EUROVENT

THE EUROPEAN COMMITTEE OF HVAC&R MANUFACTURERS

VHK

Discussion document

Review Commission Regulation (EU) No. 327/2011 (fans)

21 Nov. 2014

Introduction

This is a discussion document by the VHK study team, inviting stakeholders to react on the various elements for review of Commission Regulation (EU) No. 327/2011 (hereafter 'fan regulation').

The document is based on stakeholder input, the existing fan regulation, the requirements of the Ecodesign framework directive 2009/125/EC, consistency with the latest drafts of related Ecodesign regulations (motors, compressors 2014, ventilation units 2013, etc.), various test standards and additional VHK-research of manufacturer's catalogue data.

The main part of the document is a table with 3 columns, containing the current text of the fan regulation, a proposal for new text and explanatory notes. There is one Annex on the development of minimum efficiency requirements.

The document is available in pdf and MS Word and stakeholders are invited, through tracked changes or separate written comments to react to the various elements discussed.

The document will be discussed at the 2nd stakeholder meeting, which is currently planned for mid-January 2015. Prior written comments or questions are welcome and can be posted by e-mail to the VHK study team, project leader René Kemna. Contact details can be found at http://www.fanreview.eu/contact_links.htm.

Legal disclaimer

Commission Regulation 327/2011	Proposed change	Explanatory notes	EUROVENT POSITION
Article 1 **Subject matter and scope**	*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.	1. This Regulation establishes ecodesign requirements for the placing on the market or putting into service of fans with an end-use as component or as sub-assembly integrated in other products.	According to the EC Blue Guide, if the *'end-use as component or sub-assembly'* is explicitly formulated then there is no doubt that the responsibility for compliance is with the manufacturer/importer placing the products on the (EU) market, i.e. the declaration of conformity with Ecodesign requirements is a mandatory part of the CE-marking. The rest should be redundant, i.e. automatic for CE-marked components, but is added for clarity (to be discussed with the EC legal services if this formulation is allowed) . Note that the Regulation does not apply to fans-as-components or fans-in-products that are to be exported outside the EU (they will have to comply with the legislation at their destination country). Likewise, the CE-marking also applies to extra-EU products that are placed on the EEA market (by an extra-EU manufacturer or an importer) Motors 2014: *..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.* Ventilation units 2013: *...applies to ventilation units and establishes ecodesign requirements for their placing on the market.* Compressors 2014: *...establishes ecodesign requirements for the placing on the market and/or putting into service of rotary standard air compressors with a volume flow rate between 5 to 1280 l/s and piston standard air compressors with a volume flow rate between 2 to 64 l/s, when driven by a three-phase electric motor.* Circulators 2009: *...establishes ecodesign requirements for the placing on the market of glandless standalone circulators and glandless circulators integrated in products.* Water pumps 2012: *....establishes ecodesign requirements for the placing on the market of rotodynamic water pumps for pumping clean water, including where integrated in other products.*	Suggestion: **This Regulation establishes ecodesign requirements for fans placed on the market or put into service, and includes fans incorporated into other products without being separately placed on the market or put into service within the meaning of Directive 2009/125/EC and of which the environmental performance can be assessed independently.** Comments: Stand alone fans are placed on the market. However, that is not reflected by "components and sub-assemblies as defined in 2009/125/EC as parts intended to be incorporated into products which are not placed on the market and/or put into service as individual parts for end users or the environmental performance of which cannot be assessed independently.
2. The Regulation shall not apply to fans integrated in:	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;	(i) products with a sole electric motor of 3 kW or less where the fan is used for motor cooling only and fixed on the same shaft used for driving the main functionality;	Consensus at 1st stakeholder meeting (' 1st SHM') to exclude motor cooling impellers fixed on the motor shaft. The addition 'used for motor cooling only' avoids loopholes (otherwise it could also be e.g. a motorised impeller)	
(ii) laundry and washer dryers ≤ 3 kW maximum electrical input power;	(ii) laundry and washer dryers ≤ 3 kW maximum electrical input power;	At the 1st SHM there was a proposal by some manufacturers of products-with-integrated-fans (CECED, EHI, EPEE, etc.) to generically exclude all fans integrated in other Ecodesign-regulated products to avoid ' double regulation' (hinting at it being superfluous), restricting freedom of design to realize lower cost compliant end-products by using lower cost non-compliant fans (and making up for the lower fan-efficiency by higher efficiency for other components and system solutions).	Position: VHK arguments: - Limited operating time of fans used in this type of appliances, - Small power (power scope), Eurovent refers to basic definition of a fan, which is moving air against a certain pressure.

(iii) kitchen hoods < 280 W total maximum electrical input power attributable to the fan(s).	(iii) kitchen hoods < 280 W total maximum electrical input power attributable to the fan(s).	However, when the EC and RegCom decided to approve the current Regulation 327/2011 it was evident and explicit that they intended a scope of *'..fans, including those integrated in other energy-related products as covered by Directive 2009/125/EC.'* (Art.1, 1). Also the Least Life Cycle Cost (LLCC) target level was determined in full awareness that it would have an impact on the price of the fan and thus on the price of the final product. Furthermore, the practice of having to use CE-marked components in order to obtain CE-marked final products is normal and is valid for a host of electric components (e.g. mains transformers, relays, contactors, timers, mains disconnect devices, etc.). CE marking indicates a product's compliance with EU legislation and so enables the free movement of products within the European market (EEA=EU + EFTA). In other words, without CE-marking they cannot be sold either as a component or in any other capacity.	**Eurovent still holds that whenever the power and design of the fans used for these applications comply with the scope and definition of the 'EU Fan Regulation', such an exemption would create an artificial division in the technical standard of the products circulating in the EU Common Market. Accordingly, we ask VHK and the Commission to reconsider the exemptions of kitchen hoods and laundry dryers. In this respect, we also refer to the definition of a fan as rightly proposed within this paper.**
	(iv) with a best energy efficiency point (bep) at 8 000 rotations per minute or more;	An important reason to exempt fan-applications (i) to (iv) can be explained from the fact that the LLCC targets were determined on the basis of an average fan with an average number of operating hours (1750-3000 h/year) and the requirements might thus not be economically reasonable for certain final products with low operating hours (300-400 h/year for driers and hoods; 50 h/year for vacuum cleaner fans). Note that exemption for fans with bep at 8000 rpm was taken from Art. 3 (and removed there because already regulated in the vacuum cleaner regulation). Also note that fans in normal household laundry driers and washer-dryers <3 kW are usually in the range 60-120 W, so would be out-of-scope anyway.	
3. This Regulation shall not apply to fans which are:	3. This Regulation shall not apply to fans which are **specified to operate exclusively**:	formulation taken from the motor regulation	
(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);		In the current review process of the motor regulation ATEX motors are not excluded. However for fans some manufacturers insist that fan tip clearances are necessary that would cause a 10% deterioration of efficiency. It is proposed to handle them later in Art. 3 (with the dual purpose fans).	Position: **Eurovent holds that in the design of ATEX fans, a number of safety-related design constraints exist. The lower efficiency of the ATEX motors is only one of them. The different physical size of the ATEX motors and the mandatory safety gaps between rotating and stationary parts impact the efficiency of different types of fans by a different measure. Accordingly, we consider the 10% allowance as too small in order to compensate the effect of the currently mandated technology for these fans.** **In the opinion of Eurovent and its members, given the very small size of the market for ATEX fans, regulating them is probably not justified. If a requirement must apply, it must be different according to the category of the product – a Category 1 fan is subject to heavier impacting design requirements than a Category 3 fan. The improvement in the technology of fans for standard applications may also not be applicable to ATEX fans, which implies that the deviation in efficiency may even grow in the future.**
(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);	(a) for emergency use only, at short-time duty of 1 hour or more, with regard to fire safety requirements for temperatures of 300°C and above set out in Regulation (EU) No 305/2011 of the Councile and the Parliament.	Council Directive 89/106/EC has been repealed and replaced by Regulation (EU) No 305/2011 of the Councile and the Parliament (OJ, L 88, 4.4.2011, p. 5). The mentioning of *'1 hour or more'* and *'300°C and above'* should ensure that F200 fans (which cannot be referenced directly for legal reasons) are **not** exempted (possible loophole, see 1st SHM). Motor Regulation: *'motors specified to operate exclusively in ambient temperatures of 400 °C or above'* are excluded. Pump Regulation: *water pumps designed only for fire-fighting application.* Note: These fans need to be certified by an EU notified body, following EN 12101-3:2005. The classes are F200 (200oC/120 minutes), F300 (300oC/60 min.), F400-90 (90 min), F400-120 (120 min.), F600 (60 min.), F842(30 min.)	Position: **Eurovent holds that the words 'of 1 hour or more' should be deleted, because they conflict with at least one of the classes defined in EN12101-3.**

	(b) in nuclear power plants	In the EU these are predominantly replacement fans, subject to strictest possible international safety requirements and certification. Supply of identical fans is required over the full life time of the power plant (may be up to 40-50 years).	
(c) designed specifically to operate:			
(i) (a) where operating temperatures of the gas being moved exceed 100 °C;	(c) where operating temperatures of the gas being moved exceed 100 °C;	Note: The FAQ document emphasizes that not only the design of the fan is intended but also the real-life operation, e.g. if such fans would be mounted in final products that do not have to withstand those temperatures in real-life. This is not immediately evident from the text here, but perhaps it is covered under d). [?] VU regulation: -40/65/100 oC (as fan), draft motor regulation: 60°*C* (not 65 °C), *-30 °C in general or 0 °C for water cooled motors* (not -40 °C). pump regulation: *pumping clean water at temperatures below – 10 °C or above 120 °C* compressor regulation*: designed to function where ambient temperatures exceed 40°C and/or where average inlet air temperatures are below -15°C or above 100°C;* Circulator regulation: no temperature restrictions.	
(b) where operating ambient temperature for the motor, if located outside the gas stream, driving the fan exceeds 65 °C;	(d) where operating ambient temperature for the motor, if located outside the gas stream, driving the fan exceeds 60 °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;	(e) 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 – 30 °C;		
(iii) with a supply voltage > 1 000 V AC or > 1 500 V DC;	(f) with a supply voltage > 1 000 V AC or > 1 500 V DC;	1000 V AC and 1500 V DC are the limit values between 'high voltage' and 'low voltage' according the electric safety standard IEC 60038. The same standard also distinguishes between 'low' and 'extra low' voltage (limit at 50 V AC and 120 V DC). Note that usage-driven definitions of what is high/medium/low voltage vary very much per sector. E.g. 1000 V fans are sometimes called 'medium-voltage'. Motor Regulation: applies up to 1000 V AC motors and is part of the definition in Art. 2 and not the scope Art. 1. Other regulations: VU and pumps also include 1500 V DC (according to EBM Papst 50% of their market is EC motors, including mainly BLDC), so DC should be maintained	
(iv) in toxic, highly corrosive or flammable environments or in environments with abrasive substances;	(g) handling toxic, highly corrosive or flammable gases or vapours as set out in Regulation (EC) No 1272/2008 and its adaptations;	The definition in the current Regulation is imprecise. The CLP Regulation 1272/2008 (OJ L 353, 31.12.2008, p. 1) contains precise references to substances, at indicated limit concentration levels, that are marked as toxic, highly corrosive (i.e. more corrosive than e.g. steam), flammable, etc. and constitutes thus a clear reference. Also ' handling' means that it relates to the gas/vapour being displaced by the fan, not to just anything toxic in ' the environment' of the fan. For ' abrasive substances' there is no clear reference. We propose to follow the EC FAQ document, which specifies the hardness and concentration of the particulates in the gas/vapour handled. The reason for the exemption is that these fans would require special seals and/or lining which affect the efficiency. Also the safety may possibly be at risk if the Ecodesign regulation insists on stricter energy efficiency for these fans. Note that for ventilation units there is the same exemption. The ventilation unit mentions explicitly that it wants to exclude VUs in e.g. coal mines, bio-hazardous labs, hospitals, etc. where conditions are very harsh and/or public health might be at stake.	Position: **The addition of the reference to Regulation (EC) No 1272/2008 does not help to distinguish real special purpose fans from more standard designs.**
	(h) handling abrasive substances with a hardness of at least 5 Mohs with a concentration of at least 100 mg/m³;		
	(i) handling gases containing biohazardous substances of risk groups 2, 3 and 4 as set out in Regulation (EC) 2000/54/EC	Directive 2000/54/EC of the European Parliament and the Council of 18 September 2000 on the protection of workers from risks related to exposure to biological agents at work, (OJ L 262, 17.10.2000, p.21) lists the relevant biological agents (bacteria, virusses and funghi) and their respective risk groups. QUESTION: Directive 2004/37/EC of the European Parliament and of the Council of 29 April 2004 on the protection of workers from the risks related to exposure to carcinogens or mutagens at work, OJ L 158, 30.4.2004, p. 50. Mentions only benzene, vinyl chloride monomer and hardwood dust and limit values for exposure over prescribed periods. Should this directive also be included?	
Art. 3, 4, (c) [..shall not apply to…] as conveying fans used for the transport of non-gaseous substances in industrial process applications.	(i) handling gases with a solid particle concentration of more than 200 mg/m³ and/or particles with an average diameter of 1 mm;	Taken from the EVIA-Fan Guidance Document. Replaces Art. 3, 4 c) on *conveying fans.. etc..* with a more exact definition. At this limit, typical downstream (after filter) exhaust fans are included (cf. Industrial Emissions Directive 2010/75/EU emission limit values for particulate matter/ dust), but everything bigger --material transport fans, leaf blower fans, etc.-- will be excluded. Note that this will exempt also most radial centrifugal fans from the scope, because in practice only useful with solids in the gas stream (and in reversible, e.g. dual purpose, fans).	

