EUROPEAN COMMISSION

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Draft

**COMMISSION REGULATION (EU) No …/..**

**of**

**implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for fans driven by motors with an electric input power between 125 W and 500 kW**

Draft

**COMMISSION REGULATION (EU) No …/..**

**implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for fans driven by motors with an electric input power between 125 W and 500 kW**

**(Text with EEA relevance)**

THE EUROPEAN COMMISSION,

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 products[1] and in particular Article 15(1) thereof,

After consulting the Ecodesign Consultation Forum,

Whereas:

(1) Under Directive 2009/125/EC ecodesign requirements are to 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 in terms of their environmental impact without entailing excessive costs.

(2) Article 16(2) 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 Consultation Forum, the Commission will as appropriate introduce an implementing measure for products using electric motor systems, including fans driven by motors with an electric input between 125 W and 500 kW.

(3) Fans driven by motors with an electric input power between 125 W and 500 kW power range are an important part of various air handling products. These fans are driven by electric motors. Minimum efficiency requirements have been established for electric motors in Commission Regulation (EC) No 640/2009 of 22 July 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for electric motors[2], including electric motors equipped with variable speed drives. They apply to those motors which are part of a motor-fan system. However, most fans covered by this Regulation are used in combination with motors not covered by Regulation (EC) No 640/2009.

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1 OJ L 285, 31.10.2009, p. 10.
2 OJ L 191, 23.7.2009, p. 26.

(4) Total electricity consumption of fans driven by motors with an electric input power between 125 W and 500 kW is 410 TWh per year, rising to 660 TWh in 2020 if current Union market trends persist. The cost-efficient improvement potential through design is about 54 TWh per year in 2020, which corresponds to 25 Mt of $CO_2$ emissions. Consequently, fans with an electric input power between 125 W and 500 kW represent a priority product for which ecodesign requirements should be established.

(5) Many fans are integrated in other products without being separately placed on the market or put into service within the meaning of Article 5 of Directive 2009/125/EC and of Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC[3]. To achieve the full cost-efficient energy-saving potential, fans within a 125 W – 500 kW power range integrated in other products should also be subject to the provisions of this Regulation.

(6) The Commission has carried out a preparatory study which analysed the technical, environmental and economic aspects of fans. The study was developed together with stakeholders and interested parties from the Union and third countries, and the results have been made publicly available. Further work and consultations showed that the scope could be further extended subject to exemptions being made for some applications where the requirements would not be appropriate.

(7) The preparatory study shows that fans driven by motors with an input power between 125 W and 500 kW are placed on the Union market in large quantities, with their use-phase energy consumption being the most significant environmental aspect of all life cycle phases.

(8) The preparatory study shows that electricity consumption in use is the only significant ecodesign parameter relating to product design as laid down in Directive 2009/125/EC.

(9) Improvements in the energy efficiency of fans driven by motors with an electric input power between 125 W and 500 kW should be achieved by applying existing non-proprietary cost-effective technologies that can reduce the total combined costs of purchasing and operating them.

(10) Ecodesign requirements should harmonise the energy efficiency requirements for fans driven by motors with an electric input power between 125 W and 500 kW throughout the Union, thus contributing to the functioning of the internal market and to the improvement of the environmental performance of these products.

(11) An appropriate timeframe should be provided for manufacturers to redesign products and to adapt production lines. The timing should be such that negative impacts on the supply of fans driven by motors with an electric input power between 125 W and 500 kW 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.

(12) The energy efficiency of fans driven by motors with an input power between 125 W and 500 kW should be determined through reliable, accurate and reproducible measurement methods, which take into account the recognised state of the art,

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[3] OJ L 157, 9.6.2006, p. 24.

including, where available, harmonised standards adopted by the European standardisation bodies, as listed in Annex I to Directive 98/34/EC of the European Parliament and of the Council of 22 June 1998 laying down a procedure for the provision of information in the field of technical standards and regulations and of rules on Information Society services[4].

(13) This Regulation should increase the market penetration of technologies that limit the life-cycle environmental impact of fans driven by motors with an electric power input between 125 W and 500 kW, leading to annual estimated electricity savings of 54 TWh by 2020, compared to the situation where no measures are taken.

(14) In accordance with Article 8 of Directive 2009/125/EC, this Regulation should specify the applicable conformity assessment procedures.

