REGULATIONS

COMMISSION REGULATION (EU) No 327/2011

of 30 March 2011

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.

(3) Fans driven by motors with an electric input power between 125 W and 500 kW are an important part of various gas handling products. Minimum energy 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 also apply to those motors which are part of a motor-fan system. However, many fans covered by this Regulation are used in combination with motors not covered by Regulation (EC) No 640/2009.

(4) Total electricity consumption of fans driven by motors with an electric input power between 125 W and 500 kW is 344 TWh per year, rising to 560 TWh in 2020 if current Union market trends persist. The cost-efficient improvement potential through design is about 34 TWh per year in 2020, which corresponds to 16 Mt of CO_2 emissions. Consequently, fans with an electric input power between 125 W and 500 kW represent a 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 most of the cost-efficient energy-saving potential and facilitate enforcement of the measure, fans between 125 W and 500 kW integrated in other products should also be subject to the provisions of this Regulation.

(6) Many fans are part of ventilation systems installed in buildings. National legislation based on Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings [4], may set new stricter energy efficiency requirements on those ventilation systems, using the calculation and measurement methods defined in this regulation as regards the efficiency of the fan.

[1] OJ L 285, 31.10.2009, p. 10.

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

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

[4] OJ L 153, 18.6.2010, p. 13.

(7) 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 particular applications where the requirements would not be appropriate.

(8) The preparatory study showed 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.

(9) 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.

(10) 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.

(11) 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.

(12) Small fans (indirectly) driven by an electric motor between 125 W and 3 kW which primarily serves other functionalities are not within the scope. For illustration a small fan to cool the electric motor in a chain saw is not within the scope, even if the motor of the chain saw itself (which is also driving the fan) is above 125 W.

(13) 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.

(14) A review of this Regulation is foreseen no later than 4 years after its entry into force. The review process may be initiated earlier if evidence reaches the Commission that warrants this. The review should in particular assess the setting of technology independent requirements, the potential of the use of variable speed drives (VSD) and the necessity of the number and scope of exemptions as well as the inclusion of fans below 125 W electric input power.

(15) The energy efficiency of fans driven by motors with an electric 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, 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 [1].

(16) This Regulation should increase the market penetration of technologies that limit the life-cycle environmental impact of fans driven by motors with an electric input power between 125 W and 500 kW, leading to annual estimated electricity savings of 34 TWh by 2020, compared to the situation where no measures are taken.

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

(18) 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.

(19) 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.

(20) 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.

[1] OJ L 204, 21.7.1998, p. 37.

(21) 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, including those integrated in other energy-related products as covered by Directive 2009/125/EC.

2. The Regulation shall not apply to fans integrated in:

(i) products with a sole electric motor of 3 kW or less where the fan is fixed on the same shaft used for driving the main functionality;

(ii) laundry and washer dryers ≤ 3 kW maximum electrical input power;

(iii) kitchen hoods < 280 W total maximum electrical input power attributable to the fan(s).

3. This Regulation shall not apply to fans which are:

(a) designed specifically to operate in potentially explosive atmospheres as defined in Directive 94/9/EC of the European Parliament and of the Council [1];

(b) designed for emergency use only, at short-time duty, with regard to fire safety requirements set out in Council Directive 89/106/EC [2];

(c) designed specifically to operate:

(i) (a) where operating temperatures of the gas being moved exceed 100 °C;

(b) where operating ambient temperature for the motor, if located outside the gas stream, driving the fan exceeds 65 °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 – 40 °C;

(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;

(d) placed on the market before 1 January 2015 as replacement for identical fans integrated in products which were placed on the market before 1 January 2013; except that the packaging, the product information and the technical documentation must clearly indicate regarding (a), (b) and (c) that the fan shall only be used for the purpose for which it is designed and regarding (d) the product(s) for which it is intended.

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 (≥ 125 W and ≤ 500 kW) to drive the impeller at its optimum energy efficiency point,

— is an axial fan, centrifugal fan, cross flow fan or mixed flow 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 gas flow and is also known as the fan wheel;

3. 'Axial fan' means a fan that propels gas 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;

[1] OJ L 100, 19.4.1994, p. 1.
[2] OJ L 40, 11.2.1989, p. 12.