	(i) handling gases with a compressibility factor, rounded to the nearest 2 decimal places, in the designated pressure and temperature range of the scope that is not equal to 1,00;	In that case the compressibility factor does not need to be taken into account and defined in Annex 2. According to us (check!), the compressibility factor of air, even polluted exhaust gases, in the designated pressure and temperature range is 1.00 (rounded from 0.9999). As far as we know there are no gases typically displaced by fans in the same pT area that have a compressibility factor that deviates from 1.00 (rounded to 2 digits). Hence: It is proposed (as in Ventilation Unit regulation) to eliminate the factor in the definitions and in the calculation method.	
	(j) in cordless or battery operated equipment;	formulation taken from Motors 2014	
	(k) in hand-held equipment whose weight is supported by hand during operation;	formulation taken from Motors 2014	
(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 docu mentation 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.	(l) as a replacement for identical fans that are no longer compliant with the minimum requirements in this regulation, for a period of 5 years after the implementation date of the tier whose requirements could not be met by the identical fan to be replaced;	This is a proposal of 5 years, as is customary in some other Ecodesign-regulated products (e.g. circulators, external power supplies) and follows discussion at the 1st SHM. The current period of 2 years was deemed too short in the 1st SHM.	Question: **Is the indicated 5-year period starting with the sale of equipment, from 1 January 2015 or entry into force of the revised Regulation?** **Do you consider a grace period of 5-years sufficient enough to also account for products with a lifecycle of 15 years or more?**
	whereby the packaging, the product information and the technical docu mentation must clearly indicate regarding (a) to (k) that the fan shall only be used for the purpose for which it is specified and regarding (l) the product(s) for which it is intended.	The lay-out in 327/2011 suggests that this is part of d) but actually (indicated by the ';' mark) it is an obligation for all exemptions in Art. 1, sub 2. Hence the lay-out should be adjusted.	
	Note: Numbering and lay-out may be optimised		

Commission Regulation 327/2011	Proposed change	Explanatory notes	EUROVENT POSITION
Article 2 **Definitions**	*Article 2* **Definitions**		
In addition to the definitions set out in Directive 2009/125/EC, the following definitions shall apply:	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:	1. 'Fan' means a configuration of impeller, stator, electric motor, transmission or direct drive and possibly a variable speed drive, intended for the continuous displacement of gas with at its bep an electric input power between 125 W and 500 kW (≥ 125 W and ≤ 500 kW), a pressure-increase ratio lower than 1.1 and an output air velocity lower than 51,5 m/s, and which is an axial fan, centrifugal fan, cross flow fan, mixed flow fan or jet fan.	The separate components constituting a fan are added, following proposals in draft standards and 1stSHM that try to define a 'fan', also when it is not a self-standing product but a set of components in another product. 'continuous' sets the 'fan' apart from e.g. devices that create a single burst of gas displacement. 'displacement' of gas is also the functionality of ventilation units (see below), but here the goal is not further specified and thus can include also convection fans, combustion fans, etc.. 'bep' (best efficiency point), defined hereafter, is used throughout the regulation. The 'pressure-increase ratio' and 'electric input power' range define the scope in terms of performance, and sets fans apart from compressors (pressure-increase > 1.1), motors <125W (typical for residential ventilation units and other household appliance fans) and excludes bespoke large heavy duty fans for the process- and power industry, where market forces probably don't need EU regulation to achieve highest energy efficiency. The addition of the air velocity of 51,5 m/s means that --according to ISO 5801-- the Mach factor is lower than 0,15 and can thus be neglected. Fans above 51,5 m/s are extremely rare (e.g. high-pressure	Position: **Eurovent fully supports and highly appreciates the proposed definition; yet, we suggest to implement the term 'drive system' instead of 'motor package' and reinforce the need to take care of how to manage third-party supplied VSDs and whether coordination with the ongoing work in the US on a similar subject may prove useful.** **Eurovent further suggests to replace the term 'stator' by 'stationary aerodynamic parts'. This is due to the fact that the word 'stator' might generate confusion with the part of an electric motor.**

		combustion/pre-mix centrifugal fans with a very small outlet) and are mostly already excluded on the basis of their pressure ratio above 1,1 (>10 kPa). The inclusion of several types (axial, centrifugal, etc.) already in Art. 1 (or 2) is common in several Ecodesign regulations. 'Rotary bladed' is not needed and unnecessarily restrictive (why exclude future reciprocating solutions, acoustics?). The specification of 'not exceed 25 kJ/kg' is deleted, because it is redundant and unnecessary restrictive when already using a specific pressure ratio of 1.1 and electric power input 0.125-500 kW. It would be more consistent with other regulations to replace the electric power input with e.g. aerodynamic power, e.g. between 50W and 450 kW power output, but the change could be difficult (see also later). The addition of 'electric' excludes e.g. fossil fuel driven engines (e.g. motor cooling fan for vehicles), steam (engine) driven and compressed air driven (pneumatic) fans. We do not propose the expression 'mains-electric' as in other regulations because many fans do not use 230 V 'mains' but 12, 24, etc. V DC as a power source or medium-voltage (1000 V). By definition, given that battery powered fans are excluded, this DC power comes from a transformer (or in rare cases that will be neglected: a fossil fuel fired generator, solar PV or thermo-acoustics with DC output) and it would be fair (versus 230V AC fans) to include a correction for the transformer energy losses (e.g. following Ecodesign regulation 278/2009 for external power supplies with active efficiency 0,87 for >51W; Proposal 0,9 for power conversion, see Annex I, Cp). Where medium-voltage of e.g. 1000 V AC is used (e.g. jet fans for large tunnels, large industrial), there may be some small savings (1%?) because the final step of transforming to 230/400 V is excluded, but it is proposed not to correct for such a small effect.	
		Question: We could use 'motor package' instead of 'electric motor, transmission or direct drive and possibly variable speed drive' and then define that elsewhere. Opinions?	
		Definitions in related regulations: Motor 2014: 'Motor' means an electric single speed, 50 Hz or 50/60 Hz motor rated for operation on a sinusoidal voltage and has 2,4, 6 or 8 poles, as a rated voltage UN up to 1 000 V; has a rated output PN from 0.12 kW to 1 000 kW and is rated on the basis of continuous duty operation. Ventilation 2013: 'ventilation unit (VU)' means an electric mains-operated appliance equipped with an impeller, a motor and a casing and intended to replace utilised air by outdoor air in a building or a part of a building; (250 m3 is limit to non-residential VU and roughly comparable to 125 W input) Compressors 2014: Standard air compressor means a basic package compressor designed to supply air, sucked in from the surrounding environment, at outlet pressure levels between 7 to 14 bar(g) and... Basic package compressor means a compressor made up of compression element ('air end'), electric motor(s) and transmission or coupling to drive the compression element, and which is fully piped...etc. Compressor means a machine or apparatus converting different types of energy into the potential energy of gas pressure for displacement and compression of gaseous media to any higher pressure values above atmospheric pressure with pressure-increase ratios	

		exceeding 1.1; [VHK: this means higher than approximately 10 000 Pa=10 kPa]. Note that Art. 3, 4 b uses 1.11 kPa Water pumps 2012: ‘water pump’ is the hydraulic part of a device that moves clean water by physical or mechanical action and is of one of the following designs: Circulators 2009: ‘circulator’ means an impeller pump which has the rated hydraulic output power of between 1 W and 2 500 W and is designed for use in heating systems or in secondary circuits of cooling distribution systems;	
	2. ' bep' is the best energy efficiency point for fan operation, as declared by the manufacturer and specified by the applicable fan speed, expressed in rounds per minute (rpm);	This definition is used in Article 1 and above, plus a few more times later. We use ' bep' because it is a more common and shorter denominator than ' optimum energy efficiency point' . Furthermore, it now clearly states that bep is purely based on a declaration (question Halifax at 1stSHM) and specified for a fan speed solely determined by the manufacturer. In other words, the bep can be set at any operating point on the qv-Δp curve, independently whether this really represents the 'best' efficiency point ('best' is relative, e.g. a manufacturer may well choose a lower-speed, larger diameter fan to replace a high-speed smaller diameter if so desired). Please note that Motor Regulation and Ventilation Units also use a single point for efficiency with sometimes special provisions for vsd, but circulators, water pumps, variable speed compressors (average of efficiency at 100, 70, 40% of max. flow rate, weighted at respectively 25, 50, 25%), room air conditioners, etc. use weighted average of multiple (3,4,5) efficiency points, which avoids explicit credits for the variable speed drive. To be considered for fans??	Comment: Regulation 327/2011 EC does not require that the nominal best efficiency of the fan is measured along the maximum performance boundary. The proposed EN/ISO 12759 standard requires that such maximum is measured along the boundary. Restricting the measurement of the best efficiency to the boundary curve may lead the manufacturer to underestimate the absolute best efficiency of the fan. Leaving the choice of the best efficiency duty point unrestricted may allow for the option to design the drive system to deliberately move the best efficiency duty point below the 125W limit. Suggestion: **Eurovent suggests that the revised Regulation should clarify whether the nominal best efficiency of the fan shall have to be measured along the maximum performance boundary or at any duty point within the achievable performance range.**
— 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,		(already included above) Compare: Motor regulation: 0.12-1000 kW **output**. Ventilation unit regulation: 250 m3/h **output** is limit between residential and non-residential (derived from 125 W). Note that also fans that do not *' drive the impeller at their optimum efficiency point'* are included and thus this part should be moved to test conditions and deleted here. It would be consistent (with e.g. ventilation units) to set minimum and maximum in terms of m3/s and (static) Pa, but the present definition is acceptable (not worth the discussion). Witt has asked to harmonise the scope with the motor regulation. Currently, between 125W and 210 W motor **input** power there is a gap, where the fan scope extends below the motor scope. At the high end, between 450 and 1000 kW motor **output** power, the motor scope goes beyond the fan scope. Given that motor input power is used to determine target efficiency, it would be a major operation to completely synchronise the two. We could miss out on fan energy savings in the 125-210W range, which	