(15) In order to facilitate compliance checks, manufacturers should be requested to provide information in the technical documentation referred to in Annexes IV and V to Directive 2009/125/EC.

(16) In order to further limit the environmental impact of fans driven by motors with an electric input power between 125 W and 500 kW, manufacturers should provide relevant information on disassembly, recycling or disposal at end-of-life of such fans.

(17) Benchmarks for currently available fan types 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 and facilitate the development of more efficient products for reducing energy consumption.

(18) 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,

HAS ADOPTED THIS REGULATION:

*Article 1*
***Subject matter and scope***

1. This Regulation establishes ecodesign requirements for the placing on the market or putting into service of fans driven or designed to be driven by motors with an electric input power between 125 W and 500 kW, including those integrated in other products.

2. This Regulation shall not apply to fans with an electric input power between 125 W and 500 kW which are:

   (a) designed to operate in potentially explosive atmospheres as defined in Directive 94/9/EC[5];

[4] OJ L 204, 21.7.1998, p. 37.
[5] OJ L 100, 19.4.1994, p. 1.

(b) designed for emergency use only, at short-time duty, with regard to fire safety requirements set out in Directive 89/106/EC[6];

(c) designed to operate:

(i) a. where operating temperatures of the gas being moved exceed 100ºC;

b. where operating ambient temperature for the motor, if located outside the gas stream, driving the fan exceeds 40°C;

(ii) where the annual average temperature of the gas being moved and/or the operating ambient temperature for the motor, if located outside the gas stream, are lower than -15ºC;

(iii) with a supply voltage >1 000 V AC or >1 500 V DC;

(iv) in toxic, highly corrosive or flammable environments or in environments with abrasive substances.

(v) with an optimum energy efficiency at 8000 rotations per minute or more;

(vi) in applications in which the ratio of the discharge pressure over the suction pressure is over 1.11;

(vii) in tumble and washing dryers.

*Article 2*
***Definitions***

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

(1) 'Fan' means a rotary bladed machine that is used to maintain a continuous flow of gas, typically air, passing through it and whose work per unit mass does not exceed 25 kJ/kg, and which:

– is designed for use with or equipped with an electrical motor with an electric input power between 125 W and 500 kW to drive the impeller;

– is an axial fan, centrifugal fan, cross flow fan, box fan, mixed flow fan or roof fan;

– may or may not be equipped with a motor when placed on the market or put into service;

(2) 'Impeller' means the part of the fan that is imparting energy into the airflow and is also known as the fan wheel;

6 OJ L 40, 11.2.1989, p. 12.

(3) ‘Axial fan’ means a fan that propels air in the direction axial to the rotational axis of one or more impeller(s) with a swirling tangential motion created by the rotating impeller(s). The axial fan may or may not be equipped with a cylindrical housing, inlet or outlet guide vanes or an orifice panel or orifice ring;

(4) ‘Inlet guide vanes’ are vanes positioned before the impeller to guide the air stream towards the impeller and which may or may not be adjustable;

(5) 'Outlet guide vanes' are vanes positioned after the impeller to guide the air stream from the impeller and which may or may not be adjustable;

(6) ‘Orifice panel’ means a panel with an opening in which the fan sits and which allows the fan to be fixed to other structures;

(7) ‘Orifice ring’ means a ring with an opening in which the fan sits and which allows the fan to be fixed to other structures;

(8) ‘Centrifugal fan’ means a fan in which the air enters the impeller(s) in an essentially axial direction and leaves it in a direction perpendicular to that axis. The impeller may have one or two inlets and may or may not have a housing;

(9) ‘Centrifugal radial bladed fan’ means a centrifugal fan where the outward direction of the blades of the impeller(s) at the periphery is radial relative to the axis of rotation;

(10) ‘Centrifugal forward curved fan’ means a centrifugal fan where the outward direction of the blades of the impeller(s) at the periphery is forward relative to the direction of rotation;

(11) ‘Centrifugal backward curved fan without housing’ means a centrifugal fan where the outward direction of the blades of the impeller(s) at the periphery is backward relative to the direction of rotation and which does not have a housing;

(12) ‘Housing’ means a casing around the impeller which guides the air stream towards, through and from the impeller;

(13) ‘Centrifugal backward curved fan with housing’ means a centrifugal fan with an impeller where the outward direction of the blades at the periphery is backward relative to the direction of rotation and which has a housing;

