To:
European Commission
DG ENTR Mr. Tobias Biermann, Policy officer

Date: 2012-12-05

Reference: Ecodesign Lot 6, Draft Working Document Ventilation Units 10.10.2012

Appeal in favor of SFP based Ecodesign requirements on Ventilation Units

Specific Fan Power (SFP) is the most adequate measure to compare and specify energy efficiency in ventilation units. It reflects the electricity consumption per unit of transported air, the latter being the core purpose of a ventilation unit. By basing requirements on SFP, the authorities can target the energy efficiency, leaving maximum freedom to designers and manufacturers to develop and produce energy efficient ventilation units. Legal limits based on other quantities, e.g. air velocity, would restrict the technical and creative opportunities and lock up our industry to obsolete and resource-demanding solutions. Such restrictions might impede European ventilation industry in the global competition for more energy-efficient products.

Therefore, we strongly support "Proposal for Ecodesign requirements based on SFP" in the Swedish comments. Our appeal is sent via Svensk Ventilation for compilation into a common appeal to the European Commission.

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By email

Swedish comments on the Commission's "Draft Working Document Ventilation Units" and proposal to use the SFP method for setting ecodesign requirements for non-residential ventilation units[1]

Summary and proposals

Sweden welcomes the proposals for ecodesign requirements for Residential and Non-Residential Ventilation Units, and the energy labelling of Residential Ventilation Units.

However, Sweden urges the Commission to introduce efficiency requirements that better address the product and not only its components. The requirements proposed by the Commission are limited to the fan efficiency at a design flow rate and the air velocity, and fail to stimulate a better design of the whole product. As a consequence we propose that requirements are formulated using the SFP-Specific Fan Power method, which promotes an energy efficient design of the whole product, namely by stimulating lower internal pressure drop. Also, the requirements are set at a level that should result in more efficient products than the level proposed by the Commission. Furthermore we believe that formulating requirements in terms of SFP is better suited to the needs of modern buildings.

This document consists of two parts

- Part 1. A proposal for ecodesign requirements for non-residential ventilation units based on SFP.
- Part 2. Comments on the Commission's "Draft Working Document Ventilation Units".

[1] *This proposal has been developed by Caroline Haglund Stignor and Prof. Per Fahlén from SP Technical Research Institute of Sweden, with calculations from Svensk Ventilation. The proposal has been commissioned and edited by the Swedish Energy Agency. We would like to thank René Kemna, VhK, and Philippe Rivière, Armines, for their valuable comments on the methodology.*

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1. Proposal to revise the Commission's proposal by using the SFP method for setting Ecodesign requirements for non-residential ventilation units[2]

1.1 Summary

This document suggests revising the Commission's proposal on ecodesign requirements for NRVU- Non Residential Ventilation Units by using the SFP-Specific Fan Power method. The use of this method has the following advantages:

- **The SFP promotes the energy efficient design of the whole product** (air handling unit), as it addresses both efficient fans **and** lower internal pressure drops caused by the heat exchanger and filters. The Commission's proposal mainly promotes efficient fans (components within the unit) and does not provide information about the overall efficiency of the unit.
- SFP is widely used for setting requirements at **system** level. By implementing a SFP requirement at **product** level (i.e. for the air handling unit) a buyer or system designer can easily see which product corresponds to specified system requirements.
- SFP is defined in a European standard (EN13779) and used to express requirements in commercial and legislating documents in many European countries, especially the Nordic countries but also in Spain, UK, Estonia and Poland. Nordic manufacturers in particular strongly advocate the SFP methodology.

Requirements expressed in SFP are proposed in two tiers. An example is presented to illustrate how the SFP method can promote the design of efficient air handling units (i.e. the whole product). The case study consists of two different air handling units, both with fan efficiencies at the level of the requirements in Tier 2 (as proposed by the Commission). However, by expressing the requirements using SFP, the difference in electrical power consumption between the two units can be considerable. The reason is that the SFP indicator promotes the design of the unit with lower internal pressure drops. This illustrates that internal pressure drops can be as important as the fan and fan-drive efficiencies.

Sweden proposes that the requirements for NRVUs are formulated mainly as SFP, and complemented with some specific requirements. We have aimed at developing SFP requirement at, at least, the same ambition level as the Commission's proposal, and resulting generally in more energy efficient products.