		would no longer be in the scope at a complete synchronisation with motor output. And there is the question of the energy consumption of the vsd, currently included in fan motor input power, which would anyway hamper a complete synchronisation between the scopes of motor- and fan regulation. For now, it is judged not practical (reactions?)	
— is an axial fan, centrifugal fan, cross flow fan or mixed flow fan,		included above	
— may or may not be equipped with a motor when placed on the market or put into service;		Not final assembly' is excluded, so the motor is included.	
2. 'Impeller' means the part of the fan that is imparting energy into the gas flow and is also known as the fan wheel;	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. 'Stator' is the stationary part of the fan which interacts with the air stream passing through the impeller and, within the geometrical air-stream envelope between defined fan inlet- and outlet sections, includes any part that may increase, and excludes any non-fan component that may decrease, the fan efficiency, following manufacturer's instruction. For compliance testing the physical component that contain the stator may be Instead of the stator-component that is part of the product placed on the market, the manufacturer may use a geometrical equivalent	The definition is derived from work-in-progress (Oct. 2014) of CEN/TC 156/WG 17(Draft after Landshut), the ISO 5801 test conditions (which require a definition of inlet and outlet) and takes into account the fact that the fan may be a self-standing product or a set of components inside another product. In the latter case, the stator could be one physical part that serves also other functionality of the product and --for a level playing field with self-standing products-- the manufacturer must be given the opportunity to indicate the segment of that part which is relevant for the fan-functionality. If the fan is integrated --but also in some cases of the self-standing product-- there are non-fan components that may be close to the impeller and thus hamper the air stream (=increase the pressure drop). Examples of *'any part that may increase ...fan efficiency'* are guide vanes (adjustable or not), diffusers (static recovery), inlet/outlet bell or inlet cone (reducing friction losses). Vanes may be adjustable, but during testing they shall be stationary in one position. If these examples are to be included in the legislation they require definitions, but it would be more compact if these examples are included in the test standards (e.g. 'diffuser' is a device that improves the fan performance through static recovery; 'inlet cone' is a device that steers the air into the housing and reduces the vena contracta and turbulence that would occur at a sharp edge of the housing; 'guide vanes' are vanes positioned before the impeller to guide the gas stream towards the impeller and which may or may not be adjustable). Examples of *'any part that may decrease ...fan efficiency'* are protective fan guards, motor grids, shutters, deflectors, rain-protection devices, integrated heating, cooling or heat recovery devices, filters and filter-casings, sensors (e.g. oxygen sensors for air-gas mix), valves, dampers, stepper motors, etc. The manufacturer decides: for instance in some cases 'silencers' may increase the fan efficiency (e.g. low-	

		friction acoustic foam lining in inlet or outlet area of jet fans), decrease the fan efficiency (e.g. a padded labyrinth after/before the fan) or be neutral (e.g. active anti-noise/frequency-shifting measures). Note that in the definitions of Annex 1 for compliance testing there are provisions that enable testing with the geometrical equivalent of the manufacturer-defined 'stator'. Also scaled model testing is discussed there.	
	4. '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.	Moved here from Annex II, section 1, definition (8). because it explains this part of the fan definition. Is this definition still adequate?	
	5. '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.	Moved here from Annex II, section 1, definition (7). because it explains this part of the fan definition. Is this definition still adequate?	
6. '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.	6. 'Variable speed drive (VSD)' 'variable speed drive (VSD)' means an electronic power converter, integrated or functioning as one system or as a separate delivery with the motor and the fan, which continuously adapts the electrical power supplied to the motor in order to control its mechanical power output according to the torque-speed characteristic of the load it is driving, including EC (electronically commutated) motors with an internal control, excluding variable voltage controllers where only the supply voltage for the motor is varied;	Moved here from Annex I, section 1, definition (16). because it explains this part of the fan definition. Is this definition still adequate? The definition is taken from draft Ventilation Units 2013, which specifically confirms that not only variable frequency drives for AC motors but also internally speed controlled EC motors (incl. DC) are included.	
	7. The 'specific pressure ratio' means the stagnation pressure measured at the fan outlet divided by the stagnation pressure at the fan inlet at nominal flow rate.	We could have used the definition for *'nominal external pressure (Δp)'* of the VU regulation, but the current fan regulation uses 'stagnation pressure' (assumed to mean 'total pressure' following ISO 5801) whereas the VU regulation refers to static pressure.	

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;	8. '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 part *'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;'* adds no further precision to this particular definition. It looks like a technical description, i.e. not a 'technology-neutral' functional description as it should be, but the path of the gas is an important functional constraint. Still, given that axial fans have to comply with lower efficiency requirements than e.g. mixed flow fans, there is a possible loophole for the latter if the definition is not more precise. Possible solution (from draft standard CEN/TC 156/WG 17): *The axial fan is a fan where the average of angles α1 and α2 is smaller than 20 °, whereby angle α1 is the angle of the tangent at the hub at the intersection of the blade trailing edge with the hub and angle α2 is the angle of the tangent at the shroud or at the outer diameter of the blade at the intersection of the blade trailing edge with the shroud or with the outer diameter of the blade (see figure).* Alternative (technology neutral): *Axial fan is a fan where the angle between the average directions of the inflowing and outflowing gas-streams is less than 20°.*	
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;		Definition not used in the regulation so can be deleted	
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;		Definition not used in the regulation so can be deleted	
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;		Definition not used in the regulation so can be deleted	
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;		Definition not used in the regulation so can be deleted	
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 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.	Again the path of the gas (axial in, perpendicular out) is functionally relevant. *"and may or may not have a housing"* could be better explained at the 'stator' definition. Alternative (technology neutral): *Centrifugal fan is a fan where the angle between the average directions of the inflowing and outflowing gas-streams is 70° or more.* The second sentence adds no precision to the definition and is deleted. At the 1stSHM there was a question to also distinguish centrifugal backward inclined and air foil fans, but there was no follow-up written argumentation from the proposer. Instead, Eurovent clarified its position in writing, saying that they are not in favour of making that distinction. Also desk research by VHK did not reveal the need.	
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;		Definition not used in the main text. Should move to Annex or include it explicitly in the definition above (decided for the latter). Perhaps not necessary if we do not make the distinction and just regulate centrifugal as one category.	

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;		Definition not used in the main text. Should move to Annex or include it explicitly in the definition above (decided for the latter). Perhaps not necessary if we do not make the distinction and just regulate centrifugal as one category.	
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;		Definition not used in the main text. Should move to Annex or include it explicitly in the definition above (decided for the latter). Perhaps not necessary if we do not make the distinction and just regulate centrifugal as one category.	
12. 'Housing' means a casing around the impeller which guides the gas stream towards, through and from the impeller;		Moved upwards	
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;		Definition not used in the main text. Should move to Annex or include it explicitly in the definition above (decided for the latter). Perhaps not necessary if we do not make the distinction and just regulate centrifugal as one category.	
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;	10. '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;	Cross flow fans above 125 W are extremely rare. Best efficiency values (BAT) that we found are rarely above 11% (non-compliant with 2015 tier 2). The reason to keep them in the regulation might be to avoid that in the future manufacturers will start building cross-flow fans >125W, but we don't need a formula for that: a simple minimum efficiency of 18.4% (2015 minimum for 0.125 kW) is enough. Discussion?	
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;	11. '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;	Alternative (technology neutral): *Mixed flow fan is a fan where the angle between the average directions of the inflowing and outflowing gas-streams is equal to or more than 20° and less than 70°.*	
16. 'Short-time duty' means working of a motor at a constant load, which is not long enough to reach temperature equilibrium;		Is now specified in Art. 1 at 1 hour (60 minutes) or more , in line with EN-standard for F300 etc.. So do we still need the definition?	
17. 'Ventilation fan' means a fan that is not used in the following energy-related products:		No longer applicable. ' Ventilation fan' was used to create an exemption for the first 2013 tier in Art. 3, 2 a)	
— 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.		moved upwards	
	12. ' Jet fan' means an axial fan used for producing a jet of air in a space and unconnected to any ducting, for which an alternative test and calculation method applies based on the measured thrust.	New. Test method is ready: ISO/DIS 13350:2014 *'Fans — Performance testing of jet fans'* (first voting is approved, final voting and procedural steps to follow). There are also test data that would allow setting requirements. Note that (almost?) all jet fans are 'dual purpose', i.e. reversible in case of emergency (variable pitch). Typically they are used in tunnel	Comment: **Eurovent remarks that jet fans may be either axial or centrifugal jet fans. Many jet fans are dual-purpose meaning that they are designed to operate for both normal ventilation and for heat and smoke ventilation in case of fire. A**

		ventilation and car parks. Large, bespoke types (usually out of scope of the regulation because >500 kW) are also used in combustion air- and exhaust gas applications in power plants.	**number of axial jet fans are also specified to be designed for reversible flow, which may be achieved with a change of pitch or with a reversal of rotation.**

Commission Regulation 327/2011	Proposed change	Explanatory notes	EUROVENT POSITION
Article 3 **Ecodesign requirements**	*Article 3* **Ecodesign requirements**		
1. The ecodesign requirements for fans are set out in Annex I.	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:	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;	(a) first tier: from 1 January 2018, all fans shall not have a lower target energy efficiency than as defined in Annex I, Section 2, Table 1;	It assumes that new minimum requirements will take effect on 1 Jan 2017, 1 Jan. 2018 and 1 Jan. 2020 (=synchronised with motor regulation). To synchronize with ventilation units it should be 1 Jan 2016 and 1 jan 2018.	Position: **In order to avoid confusion, we strongly hold that the new Regulation should not restart numbering further requirements from 'tier one', but rather continue the numbering of the existing Regulation.**
(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.	(b) second tier: from 1 January 2020, all fans shall not have a lower target energy efficiency than as defined in Annex I, Section 2, Table 1.	Using the same table but a different/extra column	
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.	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 2017.		Correction: **2017 has to be replaced by 2018.**
4. The fan energy efficiency requirements of Annex I Section 2 shall not apply to fans which are designed to operate:	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;		Moved to Art. 1 (information requirements are now in vacuum cleaner regulation, so exemption is complete)	
(b) in applications in which the 'specific ratio' is over 1,11;		Already in the fan definition. By the way, the relevant ISO standard mentions ' 1.1' and not ' 1.11' , so this is corrected.	
(c) as conveying fans used for the transport of non-gaseous substances in industrial process applications.		Moved to Art. 1	
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.	5. For dual use fans designed for both ventilation under normal conditions and emergency use as set out in Art. 1, 3 (a), the values of the applicable efficiency grades set out in Annex I Section 2 will be reduced by 5 %.	These fans should also be certified by EU notified bodies, following EN 12101-3 (see Art. 1). Note that the reference to Art 1, 3(a) also sets the minimum at F300 (not F200)	Position: **We believe that the gap in efficiency between standard fans and dual use fans cannot be reduced, because the same technology used to improve the efficiency of standard fans cannot be adopted in an equally effective way in dual use fans.**
	6. For fans designed specifically to operate in potentially explosive atmospheres as defined in Directive 94/9/EC of the European Parliament and of the Council (1), the values of the applicable efficiency grades set out in Annex I Section 2 will be reduced by 10 %.	Moved from Art. 1.	Comment: **There is little published information available concerning the performance of ATEX fans, to assess whether the 10% allowance maybe enough to account for the design features, which are effectively mandated to comply with ATEX applications. A number of manufacturers do not believe that the safety requirements can be fulfilled at the same time as the proposed efficiency requirements.**
6. Compliance with ecodesign requirements shall be measured and calculated in accordance with requirements set out in Annex II.	7. Compliance with ecodesign requirements shall be measured and calculated in accordance with requirements set out in Annex II.		