(14) ‘Cross flow fan’ means a fan in which the air path through the impeller is in a direction essentially at right angles to its axis both entering and leaving the impeller at its periphery;

(15) ‘Box fan’ means a axial fan, centrifugal fan or mixed flow fan that has an additional box or enclosure around the fan to provide the required air flow direction and a means of fitment to ducts where the box is not a housing as defined in this Regulation;

(16) ‘Mixed flow fan’ means a fan in which the air path through the impeller is intermediate between the air path in fans of centrifugal and axial types;

(17) ‘Roof fan’ means a fan designed for mounting on a roof or wall having exterior weather protection and that is fitted with either an axial, centrifugal or mixed flow fan inside the device;

(18) ‘Short-time duty’ means working of a motor at a constant load, which is not long enough to reach temperature equilibrium;

(19) Ventilation fan means a fan that is not used in household appliances defined in Annex I of Commission Regulation 1275/2008 of 17 December 2008;

(20) The ‘specific ratio’ means the stagnation pressure measured at the fan outlet divided by the stagnation pressure at the fan inlet at the optimal efficiency point of the fan.

*Article 3*
***Ecodesign requirements***

The ecodesign requirements for fans driven or designed to be driven by motors with an electric input power between 125 W and 500 kW are set out in Annex I.

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

(1) First tier: from 1 July 2012, ventilation fans with an electric motor input power between 125 W and 500 kW shall not have a lower efficiency grade than as defined in Annex I, point 1, Table 1;

(2) Second tier: from 1 January 2015, all fans with an electric input power between 125 W and 500 kW shall not have a lower efficiency grade than as defined in Annex I, point 1, Table 2.

The product information requirements on fans and how they must be displayed are as set out in Annex I, point 2. These requirements shall apply from 1 July 2012.

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 2009/125/EC shall be the internal design control system set out in Annex IV to that Directive or the management system for assessing conformity set out in Annex V to that Directive.

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

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 verification procedure set out in Annex III to this Regulation.

*Article 6*
***Indicative benchmarks***

The indicative benchmarks for the best-performing fans driven by motors with an electric input power between 125 W and 500 kW available on the market at the time of entry into force of this Regulation are set out in Annex IV.

*Article 7*
***Revision***

The Commission shall review this Regulation in the light of technological progress of fans driven by motors with an electric input power between 125 W and 500 kW no later than five years after its entry into force and present the result of this review to the Ecodesign Consultation Forum.

*Article 8*
***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 fans driven by motors with an electric input power between 125 W and 500 kW

### 1. DEFINITIONS FOR THE PURPOSES OF ANNEX I

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

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

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

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

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

(6) 'Efficiency category' means the fan air output energy form used to determine the fan efficiency, either static efficiency or total efficiency, where;

a. fan static pressure has been used to determine fan air power in the efficiency equation for fan static efficiency, and

b. fan total pressure has been used to determine fan air power in the efficiency equation for total efficiency;

(7) 'Static efficiency' means the efficiency of a fan, based upon measurement of the difference between the stagnation pressure at the fan outlet and the stagnation pressure at the fan inlet minus the fan dynamic pressure corrected by the Mach factor;

(8) 'Static pressure' ($p_{sf}$) means the fan total pressure ($p_f$) minus the fan dynamic pressure corrected by the Mach factor;

(9) 'Stagnation pressure' means the pressure measured with respect to absolute zero pressure, which is exerted at a point at rest relative to the air around it;

(10) 'Dynamic pressure' means the pressure calculated from the velocity and density of the air at the fan outlet;

(11) 'Mach factor' means a correction factor applied to dynamic pressure at a point, defined as the stagnation pressure minus the pressure with respect to absolute zero pressure which is exerted at a point at rest relative to the air around it and divided by the dynamic pressure;

(12) ‘Total efficiency’ means the efficiency of a fan, based upon measurement of the difference between the stagnation pressure at the fan outlet and the stagnation pressure at the fan inlet;

(13) ‘Total pressure’ ($p_f$ ) means the difference between the stagnation pressure at the fan outlet and the stagnation pressure at the fan inlet;

(14) ‘Efficiency grade’ is a parameter in the calculation of the target energy efficiency of a fan of specific electric input power at its optimum efficiency point (expressed as parameter ‘N’ in the calculation of the fan efficiency);

(15) The 'target energy efficiency' $\eta_{target}$ is the minimum efficiency a fan must achieve in order to meet the requirements and is based on its electrical input power at its point of optimum efficiency, where $\eta_{target}$ is the output value from the appropriate equation in section 3 of Annex II, using the applicable integer N of the efficiency grade (Annex I, section 1, Tables 1 and 2) and the electrical power input $P_{e(d)}$ of the fan at its point of optimum efficiency in the applicable energy efficiency formula.