4. 'Inlet guide vanes' are vanes positioned before the impeller to guide the gas 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 gas 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 gas 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 gas 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 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;

15. 'Mixed flow fan' means a fan in which the gas path through the impeller is intermediate between the gas path in fans of centrifugal and axial types;

16. 'Short-time duty' means working of a motor at a constant load, which is not long enough to reach temperature equilibrium;

17. 'Ventilation fan' means a fan that is not used in the following energy-related products:

— laundry and washer dryers > 3 kW maximum electrical input power,

— indoor units of household air-conditioning products and indoor household air-conditioners, ≤ 12 kW maximum airco output power,

— information technology products;

18. The 'specific ratio' means the stagnation pressure measured at the fan outlet divided by the stagnation pressure at the fan inlet at the optimal energy efficiency point of the fan.

Article 3

Ecodesign requirements

1. The ecodesign requirements for fans are set out in Annex I.

2. Each fan energy efficiency requirement of Annex I Section 2 shall apply in accordance with the following timetable:

(a) first tier: from 1 January 2013, ventilation fans shall not have a lower target energy efficiency than as defined in Annex I, Section 2, Table 1;

(b) second tier: from 1 January 2015, all fans shall not have a lower target energy efficiency than as defined in Annex I, Section 2, Table 2.

3. The product information requirements on fans and how they must be displayed are as set out in Annex I, Section 3. These requirements shall apply from 1 January 2013.

4. The fan energy efficiency requirements of Annex I Section 2 shall not apply to fans which are designed to operate:

(a) with an optimum energy efficiency at 8 000 rotations per minute or more;

(b) in applications in which the 'specific ratio' is over 1,11;

(c) as conveying fans used for the transport of non-gaseous substances in industrial process applications.

5. For dual use fans designed for both ventilation under normal conditions and emergency use, at short-time duty, with regard to fire safety requirements as set out in Directive 89/106/EC, the values of the applicable efficiency grades set out in Annex I Section 2 will be reduced by 10 % for Table 1 and by 5 % for Table 2.

6. 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 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 no later than 4 years after its entry into force and present the result of this review to the Ecodesign Consultation Forum. The review shall in particular assess the feasibility of reducing the number of fan types in order to reinforce competition on grounds of energy efficiency for fans which can fulfil a comparable function. The review shall also assess whether the scope of exemptions can be reduced, including allowances for dual use fans.

Article 8

Entry into force

This Regulation shall enter into force on the 20th day following 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, 30 March 2011.

For the Commission
The President
José Manuel BARROSO

ANNEX I

ECODESIGN REQUIREMENTS FOR FANS

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 gas output energy form used to determine the fan energy efficiency, either static efficiency or total efficiency, where:

(a) 'fan static pressure' (p_{sf}) has been used to determine fan gas power in the efficiency equation for fan static efficiency; and

(b) 'fan total pressure' (p_f) has been used to determine fan gas power in the efficiency equation for total efficiency.

(7) 'Static efficiency' means the energy efficiency of a fan, based upon measurement of the 'fan static pressure' (p_{sf}).

(8) 'Fan 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 at a point in a flowing gas if it were brought to rest via an isentropic process.

(10) 'Dynamic pressure' means the pressure calculated from the mass flow rate, the average gas density at the outlet and the fan outlet area.

(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 gas around it and divided by the dynamic pressure.

(12) 'Total efficiency' means the energy efficiency of a fan, based upon measurement of the 'fan total pressure' (p_f).

(13) 'Fan 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 energy efficiency point (expressed as parameter 'N' in the calculation of the fan energy efficiency).

(15) The 'target energy efficiency' (η_{target}) is the minimum energy efficiency a fan must achieve in order to meet the requirements and is based on its electrical input power at its point of optimum energy efficiency, where η_{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 2, Tables 1 and 2) and the electrical power input $P_{e(d)}$ of the fan expressed in kW at its point of optimum energy 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.

(17) 'Overall efficiency' is either 'static efficiency' or 'total efficiency', whichever is applicable.