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[2] *This proposal has been developed by Caroline Haglund Stignor and Prof. Per Fahlén from SP Technical Research Institute of Sweden, with calculations from Svensk Ventilation. The proposal has been commissioned and edited by the Swedish Energy Agency. We would like to thank René Kemna, VhK, and Philippe Rivière, Armines, for their valuable comments on the methodology.*

1.2 Internal and external pressure drop – historical development

Over the past 30 years the development in Nordic countries has seen drastic reductions of overall pressure drop and fundamental changes in the relation between internal and external pressure differences of air-handling units (AHUs). A major driver in this development has been the use of SFP to express requirements on overall air-conditioning and distribution efficiency. From a situation where the distribution-related pressure drop of the building system was decisive for fan-pressure requirements the current situation is that the air-conditioning related pressure drop of the AHU totally dominates. Some factors that play a part in this development are:

- Upsizing of ductwork to reduce air velocities (reduced Δp_{ext})
- Introduction of VAV systems to reduce normal air flow rates (reduced Δp_{ext})
- Higher requirements on heat recovery (increased Δp_{ahu})
- Higher requirements on comfort cooling (increased Δp_{ahu})
- Higher requirements on air quality (filtration; increased Δp_{ahu})

An upcoming issue is the very low heating demand of future buildings which will reduce the requirement on heat recovery in normal operation (cooling needs will increase and be significant even in a Nordic climate). Recovery will still be very important at the design outdoor temperature for heating but for overall energy efficiency a low pressure drop may be more important than high temperature efficiency. The consequences of these developments is that the internal pressure drop of the AHU is just as important as the efficiency of the fan and fan drive for the overall efficiency of the AHU and, in modern Nordic buildings, more important than the external pressure difference.

Another important change in recent years is the market penetration of variable-speed drives (VSD) and demand-controlled ventilating systems (DCV). For instance, modern office buildings rarely use their design flow rates and on average operate at only 30-40 % of the design value. This means that the pressure drop and the efficiency of the fan and fan-drive are much more important in the low flow range than at the design value. Even with a specified face velocity, pressure drops per unit of heat recovery or filtration will differ greatly depending on the technical solution.

The Commission’s working document locks a number of design parameters such as fan-drive efficiency, face velocity and energy efficiency of heat recovery, but avoids the issue of overall internal pressure drop of the unit. This limits the designer’s alternatives to reach a given result**.** Internal pressure drop can be as important as fan and fan-drive efficiencies.

To avoid introducing a classification for yesterday’s systems, which will not fulfill stakeholders’ requirements of tomorrow, the classification should consider not only fan efficiency at a design flow rate but also fan and fan drive efficiency at normal operating flow rates (30-40 % of design flow) and, most importantly, the internal pressure drop of the AHU. To enable system designers and clients to make a full comparison between alternative AHUs, the new classification should promote AHUs with

- Wide and easily controllable flow range
- High efficiency of fan plus fan-drive
  Low pressure drop of filters and heat exchangers

In the Commission's proposal it is stated that the reference power consumption, $P_{m,ref}$, shall be evaluated at the declared design air flow rate. Therefore, in our proposal the SFP requirement shall also be evaluated at the design flow rate. However, in other Lots for products where the performance at part load is important, e.g. ENER Lot 1, a weighted value between full load and part load is applied, sometimes even a so called bin-method. For Ventilation Units, the performance at lower air flow rates than the design should be included in the ecodesign requirements as well, possibly as weighted value. However, more investigations are needed to be able to propose values for such weighting factors. If this cannot be done at this stage it should be done in a future revision of the ecodesign requirement for Ventilation Units.

1.3 Complementing the $P_{m,ref}$ (Commission) with the SFP requirement

According to the draft Working document for Ventilation Units, 10-10-2012 the ecodesign requirements for NRVU (Non Residential Ventilation Units) include:

- efficiency of the fans in the units (fan itself, fan inside casing and minimal electrical efficiency of balanced units)
- efficiency of the heat recovery system
- maximum face velocity and
- maximum sound power level

In addition there are requirements stating that the unit shall be equipped with a multispeed drive or a variable speed drive, that the unit shall have a by-passable heat recovery system and that, if a filter module is required, the product shall be able to mount a low energy consuming filter.

By applying such requirements the electricity consumption of the fans is limited and the overall efficiency of the unit is guaranteed by stipulating maximum values for the face velocity at the front of filter surface and a requirement that a low energy filter should be used. However, this could be revised in order to better relate to common procedures for procurement of ventilation units in many European countries.

1.3.1 Definition of SFP

There are definitions for different SFP values. SFP can be used for an entire building, for an individual air handling unit or a fan.