(16) ‘Variable speed drive (VSD)’ means an electronic power converter integrated - or functioning as one system - with the motor and the fan, 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.

## 2. FAN EFFICIENCY REQUIREMENTS

The minimum efficiency requirements for fans are set out in Tables 1 and 2.

**Table 1. First tier minimum energy efficiency requirements for fans**

| **Fan types** | **Measurement category** (A-D) | **Efficiency category** (static or total) | **Target energy efficiency (see also Annex II.4 for applicable power ranges)** | **Efficiency grade** |
|---|---|---|---|---|
| Axial fan | A, C | static | $\eta_{target} = 2.74 \cdot \ln(P) - 6.33 + N$ | 36 |
| | | | $\eta_{target} = 0.78 \cdot \ln(P) - 1.88 + N$ | |
| | B, D | total | $\eta_{target} = 2.74 \cdot \ln(P) - 6.33 + N$ | 56 |
| | | | $\eta_{target} = 0.78 \cdot \ln(P) - 1.88 + N$ | |
| Centrifugal forward curved fan and centrifugal radial bladed fan | A, C | static | $\eta_{target} = 2.74 \cdot \ln(P) - 6.33 + N$ | 37 |
| | | | $\eta_{target} = 0.78 \cdot \ln(P) - 1.88 + N$ | |
| | B, D | total | $\eta_{target} = 2.74 \cdot \ln(P) - 6.33 + N$ | 42 |
| | | | $\eta_{target} = 0.78 \cdot \ln(P) - 1.88 + N$ | |
| Centrifugal backward curved without housing | A, C | static | $\eta_{target} = 4.56 \cdot \ln(P) - 10.5 + N$ | 58 |
| | | | $\eta_{target} = 1.1 \cdot \ln(P) - 2.6 + N$ | |

| | | | | |
|---|---|---|---|---|
| Centrifugal backward curved fan with housing | A, C | static | $\eta_{target} = 4.56 \cdot \ln(P) - 10.5 + N$ | 58 |
| | | | $\eta_{target} = 1.1 \cdot \ln(P) - 2.6 + N$ | |
| | B, D | total | $\eta_{target} = 4.56 \cdot \ln(P) - 10.5 + N$ | 61 |
| | | | $\eta_{target} = 1.1 \cdot \ln(P) - 2.6 + N$ | |
| Mixed flow fan | A,C | static | $\eta_{target} = 4.56 \cdot \ln(P) - 10.5 + N$ | 47 |
| | | | $\eta_{target} = 1.1 \cdot \ln(P) - 2.6 + N$ | |
| | B,D | total | $\eta_{target} = 4.56 \cdot \ln(P) - 10.5 + N$ | 58 |
| | | | $\eta_{target} = 1.1 \cdot \ln(P) - 2.6 + N$ | |
| Cross flow fan | B, D | total | $\eta_{target} = 1.14 \cdot \ln(P) - 2.6 + N$ | 18 |
| | | | $\eta_{target} = N$ | |
| Box fan with backward curved or mixed flow fan | B, D | total | $\eta_{target} = 4.56 \cdot \ln(P) - 10.5 + N$ | 35 |
| | | | $\eta_{target} = 1.1 \cdot \ln(P) - 2.6 + N$ | |
| Box fan with forward curved or axial fan | B,D | total | $\eta_{target} = 4.56 \cdot \ln(P) - 10.5 + N$ | 22 |
| | | | $\eta_{target} = 1.1 \cdot \ln(P) - 2.6 + N$ | |
| Roof fan (axial fan within) | A, C | static | $\eta_{target} = 2.74 \cdot \ln(P) - 6.33 + N$ | 27 |
| | | | $\eta_{target} = 0.78 \cdot \ln(P) - 1.88 + N$ | |
| Roof fan (centrifugal or mixed flow fan within) | A, C | static | $\eta_{target} = 4.56 \cdot \ln(P) - 10.5 + N$ | 48 |
| | | | $\eta_{target} = 1.1 \cdot \ln(P) - 2.6 + N$ | |