Commission Regulation 327/2011	Proposed change	Explanatory notes	EUROVENT POSITION
Article 4 **Conformity assessment**	*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.	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.	no change	
Article 5 **Verification procedure for market surveillance purposes**	*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.	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.	no change	
Article 6 **Indicative benchmarks**	*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.	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.	no change	

Article 7 **Revision**	*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.	The Commission shall review this Regulation no later than **5** years after its entry into force in the light of technological progress. The review will include the assessment of design options that can facilitate re-use and recycling. The results of this review shall be presented to the Ecodesign Consultation Forum.	5 years instead of 4; otherwise there is a risk that review coincides with tier 3 (in 2020). For recycling, special design options for the recuperation of rare earth materials from permanent magnet (EC) motors may have become worthwhile. At the moment, following consultations with recyclers, the interest is still low. Recovery of power electronics (variable speed drives) could be regulated in a future WEEE in the new category ' other' (to be defined in 2019). If that does not happen (currently researched by BIOIS for DG ENV) or stipulations are not stringent enough then there could be a role for Ecodesign.
Article 8	*Article 8*	

Entry into force	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 enter into force on the 20th day following its publication in the Official Journal of the European Union.	no change

Commission Regulation 327/2011	Proposed change	Explanatory notes	EUROVENT POSITION
ANNEX I **ECODESIGN REQUIREMENTS FOR FANS** 1. **Definitions for the purposes of Annex I**	*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.	(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.	(2) 'Measurement category A' means an arrangement where the fan is measured with free inlet and outlet conditions.	This applies also to jet fans, but jet fans can be distinguished because the dynamic efficiency applies. EN ISO 13349:20xx, definition 3.4.5, (*Draft after Landshut*) proposes a separate *test configuration with free inlet and free outlet without a partition; also known as test configuration category E*	
(3) 'Measurement category B' means an arrangement where the fan is measured with a duct fitted to its inlet and outlet.	(3) 'Measurement category B' means an arrangement where the fan is measured with a duct fitted to its inlet and outlet.		
(4) 'Measurement category C' means an arrangement where the fan is measured with free inlet conditions and a duct fitted to its outlet	(4) 'Measurement category C' means an arrangement where the fan is measured with free inlet conditions and a duct fitted to its outlet		
(5) 'Measurement category D' means an arrangement where the fan is measured with a duct fitted to its inlet and outlet.	(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:	(6) 'Efficiency category' means the fan gas output energy form used to determine the fan energy efficiency, with a distinction between 'static', 'dynamic' or 'total' efficiency depending on whether the fan gas power has been determined with respectively the static, dynamic or total pressure difference between fan in- and outlet;		
(a) 'fan static pressure' (p_{sf}) has been used to determine fan gas power in the efficiency equation for fan static efficiency; and		already included in (6)	
(b) 'fan total pressure' (p_f) has been used to determine fan gas power in the efficiency equation for total efficiency.		already included in (6)	
(7) 'Static efficiency' means the energy efficiency of a fan, based upon measurement of the 'fan static pressure' (p_{sf}).	(7) 'Fan efficiency' (η_f) is the ratio of the fan gas power output P_u and the electric power input P_e, both expressed in W and determined at bep, multiplied with correction factors for power conversion C_p and part load compensation C_c, following the expression $\eta_f = C_p \cdot C_c \cdot P_u / P_e$, with a distinction between 'static', 'dynamic' or 'total' efficiency depending on whether the fan gas power P_u has been determined with respectively the static, dynamic or total pressure difference between fan in- and outlet;	Uses the generic definition instead of separate 'static', 'total' etc. definitions. Replaces, together with definitions below, large part of Annex II.	
	(8) 'Fan gas power' (P_u), in W, is the product of the fan volume flow rate q_v, in m³/s, and the pressure difference between fan in- and outlet Δp, in Pa, both determined at bep, following the expression $P_u = q_v \cdot \Delta p$, with a distinction between 'static', 'dynamic' or 'total' fan gas power depending on whether the fan gas power has been determined with respectively the static, dynamic or total pressure difference Δp between fan in- and outlet;	Replaces the definition in section 3.1 and makes section 3.3 redundant	
	(9) 'Electric power input' P_e, in W, is the electric input power at bep, measured at main terminals of motor or, when present, variable speed drive;	From Annex 2. Moved here to have a consistent hierarchy of definitions and equations	
	(10) 'Power conversion correction' C_p, is a correction factor for power conversion losses with a default value of 0.9 for fans using DC current with a voltage lower than 100 V;		
From Annex 2: 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 $C_c = – 0,03 \ln(P_{ed}) + 1,088$. — for a motor without a variable speed drive $C_c = 1$;	(11) 'Part load compensation' C_c is a correction factor with one of the following values: — C_c=1 for a motor without a variable speed drive, — C_c=1,04 for a motor with a variable speed drive and $P_e \geq 5$ kW, — $C_c = – 0,03 \ln(P_e) + 1,088$ for a motor with a variable speed drive and $P_e < 5$ kW;	Copied from Annex II. Note that here, as in definitions above and below, we use the notation of the ISO standards, i.e. the parameter name is in italic font and the suffix is a standard (non-italic) subscript.	

	(12) 'Fan flow rate' q_v, in m³/s, is the gas volume displaced per unit of time by the fan and is typically derived from assessment of the fan dynamic pressure difference, air velocity or measured thrust, calculated using the gravitational gas density ρ at default 1.2 kg/m³ and the fan outlet surface area;	Alternative (more technical): 'Fan flow rate' qv, in m³/s, is the gas volume displaced per unit of time by the fan and is typically derived from assessment of the fan dynamic in- and outlet pressure difference Δp_{df}, in Pa, the outlet fan surface area A_2, in m², and the gas density ρ at default 1.2 kg/m³, following the expression $q_v=A_2\cdot\sqrt{(2\rho\Delta p_{df})}$, or from measured air velocity v in m/s, following the expression $q_v=A_2\cdot v^2$, or in the case of jet fans, using the measured thrust T_m, with the expression $q_v=A_2\cdot\sqrt{(T_m/(\rho\cdot A_2))}$ Pressure is measured with a Pitot-static tube at 24 measurement points evenly distributed over the fan outlet area. Airflow must be essentially swirl-free. The Pitot-static tube measures both total and static pressure, from which the dynamic pressure results (as the difference between the two). ISO 5801 also allows explicitly venturi ('multi-vent') and orifice plate (ISO 5167) meters. These two use Bernouille's principle for the relation of pressures and air velocity before and after a constriction in a tube: $p_1-p_2=0.5\rho\cdot(v_2^2-v_1^2)$. Apart from these methods there are many others but we mention only the ones referenced in ISO 5801. Thrust is measured through a force-sensor at the jet fan support (hanging or standing) according to ISO DIS 13350.	
(8) 'Fan static pressure' (p_{sf}) means the fan total pressure (p_f) minus the fan dynamic pressure corrected by the Mach factor.	(13) 'Fan static pressure' (p_{fs}), in Pa, is the omnidirectional force per unit surface area exerted at the fan outlet and is typically assessed by measuring the stagnation pressure in a (cylindrical) hole of appropriate geometry and dimensions, in duct wall or appropriate measurement instrument perpendicular to the direction of the gas flow.	(8) 'Fan static pressure' (pfs), in Pa, is the omnidirectional force per unit surface area excerted at the fan outlet and is typically assessed by measuring the stagnation pressure in a (cilindrical) hole of appropriate geometry and dimensions, in duct wall or appropriate measurement instrument perpendicular to the direction of the gas flow.	
(10) 'Dynamic pressure' means the pressure calculated from the mass flow rate, the average gas density at the outlet and the fan outlet area.	(14) 'Fan dynamic pressure' (p_{fd}), in Pa, is the pressure derived from the kinetic energy of the fan, also known as 'velocity pressure', and is typically assessed from the difference between total and static pressure or, for jet fans, by measuring the reactive thrust force T_m, in Newton(N), exerted on the fan by the gas flow and dividing by the fan outlet surface area A_2, in m².	(10) 'Fan dynamic pressure' (pfd), in Pa, is the pressure derived from the kinetic energy of the fan, also known as 'velocity pressure', and is typically assessed from the difference between total and static pressure or, for jet fans, by measuring the reactive thrust force Tm, in N, excerted on the fan by the gas flow and dividing by the fan outlet surface area A2, in m².	
(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.		Given that in Art. 2 fans with air velocity >51,5 m/s are excluded (Mach factor<0,15) the correction with Mach factor can --according to ISO 5801-- be ignored.	
(12) 'Total efficiency' means the energy efficiency of a fan, based upon measurement of the 'fan total pressure' (p_f).		already included in (6)	
(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.	(15) 'Fan total pressure' (p_f), in Pa, is the directional force per unit surface area exerted at the fan outlet and is typically assessed by measuring the stagnation pressure in a (cylindrical) hole of appropriate geometry dimensions facing the direction of the gas flow or, for jet fans, by measuring the reactive thrust force exerted on the fan by the gas flow per unit fan outlet surface area.		

(9) 'Stagnation pressure' means the pressure measured at a point in a flowing gas if it were brought to rest via an isentropic process.	(16) 'Stagnation pressure' means the pressure measured at a point in a flowing gas if it were brought to rest via an isentropic process.	Follows ISO 5801 and is used in the pressure definitions above. It simply means that the pressure is measured at the closed end of a test tube/hole through a pressure transducer. It is probably used so frequently in ISO 5801 to make the distinction with other methods/instruments where e.g. a test impeller is held in the airstream to determine the air velocity (which is less reliable and thus deemed inadmissible). It is confusing that ISO 5801 uses 'stagnation pressure' also as a synonym for 'total pressure'.	
(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).	(17) 'Efficiency grade' is a parameter in the calculation of the target energy efficiency of a fan of specific electric input power at its bep (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 ηtarget 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 Pe(d) of the fan expressed in kW at its point of optimum energy efficiency in the applicable energy efficiency formula.	(18) The 'minimum fan efficiency' (η_{min}) is the fan efficiency to be achieved in order to meet the requirements, calculated as the outcome of the appropriate equation in Annex I, Section 2, Table 1, using the applicable integer *N* of the efficiency grade and the electrical power input P_e of the fan expressed in kW at its bep.	'target' is not used in any other regulation; 'minimum' is more common. 'fan efficiency' is already defined and can be used. The rest is editorial.	
(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.		Moved to Art. 2	
(17) 'Overall efficiency' is either 'static efficiency' or 'total efficiency', whichever is applicable.		Not used anymore (was previously used in the information requirements)	

	(19) 'test fan' is the fan, as defined in Article 2, whereby for the purpose of compliance testing the manufacturer -- must add motor or bearing struts and, except for jet fans, an orifice panel or orifice ring, to which said struts are attached for the benefit of testing, -- may remove the parts and geometry sections, e.g. in case the envelope extends beyond the defined inlet and outlet sections, that are not included in the defined stator, -- may conduct the tests with the geometrical equivalent of the stator inner surface, -- may conduct the tests with a scale model and calculate the results for the real-size product if the latter has an impeller diameter above 1 m for jet fans or 0,5 m for other fans, -- may conduct the tests at customer's or manufacturer's site if the latter has an impeller diameter above 1 m for jet fans or 0,5 m for other fans, provided that reliable, accurate and reproducible test- and calculation methods are used and modifications, test conditions and calculations are meticulously reported as prescribed in Annex I, section 3.	ISO 5801 prescribes struts and an orifice panel/ring for the testing of e.g. plug fans and other fans that do not have a duct or housing that allow the fan to be attached to the division between inlet and outlet test chambers. If the motor and drive efficiency are known this means that ISO 5801 sets the conditions for testing 'impeller efficiency' and basically would allow, in an appropriate standard (and not in the regulation) to use this parameter to determine fan efficiency. For jet fans the fan supports (hanging or standing) are described in ISO DIS 13350, but there is no confined test chamber for thrust testing. As regards the other points: The motor regulation excludes *'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'* but for fans this could create a loophole, i.e. is subjective, and it is thus proposed here to allow specific measures to avoid this loophole (also following the current CEN WG draft). For scaled testing the EC could provide a mandate to the ESOs to convert VDI 2204, which permits testing of scaled models, to a harmonised standard. In situ testing, e.g. according to EN ISO 5802:2008 (+prA1), is presented as an option but it is doubtful whether this is practical (? to be discussed). The limit values allowing scaled and on site testing of 1 m for jet fans (that do not require a test chamber) and 0,5 m for other fans are provisional (to be discussed).	Position: **Eurovent holds that the proposed text is entering too deeply into the practical details of testing. To be truly technology independent, we strongly hold that it has to be more general.** **It is widely known that scaling procedures are not universally accepted within the industry, because the amount of efficiency improvement with the fan size and Reynolds number is not completely agreed. Scaling should be kept only as a last resort. Enough testing equipment is available at European independent laboratories to allow for testing at full size fans having an impeller diameter as large as 1 or even 2 meters.** **The effect of changing the fan speed while testing is generally less controversial than the effect of testing a geometrically scaled down model.**
	(20) 'test gas' is the working fluid for the purpose of compliance testing, and independent of the actual gas used in the fan, is clean air at standard inlet conditions of 20 °C and 10325 Pa.	Following ISO 5801	

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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 …(red text)