2. **Fan energy efficiency requirements**

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

Table 1

First tier minimum energy efficiency requirements for fans from 1 January 2013

Fan types	Measurement category (A-D)	Efficiency category (static or total)	Power range P in kW	Target energy efficiency	Efficiency grade (N)
Axial fan	A, C	static	$0{,}125 \leq P \leq 10$	$\eta_{target} = 2{,}74 \cdot \ln(P) - 6{,}33 + N$	36
			$10 < P \leq 500$	$\eta_{target} = 0{,}78 \cdot \ln(P) - 1{,}88 + N$	
	B, D	total	$0{,}125 \leq P \leq 10$	$\eta_{target} = 2{,}74 \cdot \ln(P) - 6{,}33 + N$	50
			$10 < P \leq 500$	$\eta_{target} = 0{,}78 \cdot \ln(P) - 1{,}88 + N$	
Centrifugal forward curved fan and centrifugal radial bladed fan	A, C	static	$0{,}125 \leq P \leq 10$	$\eta_{target} = 2{,}74 \cdot \ln(P) - 6{,}33 + N$	37
			$10 < P \leq 500$	$\eta_{target} = 0{,}78 \cdot \ln(P) - 1{,}88 + N$	
	B, D	total	$0{,}125 \leq P \leq 10$	$\eta_{target} = 2{,}74 \cdot \ln(P) - 6{,}33 + N$	42
			$10 < P \leq 500$	$\eta_{target} = 0{,}78 \cdot \ln(P) - 1{,}88 + N$	
Centrifugal backward curved fan without housing	A, C	static	$0{,}125 \leq P \leq 10$	$\eta_{target} = 4{,}56 \cdot \ln(P) - 10{,}5 + N$	58
			$10 < P \leq 500$	$\eta_{target} = 1{,}1 \cdot \ln(P) - 2{,}6 + N$	
Centrifugal backward curved fan with housing	A, C	static	$0{,}125 \leq P \leq 10$	$\eta_{target} = 4{,}56 \cdot \ln(P) - 10{,}5 + N$	58
			$10 < P \leq 500$	$\eta_{target} = 1{,}1 \cdot \ln(P) - 2{,}6 + N$	
	B, D	total	$0{,}125 \leq P \leq 10$	$\eta_{target} = 4{,}56 \cdot \ln(P) - 10{,}5 + N$	61
			$10 < P \leq 500$	$\eta_{target} = 1{,}1 \cdot \ln(P) - 2{,}6 + N$	
Mixed flow fan	A, C	static	$0{,}125 \leq P \leq 10$	$\eta_{target} = 4{,}56 \cdot \ln(P) - 10{,}5 + N$	47
			$10 < P \leq 500$	$\eta_{target} = 1{,}1 \cdot \ln(P) - 2{,}6 + N$	
	B, D	total	$0{,}125 \leq P \leq 10$	$\eta_{target} = 4{,}56 \cdot \ln(P) - 10{,}5 + N$	58
			$10 < P \leq 500$	$\eta_{target} = 1{,}1 \cdot \ln(P) - 2{,}6 + N$	
Cross flow fan	B, D	total	$0{,}125 \leq P \leq 10$	$\eta_{target} = 1{,}14 \cdot \ln(P) - 2{,}6 + N$	13
			$10 < P \leq 500$	$\eta_{target} = N$	

Table 2

Second tier minimum energy efficiency requirements for fans from 1 January 2015

Fan types	Measurement category (A-D)	Efficiency category (static or total)	Power range P in kW	Target energy efficiency	Efficiency grade (N)
Axial fan	A, C	static	$0{,}125 \leq P \leq 10$	$\eta_{target} = 2{,}74 \cdot \ln(P) - 6{,}33 + N$	40
			$10 < P \leq 500$	$\eta_{target} = 0{,}78 \cdot \ln(P) - 1{,}88 + N$	
	B, D	total	$0{,}125 \leq P \leq 10$	$\eta_{target} = 2{,}74 \cdot \ln(P) - 6{,}33 + N$	58
			$10 < P \leq 500$	$\eta_{target} = 0{,}78 \cdot \ln(P) - 1{,}88 + N$	