**Table 2. Second tier minimum energy efficiency requirements for fans**

| **Fan types** | **Measurement category** (A-D) | **Efficiency category** (static or total) | **Target energy efficiency (see also Annex II.4 for applicable power ranges)** | **Efficiency grade** |
|---|---|---|---|---|
| Axial fan | A, C | static | $\eta_{target} = 2.74 \cdot \ln(P) - 6.33 + N$ | 40 |
| | | | $\eta_{target} = 0.78 \cdot \ln(P) - 1.88 + N$ | |
| | B, D | total | $\eta_{target} = 2.74 \cdot \ln(P) - 6.33 + N$ | 60 |
| | | | $\eta_{target} = 0.78 \cdot \ln(P) - 1.88 + N$ | |
| Centrifugal forward curved fan and centrifugal radial bladed fan | A, C | static | $\eta_{target} = 2.74 \cdot \ln(P) - 6.33 + N$ | 42 |
| | | | $\eta_{target} = 0.78 \cdot \ln(P) - 1.88 + N$ | |
| | B, D | total | $\eta_{target} = 2.74 \cdot \ln(P) - 6.33 + N$ | 47 |
| | | | $\eta_{target} = 0.78 \cdot \ln(P) - 1.88 + N$ | |
| Centrifugal backward curved without housing | A, C | static | $\eta_{target} = 4.56 \cdot \ln(P) - 10.5 + N$ | 62 |
| | | | $\eta_{target} = 1.1 \cdot \ln(P) - 2.6 + N$ | |
| Centrifugal backward curved fan with housing | A, C | static | $\eta_{target} = 4.56 \cdot \ln(P) - 10.5 + N$ | 61 |
| | | | $\eta_{target} = 1.1 \cdot \ln(P) - 2.6 + N$ | |
| | B, D | total | $\eta_{target} = 4.56 \cdot \ln(P) - 10.5 + N$ | 64 |
| | | | $\eta_{target} = 1.1 \cdot \ln(P) - 2.6 + N$ | |
| Mixed flow fan | A,C | static | $\eta_{target} = 4.56 \cdot \ln(P) - 10.5 + N$ | 50 |
| | | | $\eta_{target} = 1.1 \cdot \ln(P) - 2.6 + N$ | |
| | B,D | total | $\eta_{target} = 4.56 \cdot \ln(P) - 10.5 + N$ | 62 |
| | | | $\eta_{target} = 1.1 \cdot \ln(P) - 2.6 + N$ | |
| Cross flow fan | B, D | total | $\eta_{target} = 1.14 \cdot \ln(P) - 2.6 + N$ | 21 |
| | | | $\eta_{target} = N$ | |
| Box fan with backward curved or mixed flow fan | B, D | total | $\eta_{target} = 4.56 \cdot \ln(P) - 10.5 + N$ | 39 |
| | | | $\eta_{target} = 1.1 \cdot \ln(P) - 2.6 + N$ | |
| Box fan with forward curved or axial fan | B,D | total | $\eta_{target} = 4.56 \cdot \ln(P) - 10.5 + N$ | 25 |
| | | | $\eta_{target} = 1.1 \cdot \ln(P) - 2.6 + N$ | |

| | | | | |
|---|---|---|---|---|
| Roof fan (axial fan within) | A, C | static | $\eta_{target} = 2.74 \cdot \ln(P) - 6.33 + N$ | 31 |
| | | | $\eta_{target} = 0.78 \cdot \ln(P) - 1.88 + N$ | |
| Roof fan (centrifugal or mixed flow fan within) | A, C | static | $\eta_{target} = 1.1 \cdot \ln(P) - 2.6 + N$ | 52 |
| | | | $\eta_{target} = 1.1 \cdot \ln(P) - 2.6 + N$ | |

## 3. PRODUCT INFORMATION REQUIREMENTS ON FANS DRIVEN BY MOTORS WITH AN ELECTRIC INPUT POWER BETWEEN 125 W AND 500 KW

1. The information on fans set out in points 2(1) to 2(11) shall be visibly displayed on:

(a) the technical documentation of fans;

(b) the technical documentation of products in which fans are incorporated;

(c) free access websites of manufacturers of fans;

(d) free access websites of fans and manufacturers of products in which fans are incorporated.