Fan types	Measurement category (A-D)	Efficiency category (static or total)	Power range P in kW	Target energy efficiency	Efficiency grade (N) from 1 January 2013	Efficiency grade (N) from 1 January 2015
Axial fan	A, C	static	$0{,}125 \leq P \leq 10$	$\eta_{target} = 2{,}74 \cdot \ln(P) - 6{,}33 + N$	36	40
			$10 < P \leq 500$	$\eta_{target} = 0{,}78 \cdot \ln(P) - 1{,}88 + N$		
	B, D	total	$0{,}125 \leq P \leq 10$	$\eta_{target} = 2{,}74 \cdot \ln(P) - 6{,}33 + N$	50	58
			$10 < P \leq 500$	$\eta_{target} = 0{,}78 \cdot \ln(P) - 1{,}88 + N$		
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	44
			$10 < P \leq 500$	$\eta_{target} = 0{,}78 \cdot \ln(P) - 1{,}88 + N$		
	B, D	total	$0{,}125 \leq P \leq 10$	$\eta_{target} = 2{,}74 \cdot \ln(P) - 6{,}33 + N$	42	49
			$10 < P \leq 500$	$\eta_{target} = 0{,}78 \cdot \ln(P) - 1{,}88 + N$		
Centrifugal backward curved fan without housing	A, C	static	$0{,}125 \leq P \leq 10$	$\eta_{target} = 4{,}56 \cdot \ln(P) - 10{,}5 + N$	58	62
			$10 < P \leq 500$	$\eta_{target} = 1{,}1 \cdot \ln(P) - 2{,}6 + N$		
Centrifugal backward curved fan with housing	A, C	static	$0{,}125 \leq P \leq 10$	$\eta_{target} = 4{,}56 \cdot \ln(P) - 10{,}5 + N$	58	61
			$10 < P \leq 500$	$\eta_{target} = 1{,}1 \cdot \ln(P) - 2{,}6 + N$		
	B, D	total	$0{,}125 \leq P \leq 10$	$\eta_{target} = 4{,}56 \cdot \ln(P) - 10{,}5 + N$	61	64
			$10 < P \leq 500$	$\eta_{target} = 1{,}1 \cdot \ln(P) - 2{,}6 + N$		
Mixed flow fan	A, C	static	$0{,}125 \leq P \leq 10$	$\eta_{target} = 4{,}56 \cdot \ln(P) - 10{,}5 + N$	47	50
			$10 < P \leq 500$	$\eta_{target} = 1{,}1 \cdot \ln(P) - 2{,}6 + N$		
	B, D	total	$0{,}125 \leq P \leq 10$	$\eta_{target} = 4{,}56 \cdot \ln(P) - 10{,}5 + N$	58	62
			$10 < P \leq 500$	$\eta_{target} = 1{,}1 \cdot \ln(P) - 2{,}6 + N$		
Cross flow fan	B, D	total	$0{,}125 \leq P \leq 10$	$\eta_{target} = 1{,}14 \cdot \ln(P) - 2{,}6 + N$	13	21
			$10 < P \leq 500$	$\eta_{target} = N$		

Proposed change (Explanation see text)

2. **Fan energy efficiency requirements**

The minimum energy efficiency requirements for fans are set out in Tables 1 below, whereby the minimum efficiency requirement per 1.1.2018 is calculated with *N*=N2018 and the minimum efficiency requirement per 1.1.2020 is calculated with *N*=2020

Table 1

Minimum energy efficiency requirements per fan type (with P=P_e and N is efficiency grade)

Axial fans						
Efficiency category (measurement category)		**N2020**	η_{min} **at $P \leq 1$ kW**	η_{min} **at 1kW<$P \leq 200$ kW**		η_{min} **at P>200 kW**
static (A, C)	44%	48%	$(3.8\%+0.5(N-N2018)) \cdot \ln(P) - 7.4\%+N$	$3.8\% \cdot \ln(P) - 7.4\%+N$		$3.8\% \cdot \ln(200) - 7.4\%+N$
'dynamic' (A)	53%	57%				
total (B, D)	62%	66%				
Mixed flow fans						
Efficiency category (measurement category)	**N2018**	**N2020**	η_{min} **at $P \leq 1$ kW**	η_{min} **at 1kW<$P \leq 10$ kW**	η_{min} **at 10kW<$P \leq 200$ kW**	η_{min} **at P>200 kW**
static (A, C)	54%	58%	$(5\%+0.5(N-N2018)) \cdot \ln(P) - 8.7\%+N$	$5\% \cdot \ln(P) - 8.7\%+N$	$3.4\% \cdot \ln(P) - 5.1\%+N$	$3.4\% \cdot \ln(200) - 5.1\%+N$
total (B,D)	64%	68%				
Centrifugal fans						
Efficiency category (measurement category)	**N2018**	**N2020**	η_{min} **at $P \leq 1$ kW**	η_{min} **at 1kW<$P \leq 10$ kW**	η_{min} **at 10kW<$P \leq 200$ kW**	η_{min} **at P>200 kW**
static (A, C)	64%	68%	$(6.2\%+0.5(N-N2018)) \cdot \ln(P) - 10\%+N$	$6.2\% \cdot \ln(P) - 10\%+N$	$3\% \cdot \ln(P) - 2.8\%+N$	$3\% \cdot \ln(200) - 2.8\%+N$
total (B,D)	67%	70%				
Cross flow fans						
Efficiency category (measurement category)	**N2018**	**N2020**	η_{min}			
total (B,D)	21%	21%	N			

Commented [A1]: Eurovent suggests to keep the existing power sub ranges and equations, and to increase the N-value for installation types A and C, from N=40 in 2015 to N=42 in 2020, while keeping the current value for N for installation types B and D, as this value is considered to already be at the technology limit and to result from a typing mistake.

Commission Regulation 327/2011	Proposed change	Explanatory notes	EUROVENT POSITION
3. **Product information requirements on fans**	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:	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;	(a) the technical documentation of fans;		
(b) free access websites of manufacturers of fans.	(b) free access websites of manufacturers of fans.	To be reformulated?(following latest amendment on digital publication)	

2. The following information shall be displayed:	2. The following information shall be displayed:		
(1) overall efficiency (η), rounded to 1 decimal place;	(1) applicable fan efficiency (η_f), rounded to the closest value in 3 decimal places, with specification of the type of fan (axial, jet, mixed flow, centrifugal or cross flow);	As in many regulations, the use of '%' is leading to much confusion. A % is not an accounting unit, but just a different notation for 'x 0.01' or 'x 10^{-2}'. Therefore, we strongly suggest to stop treating '%' as if it were an accounting unit and simply state the real number and then --as appropriate-- one can use that number or use %. Note that 'applicable fan efficiency' replaces 'overall efficiency' so the definition of the latter is no longer needed. 'Applicable' means the fan efficiency that is used for compliance.	
(2) measurement category used to determine the energy efficiency (A-D);	(2) measurement category used to determine the energy efficiency (A-D);		
(3) efficiency category (static or total);	(3) efficiency category (static, dynamic or total);		
(4) efficiency grade at optimum energy efficiency point;	(4) efficiency grade ***N*** at **bep**;		
(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;	(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;	To discuss if this is still allowed as an alibi to obtain the VSD-bonus in C_c, i.e. should not the VSD be either (a) supplied as a part of the component package from the fan supplier, or (b) when VSD is added later in the final product?	
(6) year of manufacture;	(6) year of manufacture;	Relevant for the 'spare parts' problem.	
(7) manufacturer's name or trade mark, commercial registration number and place of manufacturer;	(7) manufacturer's name or trade mark, commercial registration number and place of manufacturer;		
(8) product's model number;	(8) product's model number;		
(9) the rated motor power input(s) (kW), flow rate(s) and pressure(s) at optimum energy efficiency;	(9) the electric motor power input P_e (in kW), flow rate q_v (in m³/h rounded to the closest integer value when <1 m³/s, else in m³/s rounded to the closest value in 2 decimal places) and applicable pressure difference Δp (in Pa, rounded to the closest integer value) at **bep**;	rated' is confusing (see motor regulaion) and means something different from 'electric input at bep'	
(10) rotations per minute at the optimum energy efficiency point;	(10) fan speed in rotations per minute (rpm, rounded to the closest integer value) at **bep**;	this just helps the surveillance authority to know how to test for compliance.	
(11) the 'specific ratio';	(11) the 'specific ratio', rounded to the closest value in 2 decimal places;	Is largely redundant if Δp is given, but is needed because of definition. Should we add 'at bep'?	
(12) information relevant for facilitating disassembly, recycling or disposal at end-of-life;	(12) information relevant for facilitating disassembly, recycling or disposal at end-of-life;	To discuss. The recovery of permanent magnets from motors, especially for larger fans (>xx kW), might be relevant for disassembly/recycling?	
(13) information relevant to minimise impact on the environment and ensure optimal life expectancy as regards installation, use and maintenance of the fan;	(13) information relevant to minimise impact on the environment and ensure optimal life expectancy as regards installation, use and maintenance of the fan;	To discuss. To the study team 'proper fan selection' seems to be the most relevant environmental impact, especially regarding efficiency in non-bep working points (ISO 5801 requires also test results for 2 adjacent points to bep; other points to be calculated to give approximate efficiency curves?).	
(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.	(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.	To discuss. What is intended is probably a reference to the applied test standard + test configuration here (in the public domain) and a full test report in accordance with the test standard used, accessible (at least) to market surveillance authorities.	
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.	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:	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:	Same question as above. Is this still allowed?	Comment: **Only to be valid for standalone fans, but not when incorporated if the same information is included in the technical manual of the complete product.**
— 'A variable speed drive must be installed with this fan',	— 'A variable speed drive must be installed with this fan',		
— 'A variable speed drive is integrated within the 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.	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.	See above	

4. 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*.	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*.	No change, but it was moved from Annex 2	

Commission Regulation 327/2011	Proposed change	Explanatory notes	EUROVENT POSITION
ANNEX II **MEASUREMENTS AND CALCULATIONS** 1. **Definitions for the purposes of Annex II**	*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 m3/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/m3).		No longer necessary, moved to Annex 1	

(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}).		According to us (check!), the compressibility factor of air, even polluted exhaust gases, in the designated pressure and temperature range is 1.00 (rounded from 0.9999). As far as we know there are no gases typically displaced by fans in the same pT area that have a compressibility factor that deviates from 1.00 (rounded to 2 digits). Hence: It is proposed (as in Ventilation Unit regulation) to eliminate the factors in the definitions and in the calculation method.	
(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.		If there is no distinction with ' non final assembly' this is not needed, i.e. already in the definition of ' fan' (Art. 2)	Position: **The revised Regulation should encourage, in the calculation of the efficiency of a fan, the use of actual performance data instead of default values. Information such as test bench curves for the actual motors adopted to drive the fan allow for a more precise estimate of the operating efficiency of fan components such as motors and mechanical drives. At the same time, the use of actual data encourages the adoption of more efficient 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.		Not needed. 1st SHM majority wanted it eliminated (loophole), which is in line with wish for simplification. For large fans, where some manufacturers wanted to retain ' impeller efficiency' to prove compliance, another solution should be found, e.g. provide a mandate to convert VDI 2204, which permits testing of scaled models, to a harmonised standard. Alternatively, EN ISO 5802 (in situ) could help?	
(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.		Moved to Art. 2	
(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.		Moved to Art. 2	
(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'.		Not needed anymore (was only for not final assembly)	
(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.		Not needed anymore (was only for not final assembly)	

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*.	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*.	Moved (would be the only remaining trace of Annex 2)	

Commission Regulation 327/2011	Proposed change	Explanatory notes	EUROVENT POSITION
ANNEX II **MEASUREMENTS AND CALCULATIONS** 1. **Definitions for the purposes of Annex II**	*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 m3/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/m3).		No longer necessary, moved to Annex 1	
(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' (kp) or 'static pressure' (kps).		According to us (check!), the compressibility factor of air, even polluted exhaust gases, in the designated pressure and temperature range is 1.00 (rounded from 0.9999). As far as we know there are no gases typically displaced by fans in the same pT area that have a compressibility factor that deviates from 1.00 (rounded to 2 digits). Hence: It is proposed (as in Ventilation Unit regulation) to eliminate the factors in the definitions and in the calculation method.	
(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.		If there is no distinction with ' non final assembly' this is not needed, i.e. already in the definition of ' fan' (Art. 2)	

