verification procedure

When performing the market surveillance checks referred to in Article 3 (2) of Directive 2009/125/EC, the authorities of the Member States shall apply the following verification procedure for the requirements set out in Annex I.

For motors with a rated output of equal or above 120 and equal or below 375 kW:

1. If the values in the technical documentation do not comply with the requirements set out in Annex I the model shall be considered not to comply with this Regulation.
2. The authorities of the Member State shall test one single unit.
3. The model shall be considered to comply with the provisions set out in this Regulation, if in the nominal motor efficiency (η), the losses $(1-\eta)$ do not vary from the values set out in Annex I by more than 15% for motors with on power range equal or above 120 W and below 150 kW and 10% on power range above 150 kW and equal or below 1 000 kW.
4. If the result referred to in point 3 is not achieved the market surveillance authority shall randomly test three additional units, except for motors that are produced in lower quantities than five per year.
5. The same model shall be considered to comply with the provisions set out in this Regulation, if in the average of the nominal efficiency (η), the losses $(1-\eta)$ of the three units referred to in point 4 do not vary from the values set out in Annex I by more than 15% for motors with on power range equal or above 120 W and below 150 kW and 10% on power range above 150 kW and equal or below 1 000 kW.
6. For motors that are produced in lower quantities than five per year, if the results referred to in point 3 are not achieved, the model shall be considered not to comply with this Regulation.
7. For motors that are produced in quantities of five or more per year, if the results referred to in point 5 are not achieved, the model shall be considered not to comply with this Regulation.

For variable speed drives:

1. If the values in the technical documentation do not comply with the requirements set out in Annex I the model shall be considered not to comply with this Regulation.
2. The authorities of the Member State shall test one single unit.
3. The model shall be considered to comply with the provisions set out in this Regulation, if the power losses do not vary from the values set out in Annex I by more than 5%.
4. If the result referred to in point 3 is not achieved the market surveillance authority shall randomly test three additional units, except for variable speed drives that are produced in lower quantities than five per year.
5. The same model shall be considered to comply with the provisions set out in this Regulation, if the average power losses of the three units referred to in point 4 do not vary from the values set out in Annex I by more than 5%.

6. For variable speed drives that are produced in lower quantities than five per year, if the results referred to in point 3 are not achieved, the model shall be considered not to comply with this Regulation.
7. For variable speed drives that are produced in quantities of five or more per year, if the results referred to in point 5 are not achieved, the model shall be considered not to comply with this Regulation.

Member States authorities shall use the measurement methods and calculation methods set out in Annex II.

Given the weight and size limitations in the transportation of electric motors and variable speed drives with a rated output of 375 – 1 000 kW, Member States authorities may decide to undertake the verification procedure at the premises of manufacturers, before they are put into service in their final destination.

The verification tolerances set out in this Annex relate only to the verification of the measured parameters by Member States authorities and shall not be used by the manufacturer or importer as an allowed tolerance to establish the values in the technical documentation.

ANNEX IV

Indicative Benchmarks referred to in Article 6

At the time of adoption of this Regulation, the best available technology on the market for motors was identified as the IE4 level, or an IE4 motor equipped with a variable speed drive, as defined in Annex I.

IE5 motors exist, but within limited availability and not in all power ranges covered by the present Regulation.

At the time of adoption of this Regulation, the best available technology on the market for variable speed drives was identified as IE2 level.