2. The following information shall be displayed:

(1) overall efficiency ($\eta$) , rounded to one decimal place;

(2) measurement category used to determine efficiency (A-D);

(3) efficiency category (static or total);

(4) efficiency grade at optimum efficiency point;

(5) whether the calculation of fan efficiency assumed use of a VSD and if so, whether the VSD is integrated within the fan or the VSD must be installed with the fan;

(6) year of manufacture;

(7) manufacturer's name or trade mark, commercial registration number and place of manufacturer;

(8) product's model number;

(9) the rated power input(s) at optimum efficiency (kW);

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

(11) information relevant for installing, using and maintaining the fan in order to minimise impact on the environment and ensure optimal life expectancy;

(12) description of additional items used when determining the fan efficiency, such as ducts, that are not described in the measurement category and not supplied with the fan.

3. The information in the technical documentation shall be provided in the order as presented in points 2(1) to 2(11). 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.

4. The information referred to in points 2(1), 2(2), 2(3), 2(4) and 2(5) shall be durably marked on or near the rating plate of the fan, where for point 2(5) one of the following forms of words must be used to indicate what is applicable:

– ‘A variable speed drive must be installed with this fan’;

– ‘A variable speed drive is integrated within the fan’;

5. Manufacturers shall provide information in the technical documentation on specific precautions to be taken when fans are assembled, installed or maintained.

## ANNEX II
## Measurements and calculations

### 1. Definitions

(1) 'Inlet stagnation volume flow rate' (q) is the volume of air that passes through the fan per unit of time (in $m^3/s$) and is calculated on the basis of the mass of air moved by the fan (in kg/s) divided by the density of this air at the fan inlet (in $kg/m^3$);

(2) 'Compressibility factor' is a dimensionless number that describes the amount of compressibility that the air stream experiences during the test and is calculated as the ratio of mechanical work exerted by the fan on the air to the same work exerted on an incompressible gas at the same flow rate, taking into account the fan pressure as 'total pressure' ($k_p$) or 'static pressure' ($k_{ps}$);

(3) $k_{ps}$ means compressibility coefficient for the calculation of fan static air power;

(4) $k_p$ means compressibility coefficient for the calculation of fan total air power;

(5) 'Final assembly', means a finished or assembled on-site assembly of a fan that contains all the elements to convert electric energy into fan air power without the need to add more parts or components;

(6) 'Not final assembly', means an assembly of fan parts, consisting of at least the impeller, which needs one or more externally supplied components in order to be able to convert electric energy into fan air power;

(7) 'Direct drive' means a driving arrangement for a fan where the impeller is fixed to the motor shaft, either directly or with a co-axial coupling, and where the impeller speed is identical to the motor's rotational speed;

(8) 'Transmission' means a driving arrangement for a fan which is not 'direct drive' as defined above. Such driving arrangements may include transmissions using a belt-drive, gearbox or slipping coupling;

(9) 'Low-efficiency drive' means a transmission using a belt whose width is less than three times the height of the belt or using some other form of transmission apart from a 'high-efficiency drive';

(10) 'High-efficiency drive' means a transmission using a belt whose width is at least three times the height of the belt or using toothed gears.

### 2. Measurement method

For the purposes of compliance and verification of compliance with the requirements of this Regulation, measurements and calculations must be made using a reliable, accurate and reproducible method, which takes into account the generally recognised state-of-the-art measurement methods, and whose results are deemed to be of low uncertainty, including methods set out in documents the reference numbers of which have been published for that purpose in the *Official Journal of the European Union*.

## 3. Calculation method

The methodology for calculating the efficiency of a specific fan is based on the ratio of air power to electrical input power to the motor, where fan air power is the product of air volume flow rate and pressure difference across the fan. The pressure is either the static pressure or the total pressure, which is the sum of static and dynamic pressure depending upon the measurement and efficiency category.

3.1 Where the fan is supplied as a 'final assembly', measure the fan efficiency at its optimum efficiency point:

(a) Where the fan does not include a variable speed drive, calculate the efficiency using the following equation:

$\eta_e = P_{u(s)} / P_e$ , where:
$\eta_e$ is the overall efficiency;
$P_{u(s)}$ is the fan air power, determined according to point 3.3, of the fan when it is operating at its optimal efficiency point;
$P_e$ is the power measured at the mains input terminals to the motor of the fan when the fan is operating at its optimal efficiency point.