Fan types	Measurement category (A-D)	Efficiency category (static or total)	Power range P in kW	Target energy efficiency	Efficiency grade (N)
Centrifugal forward curved fan and centrifugal radial bladed fan	A, C	static	$0{,}125 \leq P \leq 10$	$\eta_{target} = 2{,}74 \cdot \ln(P) - 6{,}33 + N$	44
			$10 < P \leq 500$	$\eta_{target} = 0{,}78 \cdot \ln(P) - 1{,}88 + N$	
	B, D	total	$0{,}125 \leq P \leq 10$	$\eta_{target} = 2{,}74 \cdot \ln(P) - 6{,}33 + N$	49
			$10 < P \leq 500$	$\eta_{target} = 0{,}78 \cdot \ln(P) - 1{,}88 + N$	
Centrifugal backward curved fan without housing	A, C	static	$0{,}125 \leq P \leq 10$	$\eta_{target} = 4{,}56 \cdot \ln(P) - 10{,}5 + N$	62
			$10 < P \leq 500$	$\eta_{target} = 1{,}1 \cdot \ln(P) - 2{,}6 + N$	
Centrifugal backward curved fan with housing	A, C	static	$0{,}125 \leq P \leq 10$	$\eta_{target} = 4{,}56 \cdot \ln(P) - 10{,}5 + N$	61
			$10 < P \leq 500$	$\eta_{target} = 1{,}1 \cdot \ln(P) - 2{,}6 + N$	
	B, D	total	$0{,}125 \leq P \leq 10$	$\eta_{target} = 4{,}56 \cdot \ln(P) - 10{,}5 + N$	64
			$10 < P \leq 500$	$\eta_{target} = 1{,}1 \cdot \ln(P) - 2{,}6 + N$	
Mixed flow fan	A, C	static	$0{,}125 \leq P \leq 10$	$\eta_{target} = 4{,}56 \cdot \ln(P) - 10{,}5 + N$	50
			$10 < P \leq 500$	$\eta_{target} = 1{,}1 \cdot \ln(P) - 2{,}6 + N$	
	B, D	total	$0{,}125 \leq P \leq 10$	$\eta_{target} = 4{,}56 \cdot \ln(P) - 10{,}5 + N$	62
			$10 < P \leq 500$	$\eta_{target} = 1{,}1 \cdot \ln(P) - 2{,}6 + N$	
Cross flow fan	B, D	total	$0{,}125 \leq P \leq 10$	$\eta_{target} = 1{,}14 \cdot \ln(P) - 2{,}6 + N$	21
			$10 < P \leq 500$	$\eta_{target} = N$	

3. **Product information requirements on fans**

1. The information on fans set out in points 2(1) to 2(14) shall be visibly displayed on:

(a) the technical documentation of fans;

(b) free access websites of manufacturers of fans.

2. The following information shall be displayed:

(1) overall efficiency (η), rounded to 1 decimal place;

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

(3) efficiency category (static or total);

(4) efficiency grade at optimum energy 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 motor power input(s) (kW), flow rate(s) and pressure(s) at optimum energy efficiency;

(10) rotations per minute at the optimum energy efficiency point;

(11) the 'specific ratio';

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

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

(14) description of additional items used when determining the fan energy 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(14). 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 manual of instruction on specific precautions to be taken when fans are assembled, installed or maintained. If provision 2(5) of the product information requirements indicates that a VSD must be installed with the fan, manufacturers shall provide details on the characteristics of the VSD to ensure optimal use after assembly.

ANNEX II

MEASUREMENTS AND CALCULATIONS

1. **Definitions for the purposes of Annex II**

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

(2) 'Compressibility factor' is a dimensionless number that describes the amount of compressibility that the gas stream experiences during the test and is calculated as the ratio of the mechanical work done by the fan on the gas to the work that would be done on an incompressible fluid with the same mass flow, inlet density and pressure ratio, 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 gas power.