(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.		Not needed. 1st SHM majority wanted it eliminated (loophole), which is in line with wish for simplification. For large fans, where some manufacturers wanted to retain ' impeller efficiency' to prove compliance, another solution should be found, e.g. provide a mandate to convert VDI 2204, which permits testing of scaled models, to a harmonised standard. Alternatively, EN ISO 5802 (in situ) could help?	
(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.		Moved to Art. 2	
(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.		Moved to Art. 2	
(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'.		Not needed anymore (was only for not final assembly)	
(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.		Not needed anymore (was only for not final assembly)	

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*.	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*.	Moved (would be the only remaining trace of Annex 2)	

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:		Already covered in Annex I	

(a) where the fan does not include a variable speed drive, calculate the overall efficiency using the following equation: ηe = Pu(s) / Pe where: ηe is the overall efficiency; Pu(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; Pe 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: ηe = (Pu(s) / Ped) · Cc where: ηe is the overall efficiency; Pu(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; Ped 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; Cc is a part load compensation factor as follows: — for a motor with a variable speed drive and Ped ≥ 5 kW, then Cc = 1,04, — for a motor with a variable speed drive and Ped < 5 kW, then Cc = – 0,03 ln(Ped) + 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:			
ηe = ηr · ηm · ηT · Cm · Cc where: ηe is the overall efficiency; ηr is the fan impeller efficiency according to Pu(s) / Pa			

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,

$\eta_m = 0{,}000278*(x3) - 0{,}019247*(x2) + 0{,}104395*x + 0{,}809761$, where $x = Lg(P_e)$,

and Pe 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 Pe 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, $\eta_T = 0{,}0175 * P_a + 0{,}8725$, 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, $\eta_T = 0{,}01 * P_a + 0{,}93$, 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 Pus is used from the equation Pus = q · psf · kps;
(b) where the fan has been measured according to measurement category B, fan gas power Pu is used from the equation Pu = q · pf · kp;
(c) where the fan has been measured according to measurement category C, fan static gas power Pus is used from the equation Pus = q · psf · kps;
(d) where the fan has been measured according to measurement category D, fan gas power Pu is used from the equation Pu = q · pf · kp.

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 Pe(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	
ηtarget = 2,74 · ln(P) – 6,33 + N	

where the input power P is the electrical input power Pe(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			
ηtarget = 4,56 · ln(P) – 10,5 + N			
where the input power P is the electrical input power Pe(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			
ηtarget = 1,14 · ln(P) – 2,6 + N			
where the input power P is the electrical input power Pe(d) and N is the integer of the energy efficiency grade required. 5. **Applying the target energy efficiency** The fan overall efficiency ηe calculated according to the appropriate method in Section 3 of Annex II must be equal to or greater than the target value ηtarget set by the efficiency grade to meet the minimum energy efficiency requirements.			

Commission Regulation 327/2011	Proposed change	EUROVENT POSITION
VERIFICATION PROCEDURE FOR MARKET SURVEILLANCE PURPOSES	**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.	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.	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 (ηe) 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.	2. The model shall be considered to comply with the provisions set out in this Regulation if the overall efficiency of the fan (ηe) is at least target energy efficiency***0,93 [see note]** 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:	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 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.	— 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 (ηe) 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.	4. The model shall be considered to comply with the provisions set out in this Regulation if the average of the overall efficiency (ηe) 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.	5. If the results referred to in point 4 are not achieved, the model shall be considered not to comply with this Regulation.	
	Note: 0,9 is generous compared to e.g. ventilation units which use 0,93. Furthermore, the Commission is planning generic measures on verification tolerances. Subject is to be discussed.	

Commission Regulation 327/2011

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

Proposed change

ANNEX IV

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Fan types	Measurement category (A-D)	Efficiency category (static or total)	Efficiency grade
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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

Question: Update of values needed (with new formulas, new technologies)?

*= Question: Does anyone know a cross flow fan with this efficiency?

Discussion document (Eurovent review)

Current structure 327/2011:

- Regulation main text (5 p.)
- Annex I: Ecodesign requirements (4 p.)
- Annex II: Measurements and calculations (3 p.)
- Annex IV: Verification procedure for market surveillance purposes (1 p.)
- Annex V: Benchmarks (1 p.)

Total 14 pages

Proposal new structure:

- Regulation main text (4 or 5 p.)
- Annex I: Definitions (1-2 p.)
- Annex II: Ecodesign efficiency requirements (1 p.)
- Annex III: Product information requirements (1 p.)
- Annex IV: Verification procedure for market surveillance purposes (1 p.)
- Annex V: Benchmarks (1 p.)

Total approx. 10 pages

ANNEX: Formulas

This annex gives details on the considerations for the formulas and ambition levels proposed for minimum fan efficiency . It also addresses the issue of synchronisation not only with motors but with other fan-related products, also in terms of formulas and ambition level.

The comparisons are made, throughout this discussion document, not necessarily with the current regulations, but with the most recent (draft) documents. For motors (version presented at Consultation Forum 29 Sept. 2014), ventilation units (version CF Dec. 2013), compressors (version CF Oct. 2014) we refer to the most recent drafts. For pumps and circulators we compared to the current regulations.

Synchronisation with motor regulation

As regards the synchronisation with the scope of the motor regulation. On the low-end, the limit of 120 W **output** in the motor regulation gives –at the indicated limit values—a motor **input** of 200-300W. The fans start at 125W input, so there would be a gap between 125W and 200-250W motor-input where the fans (and motors) are regulated and the motors are not. Alternatives are:

- refer to **output (shaft) power 120W** for the fan motor to determine the scope. To avoid changing the whole calculation method and --to keep the fan regulation synchronised with the ventilation unit regulation-- we could still use the input power for the efficiency formulas, or
- refer to the **air power** output of the fan --like in the ventilation unit regulation-- and set a lower limit of the scope at e.g. **50 W** aerodynamic output (e.g. 0.2 m³/s * 250 Pa at 40% efficiency for 125W el. input). The upper limit could be at approx. 400 kW air power. Calculation of the minimum efficiency formulas could still be on the basis of electric input power (without a lower or upper limit). Methodologically this is the correct way forward, but it synchronisation with the motor regulation.

On the high-end, there is the gap between 500 and 1000 kW, where fans are not regulated and motors are. These could be very large jet fans for tunnels but also relatively (for the application) small-mid size axial fans for cooling towers, air condensers in (petro)chemical plants, etc. or centrifugal fans in mining. The efficiencies in these applications are high, e.g. there is anecdotal evidence of e.g. an axial fan of 7000 kW with a claimed efficiency of **over 89%,** and it will be hard for the legislator to improve on that. On the other hand, the energy use, and thus the benefit of saving only a few per cent extra, is also very high..

As regards synchronisation with the ambition level and shape of the minimum efficiency curve, this is included in the graphs hereafter as the 'Motors 2020 (IE3)' level (from 4-pole motors). For information, the 'motor IE4' curve, which is comparable to the performance of EC motors is also included.

Development of the new formulas and minimum efficiency level

In developing the new formulas and minimum efficiency levels, we started from the notion that according to the stakeholders, confirmed by our research, the requirements in the current regulation are relatively more stringent for smaller fans and could be more ambitious for the bigger fans.

Furthermore, we strived for consistency with minimum efficiency requirements for motors and ventilation units, but also coherence with standard air compressors (doing a tougher fluid dynamics job at 6-14 bar).

Finally, although a representative database on fans is not available, we made the comparison with anecdotal data from some manufacturer's catalogues.

Guiding principles:

- Initial values (around 125W input) are kept at the same level as the 2015-tier, at least for the 2018 tier, but the inclination of the LN curve was used as a variable, at least between 0.125 and 1 kW (proposed as a range with its own formula)
- The 10 kW limit between a steeper and flatter curve was kept for reasons of continuity (though for ventilation units 30 kW was found more appropriate);
- Also for reasons of continuity, we tried to tune the variables in such a way that the efficiency grade (N) was more or less plausible from the past.
- Given that the efficiency grade (N) jumped by 4 percentage points from tier 1 (2013) to tier 2(2015) we assumed that, as long as we guaranteed enough product differentiation above the minimum efficiency, it is logical that for the tier per 1.1.2018 (probably the earliest possible date) the jump would be at least 4 percentage points between 2015 and 2018. The same goes for the jump between 2018 and 2020.
- It makes technical sense if the fan minimum efficiency (for centrifugal fans) is somewhere in the middle between the ventilation unit and the motor minimum efficiency curves. It also makes sense to have more stringent requirements for fans (up to 10 kPa) than for standard air compressors (6-14 bar=600-1400 kPa) at the same power input P.
- From manufacturer's catalogues we see that Measurement category A (free inlet and outlet, static pressure) is by far the most popular (except for jet fans of course), so when trying to fit the curve to manufacturers catalogue data we assumed measurement categories A&C and developed the curves for categories B&D as a derivatives.
- As regards the categories:
    - Cross flow fans: We cannot find cross flow fans that even meet the 2015 level, so we see no reason to increase the requirements for 2018 and 2020.
    - Centrifugal fans: We propose one minimum efficiency for all. This would be a) following the stipulations of the review clause (reduce fan categories), b) methodologically correct (technology-neutral) and c) technically plausible. Radial blades are good for anti-clogging with high solid particle content (already excluded in Art. 1) or when they have to be reversible without a variable pitch (already included in the 10% bonus for dual purpose fans). Forward curved (FC) fans are a low-cost, low-efficiency alternative, but offer no unique qualities that cannot be reached with a backwards curved (BC) fan. Making separate, less stringent requirements for FC fans versus BC fans would <u>not</u> create a level playing field and would seriously hamper attempts to reach higher energy efficiency in important markets.
    - Mixed flow fans: Are proposed to be the straight average between axial and centrifugal fans.
    - Axial and jet fans: Jet fans are axial fans optimised for generating thrust and thus, for those axial fans declared by the manufacturer to be a 'jet fan', allowed a different test- and measurement method for dynamic pressure. It would give the wrong signal if we would depict them in any other way (i.e. give rise to a host of new 'special' fan type definitions).

Centrifugal fans

The following graphs give the relevant comparisons for the new centrifugal fan formulas.

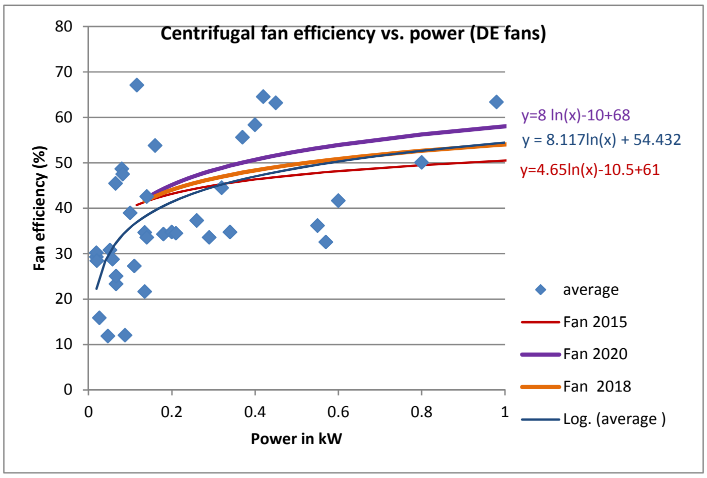

Figure 1. Comparison minimum efficiency curves for 2015 (existing), 2018 and 2020 (both new) for centrifugal fan (measurement category A) with anecdotal manufacturer catalogue data in the lowest power range (0.125-1 kW). The catalogue data logarithmic trend line is 8.117*LN(P) + 54.43. The 2020 fan curve uses a similar multiplier (8) for the LN function. The 2018 fan curve uses an intermediate value. The minimum efficiency at 0.125 kW is used as a pivot point.