(b) Where the fan includes a variable speed drive, calculate the efficiency using the following equation:

$\eta_e = (P_{u(s)} / P_{ed}) \cdot C_c$ , where:
$\eta_e$ is the overall efficiency;
$P_{u(s)}$ is the fan air power, determined according to point 3.3, of the fan when it is operating at its optimal efficiency point;
$P_{ed}$ is the power measured at the mains input terminals to the variable speed drive of the fan when the fan is operating at its optimal efficiency point;

$C_c$ is a part load compensation factor as follows:

for a motor with a variable speed drive and $P_{e(d)} \geq 5$ kW then $C_c = 1.04$

for a motor with a variable speed drive and $P_{e(d)} < 5$ kW then
$C_c = -0.03 \ln(Pe) + 1.088$.

For roof fans and box fans only the 'final assembly' calculation method described in this section can be applied.

3.2. Where the fan is supplied as 'not final assembly', the fan efficiency is calculated at the impeller's optimum efficiency point, using the following equation:

$\eta_e = \eta_r \cdot \eta_m \cdot \eta_T \cdot C_m \cdot C_c$ , where:

$\eta_e$ is the overall efficiency;

$\eta_r$ is the fan impeller efficiency according to $P_{u(s)} / P_a$ ,where:

$P_{u(s)}$ is fan air power determined at the point of optimal efficiency for the impeller and according to point 3.3 below;

$P_a$ is the fan shaft power at the point of optimal efficiency of the impeller;

$\eta_m$ is the nominal rated motor efficiency of the supplied motor. If no motor is supplied a default $\eta_m$ is calculated using the following values:

if the required electric input power 'Pe(d)' is $\geq$ 0.75 kW,

$\eta_m = 0.000278(x^3) - 0.019247(x^2) + 0.104395*x + 0.809761$

where $x = \text{Log}(P_{e(d)})$

and $P_{e(d)}$ is as defined in 3.1.(a)/(b);

if the required motor input power 'Pe(d)' is < 0.75 kW,

$\eta_m = 0.1462*\ln(P_{e(d)}) + 0.8381$

and $P_{e(d)}$ is as defined in 3.1.(a)/(b), where the electric input power Pe(d) recommended by the manufacturer of the fan should be enough for the fan to reach its optimum efficiency point, taking into account losses from transmission systems if applicable;

$\eta_T$ is the efficiency of the driving arrangement for which the following default values must be used:

for direct drive $\eta_T = 1.0$;

if the transmission is a low-efficiency drive as defined in (9) and

$P_a \geq 5$ kW, $\eta_T = 0.96$ or 1 kW < $P_a$ < 5 kW, $\eta_T = 0.0175 * Pa + 0.875$ or

$P_a \leq 1$ kW, $\eta_T = 0.89$

if the transmission is a high-efficiency drive as defined in (10) and

$P_a \geq 5$ kW, $\eta_T = 0.98$ or 1 kW < $P_a$ < 5 kW, $\eta_T = 0.01 * Pa + 0.93$ or

$P_a \leq 1$ kW, $\eta_T = 0.94$

$C_m$ is the compensation factor to account for matching of components = 0.9;

$C_c$ is the part load compensation factor:

for a motor without a variable speed drive $C_c = 1.0$

for a motor with a variable speed drive and $P_{e(d)} \geq 5$ kW then $C_c = 1.04$

for a motor with a variable speed drive and $P_{e(d)} < 5$ kW then
$C_c = -0.03 \ln(Pe) + 1.088$.

3.3 The fan air power, $P_{u(s)}$, is calculated according to the measurement category test method chosen by the fan supplier:

(a) Where the fan has been measured according to measurement category A, fan static air power $P_{us}$ is used from the equation $P_{us} = q \cdot p_{sf} \cdot k_{ps}$;

(b) Where the fan has been measured according to measurement category B, fan air power $P_u$ is used from the equation $P_u = q \cdot p_f \cdot k_p$;

(c) Where the fan has been measured according to measurement category C, fan static air power $P_{us}$ is used from the equation $P_{us} = q \cdot p_{sf} \cdot k_{ps}$;

(d) Where the fan has been measured according to measurement category D, fan air power $P_u$ is used from the equation $P_u = q \cdot p_f \cdot k_p$.