(4) k_p means compressibility coefficient for the calculation of fan total gas 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 gas 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 gas 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, a toothed 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 energy efficiency of a specific fan is based on the ratio of gas power to electrical input power to the motor, where fan gas power is the product of gas 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 gas power and the electric input power of the fan at its optimum energy efficiency point:

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

$$\eta_e = P_{u(s)} / P_e$$

where:

η_e is the overall efficiency;

$P_{u(s)}$ is the fan gas power, determined according to point 3.3, of the fan when it is operating at its optimal energy 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 energy efficiency point;

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

$$\eta_e = (P_{u(s)} / P_{ed}) \cdot C_c$$

where:

η_e is the overall efficiency;

$P_{u(s)}$ is the fan gas power, determined according to point 3.3, of the fan when it is operating at its optimal energy 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 energy efficiency point;

C_c is a part load compensation factor as follows:

— for a motor with a variable speed drive and $P_{ed} \geq 5$ kW, then $C_c = 1{,}04$,

— for a motor with a variable speed drive and $P_{ed} < 5$ kW, then $C_c = -0{,}03 \ln(P_{ed}) + 1{,}088$.

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

$$\eta_e = \eta_r \cdot \eta_m \cdot \eta_T \cdot C_m \cdot C_c$$

where:

η_e is the overall efficiency;

η_r is the fan impeller efficiency according to $P_{u(s)} / P_a$

where:

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

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

η_m is the nominal rated motor efficiency in accordance with Regulation (EC) No 640/2009 whenever applicable. If the motor is not covered by Regulation (EC) No 640/2009 or in case no motor is supplied a default η_m is calculated for the motor using the following values:

— if the recommended electric input power 'Pe' is ≥ 0,75 kW,

$\eta_m = 0{,}000278*(x^3) - 0{,}019247*(x^2) + 0{,}104395*x + 0{,}809761$,

where $x = \text{Lg}\ (P_e)$,

and P_e is as defined in 3.1(a),

— if the recommended motor input power 'Pe' is < 0,75 kW,

$\eta_m = 0{,}1462*\ln(P_e) + 0{,}8381$,

and P_e is as defined in 3.1(a), where the electric input power Pe recommended by the manufacturer of the fan should be enough for the fan to reach its optimum energy efficiency point, taking into account losses from transmission systems if applicable.

η_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 1(9) and

— $P_a \geq 5$ kW, $\eta_T = 0{,}96$, or

— 1 kW < P_a < 5 kW, $\eta_T = 0{,}0175 * Pa + 0{,}8725$, or

— $P_a \leq 1$ kW, $\eta_T = 0{,}89$,

— if the transmission is a high-efficiency drive as defined in 1(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 $P_{ed} \geq 5$ kW, then $C_c = 1{,}04$,

— for a motor with a variable speed drive and $P_{ed} < 5$ kW, then $C_c = -0{,}03 \ln(P_{ed}) + 1{,}088$.

3.3. The fan gas power, $P_{u(s)}$ (kW), 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 gas 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 gas 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 gas 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 gas 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 energy efficiency is the energy efficiency a fan from a given fan type must achieve in order to comply with the requirements set out in this Regulation (expressed in full percentage points). The target energy 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 types 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 and centrifugal radial bladed 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 the electrical input power $P_{e(d)}$ 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 and mixed 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
$\eta_{target} = 4{,}56 \cdot \ln(P) - 10{,}5 + N$	$\eta_{target} = 1{,}1 \cdot \ln(P) - 2{,}6 + N$

where the input power P is the electrical input power $P_{e(d)}$ 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 the electrical input power $P_{e(d)}$ and N is the integer of the energy efficiency grade required.

5. **Applying the target energy efficiency**

The fan overall efficiency η_e calculated according to the appropriate method in Section 3 of Annex II must be equal to or greater than the target value η_{target} set by the efficiency grade to meet the minimum energy 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 shall apply the following verification procedure for the requirements set out in Annex I.

1. The authorities of the Member State shall test one single unit.

2. The model shall be considered to comply with the provisions set out in this Regulation if the overall efficiency of the fan (η_e) is at least target energy 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:

   — for models that are produced in lower quantities than five per year, the model shall be considered not to comply with this Regulation,

   — 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 with the provisions set out in this Regulation 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 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 shall 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. These benchmarks may not always be achievable in all applications or for the full power range covered by the Regulation.

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 fan without housing	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