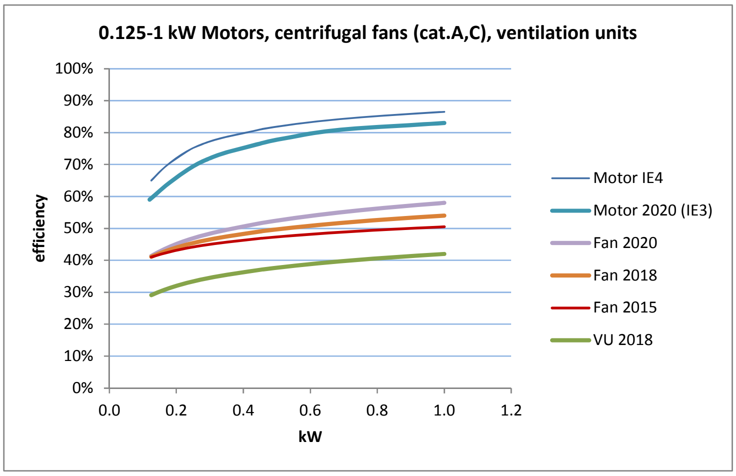

Figure 2. Comparison minimum efficiency curves of the Fan regulation 2015 (existing), 2018 and 2020 (both new) for centrifugal fans (Category A) with the curves from the draft Motor regulation (Sept. 2014) and draft Ventilation Unit (VU) regulation for 2018 (Dec. 2013) in the lower power range. Note that the fan efficiency curve 2015 is relatively too flat, whereas the 2020 curve has technically plausible mid-values between motors and VU.

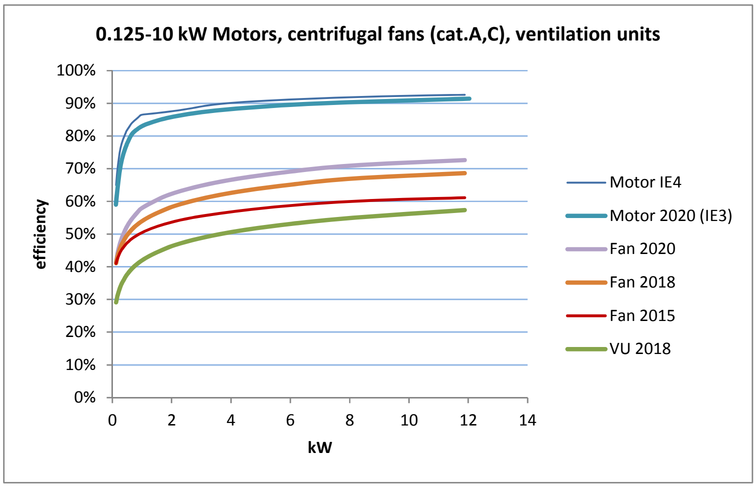

Figure 3. Comparison minimum efficiency curves of the Fan regulation 2015 (existing), 2018 and 2020 (both new) for centrifugal fans (Category A) with the curves from the draft Motor regulation (Sept. 2014) and draft Ventilation Unit (VU) regulation for 2018 (Dec. 2013) in the medium power range. Note that the fan efficiency curve 2015 is relatively too flat, whereas the 2020 curve has technically plausible mid-values between motors and VU.

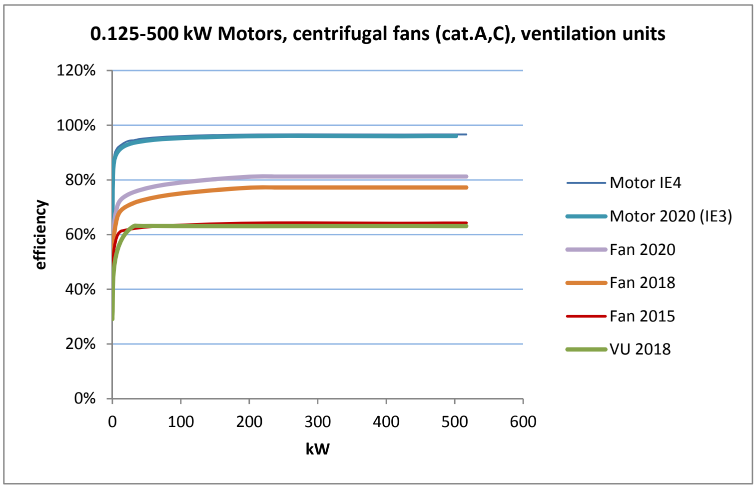

Figure 4. Comparison minimum efficiency curves of the Fan regulation 2015 (existing), 2018 and 2020 (both new) for centrifugal fans (Category A) with the curves from the draft Motor regulation (Sept. 2014) and draft Ventilation Unit (VU) regulation for 2018 (Dec. 2013) in the high power range. Note that the fan efficiency curves 2018 and 2020 above 200 kW are flat, as the motor regulation (and VUs), at respectively 77% and 81%. The motor regulation for AC motors gives 96% (IE3, year 2020) and the VU regulation 63,1% in the power range above 200 kW.

Table 1. Efficiency values for previous graphs. Motor 2020 (IE3) refer to the power input values in the first column. All other efficiency values refer to the IE4 input power values in the third column. The motor regulation values apply to 4-pole motors and were recalculated to input values. Values in brackets () are outside the scope of the motor regulation.

IE3 input power kW	Motor 2020 (IE3) η_{min}	IE4 input power kW	Motor IE4 η_{min}	Fan 2015 η_{min}	Fan 2018 η_{min}	Fan 2020 η_{min}	VU 2018 η_{min}
(0.12)		**(0.125)**		41.0%	41%	41%	29%
0.19	64.8%	**0.17**	69.8%	42.5%	43%	44%	31%
0.26	69.9%	**0.24**	74.7%	44.0%	45%	47%	33%
0.28	71.1%	**0.26**	75.8%	44.4%	46%	47%	34%
0.34	73.5%	**0.32**	77.9%	45.3%	47%	49%	35%
0.48	77.3%	**0.46**	81.1%	46.9%	49%	52%	37%
0.51	78.0%	**0.49**	81.7%	47.2%	50%	52%	38%
0.68	80.8%	**0.66**	83.9%	48.6%	51%	55%	39%
1.00	83.0%	**0.88**	85.7%	49.9%	53%	57%	41%
1.31	84.1%	**1.00**	86.5%	50.5%	54%	58%	42%
1.76	85.3%	**1.72**	87.2%	53.0%	57%	61%	45%
2.54	86.7%	**2.49**	88.2%	54.7%	60%	64%	48%
3.42	87.7%	**3.35**	89.5%	56.0%	61%	65%	49%
4.51	88.6%	**4.42**	90.4%	57.3%	63%	67%	51%
6.14	89.6%	**6.04**	91.1%	58.7%	65%	69%	53%
8.30	90.4%	**8.16**	91.9%	60.1%	67%	71%	55%
12.04	91.4%	**11.88**	92.6%	61.1%	69%	73%	57%
16.29	92.1%	**16.08**	93.3%	61.5%	70%	74%	59%
19.98	92.6%	**19.70**	93.9%	61.7%	70%	74%	60%
23.66	93.0%	**23.35**	94.2%	61.9%	71%	75%	62%
32.05	93.6%	**31.75**	94.5%	62.2%	72%	76%	63%
39.40	93.9%	**38.99**	94.9%	62.4%	72%	76%	63%
47.77	94.2%	**47.27**	95.2%	62.6%	73%	77%	63%
58.14	94.6%	**57.65**	95.4%	62.9%	73%	77%	63%
78.95	95.0%	**78.37**	95.7%	63.2%	74%	78%	63%
94.54	95.2%	**93.75**	96.0%	63.4%	75%	79%	63%
115.30	95.4%	**114.46**	96.1%	63.6%	75%	79%	63%
138.08	95.6%	**137.07**	96.3%	63.8%	76%	80%	63%
167.01	95.8%	**165.98**	96.4%	64.0%	77%	81%	63%
208.33	96.0%	**207.04**	96.6%	64.3%	77%	81%	63%
258.00	96.0%	**258.53**	96.6%	64.3%	77%	81%	63%
502.00	96.0%	**517.06**	96.6%	64.3%	77%	81%	63%

Note: The Motor Regulation does not use formulas, but a table + formulas for calculating intermediates.

Ventilation Units follow minimum fan efficiency for UVUs (η_{vu}) is 6,2% * ln(P) + 42,0 % if P ≤ 30 kW and 63,1 % if P > 30 kW per 1.1.2018 (for 2016 the term is 7% points lower).

Fans follow formulas in the discussion document.

Table 2. Comparison centrifugal fan and standard air fixed speed rotary compressors 2020

V_1 (l/s) at p_2=10 bar	Pin (kW)	Fixed speed rotary compressor min. eff. 2020	Fan 2020	Pin (kW)	Variable speed rotary compressor min. eff. 2020	Fan 2020
5	7.2	47%	68.0%	10.7	32%	72%
10	12.5	54%	73%	16.0	42%	74%
15	17.5	58%	74%	21.2	48%	74%
20	22.4	60%	75%	26.3	52%	75%
30	31.9	64%	76%	36.1	56%	76%
50	50.3	67%	77%	55.0	62%	77%
100	94.8	71%	79%	100.6	67%	79%
200	181.3	75%	81%	189.0	72%	81%
500	436.0	78%	81%	450.9	75%	81%

Fixed speed rotary compressors minimum efficiency=

-0.00928*LN(V_1)^2+0.13911*LN(V_1)+0.2711+(100-(-0.928*LN(V_1)^2+13.911*LN(V_1)+27.11))*d/10000

Where v=flow rate in l/s (from 5 l/s to 1280 l/s) and d=proportional loss factor (-5 per 1.1.2018, 0 per 1.1. 2020). Pressure range 6-14 bar (600-1400 kPa). With compressor isentropic efficiency (including compressibility factor, etc.):

$\eta_{isen} = (0.35 * V_1 * p_2^{0.2857}) / P_{real}$

η_{isen} = isentropic efficiency of the standard air compressor (-), multiplied by 100 gives percentages (%); V_1 = inlet volume flow rate (l/s), at full load; p_2 = outlet pressure (bar[a]), at full load; P_{real} = basic package compressor electric input power (kW), at full load.

Variable speed rotary compressors minimum efficiency =

-0.01549*LN(V_1)^2+0.21573*LN(V_1)+0.00905+(100-(-1.549*LN(V_1)^2+21.573*LN(V_1)+0.905))*d/10000

For variable speed rotary compressors the isentropic efficiency is the weighted average of efficiencies at 100, 70 and 40% of nominal flow rate V1 (always at p_2=100%), weighted at respectively 25, 50 and 25%.

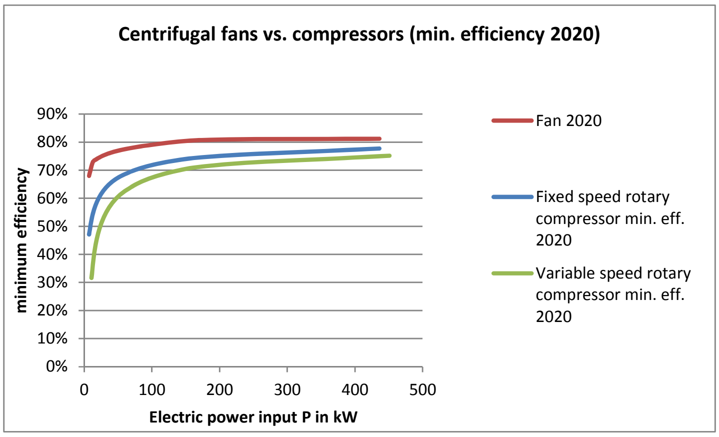

Figure 5. Centrifugal fans versus standard air compressors, minimum efficiency per 1.1.2020

Table 3. Range hoods minimum fluid dynamics efficiency FDE_{hood} versus misc. fan efficiencies

Pin (kW)	Range hood FDE min. 2020	Centrifugal BC fan eff. 2015	Mixed flow fan eff. 2015	Axial static fan eff. 2015	Centrifugal static fan eff. 2020
0.125	8%	41%	30%	28%	41%
0.172	8%	42%	31%	29%	44%
0.241	8%	44%	33%	30%	47%
0.264	8%	44%	33%	30%	47%
0.321	8%	45%	34%	31%	49%
0.456	8%	47%	36%	32%	52%
0.490	8%	47%	36%	32%	52%
0.656	8%	49%	38%	33%	55%
0.875	8%	50%	39%	33%	57%
1.000	8%	51%	40%	34%	58%

Range hoods have a minimum fluid dynamics efficiency FDE_{hood} (at bep: air power out/electric power in) of **8%** in 2020 (5% in 2018, 3% in 2015). There is a large gap between range hood and generic minimum fan efficiency requirements.