## 4. Methodology for calculating the target energy efficiency

The target efficiency is the energy efficiency a fan from a given fan category must achieve in order to comply with the requirements set out in this Regulation. The target efficiency is calculated by efficiency formulas that include the electrical input power, $P_{e(d)}$ and the minimum efficiency grade as defined in Annex I. The complete power range is covered by two formulas: one for fans with an electric input power from 0.125 kW up to and including 10 kW and the other for fans above 10 kW up to and including 500 kW.

There are three series of fan categories for which energy efficiency formulas are developed to reflect the different characteristics of various fan types:

4.1. The target energy efficiency for axial fans, centrifugal forward curved fans, centrifugal radial bladed fans and roof fans (axial fan within) is calculated using the following equations:

| **Power range P from 0.125 kW to 10 kW** | **Power range P from 10 kW to 500 kW** |
|---|---|
| $\eta_{target} = 2.74 \cdot \ln(P) - 6.33 + N$ | $\eta_{target} = 0.78 \cdot \ln(P) - 1.88 + N$ |

where the input power P is either the electrical power input $P_{e(d)}$ if the fan has a 'direct drive' or fan shaft power $P_a$ if the fan has a 'transmission' and N is the integer of the energy efficiency grade required.

4.2. The target energy efficiency for centrifugal backward curved fans without housing, centrifugal backward curved fans with housing, mixed flow fans, roof fans (centrifugal fan or mixed flow within) and box fans is calculated using the following equations:

| **Power range P from 0.125 kW to 10 kW** | **Power range P from 10 kW to 500 kW** |
|---|---|
| $\eta_{target} = 4.56 \cdot \ln(P) - 10.5 + N$ | $\eta_{target} = 1.1 \cdot \ln(P) - 2.6 + N$ |

where the input power P is either the electrical power input $P_{e(d)}$ if the fan has a 'direct drive' or fan shaft power $P_a$ if the fan has a 'transmission' and N is the integer of the energy efficiency grade required.

4.3. The target energy efficiency for cross flow fans is calculated using the following equations:

| **Power range P from 0.125 kW to 10 kW** | **Power range P from 10 kW to 500 kW** |
|---|---|

| | |
|---|---|
| $\eta_{target} = 1.14 \cdot \ln(P) - 2.6 + N$ | $\eta_{target} = N$ |

where the input power P is either the electrical power input $P_{e(d)}$ if the fan has a 'direct drive' or fan shaft power $P_a$ if the fan has a 'transmission' and N is the integer of the energy efficiency grade required.

## 5. Applying the target energy efficiency

The fan efficiency $\eta_e$ calculated according to the appropriate method in section 3 of Annex II must be equal to or greater than the target value $\eta_{target}$ set by the efficiency grade to meet the minimum efficiency requirements.

## ANNEX III
## Verification procedure for market surveillance purposes

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

1. The authorities of the Member State must test one single unit.
2. The model will be considered to comply with the provisions set out in this Regulation if the overall efficiency of the fan ($\eta_e$) is at least target efficiency*0.9 calculated using the formulas in Annex II (section 3) and the applicable efficiency grades from Annex I.
3. If the result referred to in point 2 is not achieved, the market surveillance authority must randomly test three additional units.
4. The unit will be considered to comply with the provisions set out in this Regulation if the average of the overall efficiency ($\eta_e$) of the three units referred to in point 3 is at least target efficiency*0.9 using the formulas in Annex II (section 3) and the applicable efficiency grades from Annex I.
5. If the results referred to in point 4 are not achieved, the model will be considered not to comply with this Regulation.

## 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 fans is as indicated in Table 1.

**Table 1. Indicative benchmarks for fans**

| **Fan types** | **Measurement category** (A-D) | **Efficiency category** (static or total) | **Efficiency grade** |
|---|---|---|---|
| Axial fan | A, C | static | 65 |
| | B, D | total | 75 |
| Centrifugal forward curved fan and centrifugal radial bladed fan | A, C | static | 62 |
| | B, D | total | 65 |
| Centrifugal backward curved open wheel fan | A, C | static | 70 |
| Centrifugal backward curved fan with housing | A, C | static | 72 |
| | B, D | total | 75 |
| Mixed flow fan | A,C | static | 61 |
| | B,D | total | 65 |
| Cross flow fan | B, D | total | 32 |
| Box fan | B, D | total | 65 |
| Roof fan (axial fan within) | A, C | static | 55 |
| Roof fan (centrifugal or mixed flow fan within) | A, C | static | 62 |

*Note: These benchmarks may not always be achievable in all applications or for the full power range covered by the Regulation.*