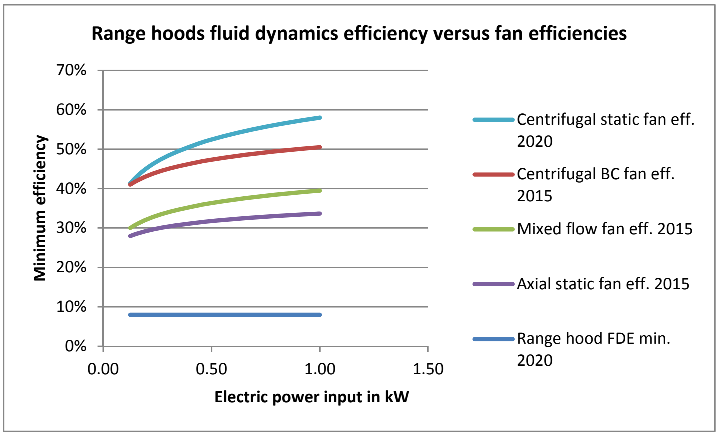

Figure 6. Range hood FDE versus Fan efficiencies.

Axial fans

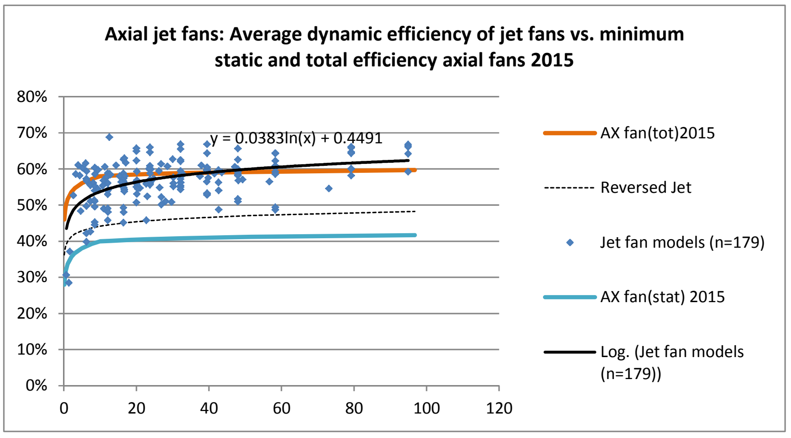

Figure 7. Database of (axial) jet fan models and their dynamic (thrust-based) efficiency versus the current (2015) minimum static and total fan efficiency (x-axis is input power P). The black curve is the log trend line of the database, which could be a basis for the 2020 jet fan efficiency line. The log-multiplier of the trend line is 3.83%, which gives a steeper curve than the current 2.74%.

The dotted line is the trend line of the jet fans when they run in reverse, which only happens in case of emergency (i.e. fire), and can be ignored. Note that all jet fans in the database can have this dual purpose feature and thus could claim a 10% (factor 0.9) discount on the minimum efficiency curve.

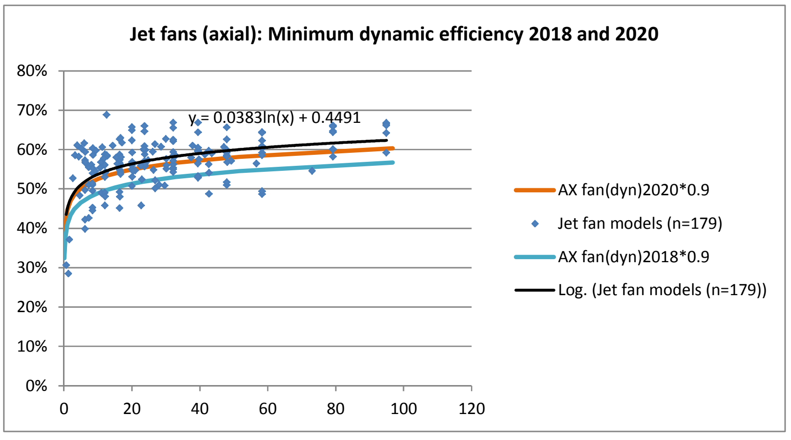

Figure 8. Proposed minimum dynamic efficiency for jet fans 2018 and 2020.

Table 4. Axial fan: minimum efficiencies (static and total) 2015, proposed 2018 and 2020 (static, dynamic, total), proposed dual purpose 2018 and 2018 (dynamic*0.9), average jet fan efficiency 2014.

Power input P	**0.125**	**0.3**	**0.5**	**1**	**2**	**3**	**5**	**7.6**	**10**	**13.1**	**18.2**	**23.2**	**32.9**	**51.6**	**96.7**	**200**	**500**	**N**
															53%	56%	60%	
AX fan(stat) 2015	28%	30%	32%	34%	36%	37%	38%	39%	40%	40%	40%	41%	41%	41%	42%	42%	43%	**40%**
AX fan(tot)2015	46%	48%	50%	52%	54%	55%	56%	57%	58%	58%	58%	59%	59%	59%	60%	60%	60%	**58%**
AX fan(stat) 2018	29%	32%	34%	37%	39%	41%	43%	44%	45%	46%	48%	49%	50%	52%	54%	57%	57%	**44%**
AX fan(dyn) 2018	**38%**	**41%**	**43%**	**46%**	**48%**	**50%**	**52%**	**53%**	**54%**	**55%**	**57%**	**58%**	**59%**	**61%**	**63%**	**66%**	**66%**	**53%**
AX fan(tot) 2018	47%	50%	52%	55%	57%	58%	60%	62%	63%	64%	65%	66%	67%	69%	71%	74%	74%	**62%**
AX fan(stat) 2020	29%	34%	37%	41%	43%	45%	47%	48%	49%	50%	52%	53%	54%	56%	58%	61%	61%	**48%**
AX fan(dyn) 2020	**38%**	**43%**	**46%**	**50%**	**52%**	**54%**	**56%**	**57%**	**58%**	**59%**	**61%**	**62%**	**63%**	**65%**	**67%**	**70%**	**70%**	**57%**
AX fan (tot) 2020	47%	52%	55%	59%	61%	63%	65%	66%	67%	68%	70%	71%	72%	74%	76%	79%	79%	**66%**
AX fan(dyn)2018*0.9	**34%**	**37%**	**39%**	**41%**	**43%**	**45%**	**47%**	**48%**	**49%**	**50%**	**51%**	**52%**	**53%**	**55%**	**57%**	**59%**	**59%**	
AX fan(dyn)2020*0.9	**34%**	**38%**	**41%**	**45%**	**47%**	**48%**	**50%**	**52%**	**53%**	**53%**	**55%**	**55%**	**57%**	**58%**	**60%**	**63%**	**63%**	
Average Jet 2014							42%	44%	45%	46%	47%	48%	49%	51%	53%	56%	60%	

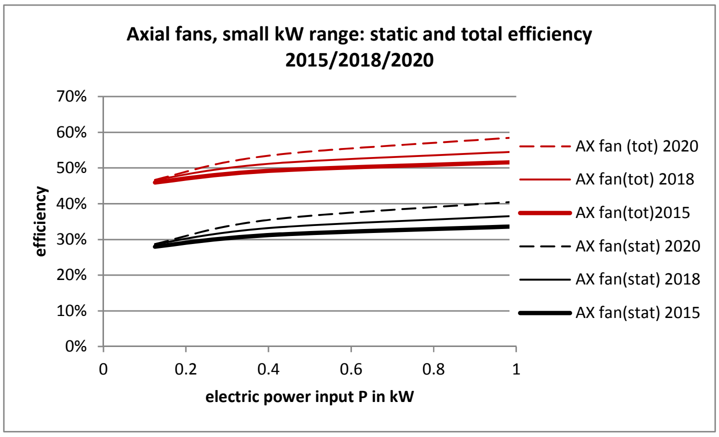

Figure 9. Axial fans, small: current and proposed minimum static and total efficiencies.

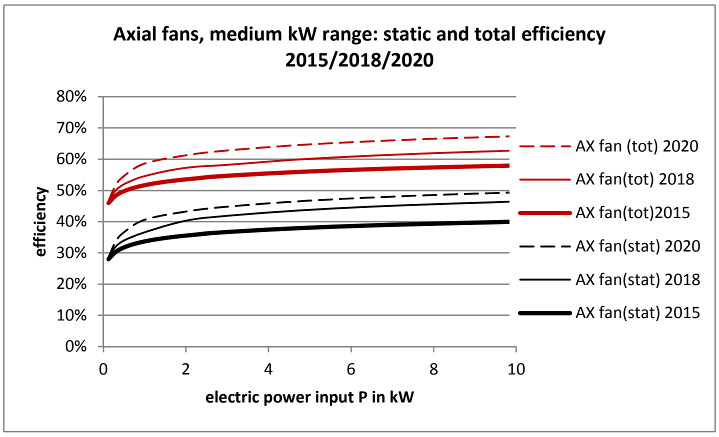

Figure 10. Axial fans, medium size: current and proposed minimum static and total efficiencies.

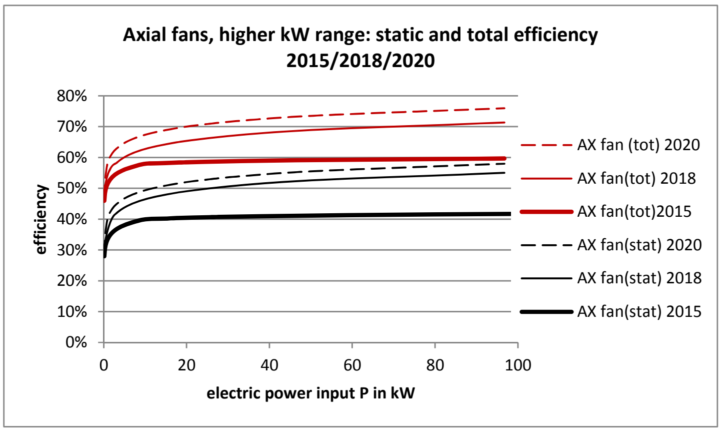

Figure 11. Axial fans, higher range: current and proposed minimum static and total efficiencies.

Table 5. Minimum efficiency per fan type (N=N2018 per 1.1.2018, N=N2020 per 1.1.2020)

Axial fans (α* ≤ 20°)					
Efficiency category (measurement category)	**N2018**	**N2020**	**η_{min} at Pe≤1 kW**	**η_{min} at 1kW<Pe≤200 kW**	**η_{min} at Pe>200 kW**
static (A, C)	44%	48%	(3.8%+0.5(N-N2018))*LN(P) -7.4%+N	3.8%*LN(P)-7.4%+N	3.8%*LN(200)-7.4%+N
'dynamic' (A)	53%	57%			
total (B, D)	62%	66%			

Mixed flow fans (20°< α ≤ 70°)						
Efficiency category (measurement category)	**N2018**	**N2020**	**η_{min} at Pe≤1 kW**	**η_{min} at 1kW<Pe≤10 kW**	**η_{min} at 10kW<Pe≤200 kW**	**η_{min} at Pe>200 kW**
static (A, C)	54%	58%	(5%+0.5(N-N2018))*LN(P) -8.7%+N	5%*LN(P)-8.7%+N	3.4%*LN(P)-5.1%+N	3.4%*LN(200)-5.1%+N
total (B,D)	64%	68%				

Centrifugal fans (α > 70°)						
Efficiency category (measurement category)	**N2018**	**N2020**	**η_{min} at Pe≤1 kW**	**η_{min} at 1kW<Pe≤10 kW**	**η_{min} at 10kW<Pe≤200 kW**	**η_{min} at Pe>200 kW**
static (A, C)	64%	68%	(6.2%+0.5(N-N2018))*LN(P) -10%+N	6.2%*LN(P)-10%+N	3%*LN(P)-2.8%+N	3%*LN(200)-2.8%+N
total (B,D)	67%	70%				

Cross flow fans (rotary fan, flow tangential to periphery impeller)			
Efficiency category (measurement category)	**N2018**	**N2020**	**η_{min}**
total (B,D)	21%	21%	N

* α is the angle between the direction of entry and the direction of exit of gas flow of the fan.

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Enclosed:

Files linked within this documents can be found within the 'Attachment' section of Adobe Acrobat.

Eurovent - The European Committee of HVAC&R Manufacturers AISBL / IVZW / INPA

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