SFP at "building" level

According to EN13779, Annex D, SFP for an entire building is defined as "The combined amount of electric power consumed by all the fans in the air distribution system divided by the total air flow rate through the building under design load conditions, in W·m^{-3}·s".

$$SFP = \frac{P_{sf} + P_{ef}}{q_{max}}$$

Where:

- SFP is the specific fan power demand in W·m^{-3}·s
- P_{sf} is the total fan power of the supply air fans at the design air flow rate in W
- P_{ef} is the total fan power of the exhaust air fans at the design air flow rate in W
- q_{max} is the design airflow rate through the building, which should be the extract air flow in m^3·s^{-1}

The load condition is defined as when the filter pressure drop is the average of the clean filter pressure drop and the recommended maximum (dirty filter) pressure drops. The pressure drops of the other components (e.g. heat exchanger, cooling coil and humidifier) are the mean of dry and wet conditions.

SFP at "Air Handling Unit" level

To enable the system designers to quickly determine whether a given air handling unit will positively or negatively meet the overall demands on energy efficiency, both SFP_E and SFP_V values are defined in EN13779.

The specific fan power for a heat recovery air handling unit with supply air and extract air, SFP_E, is the total amount of electric power, in W, supplied to the fans in the air handling unit, divided by the largest of the supply air or the extract air flow rates (i.e. not the outdoor air or the exhaust air flow rates) expressed in m^3/s *under design load conditions*.

$$SFP_E = \frac{P_{sfm} + P_{efm}}{q_{max}}$$

SFP_V is calculated in the same way but at the *validation load condition*, which means when the filters are clean and all other components dry.

$$SFP_V = \frac{P_{sfm} + P_{efm}}{q_{max}}$$

Where:

- SFP_E is the specific fan power of a heat recovery air handling unit at design load conditions in $W \cdot m^{-3} \cdot s$
- SFP_V is the specific fan power of a heat recovery air handling unit at validation load conditions in $W \cdot m^{-3} \cdot s$
- P_{sfm} is the power supplied to the supply air fan in W
- P_{efm} is the power supplied to the extract air fan in W
- q_{max} is the largest of supply air or extract air flow through the air handling unit in $m^3 \cdot s^{-1}$

1.3.2 The relation between $P_{m,ref}$ and SFP

The efficiency requirement in the Commissions draft working document regarding the minimum electrical efficiency of balanced ventilation units are based on $P_{m,\ ref}$. and is defined as

$$P_{m,ref} = \left(\frac{\Delta p_{stat}}{450}\right)^{0.925} \cdot (q_v + 0.08)^{0.95}$$

As stated above SFP is defined as

$$SFP_V = \frac{P_{sfm} + P_{efm}}{q_{max}}$$

Hence a simple relation between class limits for SFP and P is

$$SFP_{limit} = \frac{2 \cdot P_{limit}}{q_{max}}$$

The minimum electrical efficiency limit (in Tier 2) is given by the relation

$$P_{limit} = 0{,}85 \cdot P_{m,ref}$$

with $P_{m,ref}$ according to above.

1.4 Proposal for Ecodesign requirements based on SFP

For balanced NRVU the Commission's proposal includes requirements regarding

- Multispeed or variable speed drives
- By-passable heat recovery system
- Energy efficiency of heat recovery system
- Minimum fan efficiency
- Minimum electrical efficiency for the supply side
- Maximum face velocity
- Possibility to mount a low energy consuming filter if filter module is required
- Sound power level

We propose that *the minimum electrical efficiency requirement*, *the maximum face velocity requirement* and *the requirement of low energy filter* for balanced NRVU shall be replaced by a SFP requirement.

In addition we propose that the requirement that all balanced ventilation units shall have a "*by-passable* heat recovery system" is revised to "*thermally by-passable* heat recovery system". The reason is that there are other means to control the efficiency of the heat recovery system than a physical by-pass, which are of concern for example for regenerators and run-around systems. The SFP requirements described below shall be fulfilled also when the air flow is by-passed (i.e. the pressure drop of the by-bass shall not be higher than through the heat exchanger). It should also be required that the control system of the unit avoids harmful freezing of the unit at low outdoor temperatures below zero °C.

We propose that the following components shall be included in the SFP definition:

- Fans for supply and extract air;
- Heat recovery unit[3]
- Supply air filter class F7 and Extract air filter class M5 according to EN779:2012 or equivalent definition are used when determining the declared value. According to our proposal, it is **not** stipulated that the units must be equipped with F7 and M5 filters, but the SFP values shall be declared with this type of filter mounted in the unit. The reason for this is 1) to ensure that all units are equally assessed and 2) to promote the use of low energy filters, whenever filters are used. The manufacturer should declare which filters are to be used in the unit to fulfill the SFP requirement and it shall be possible to mount such filters in the unit. In case the NRVU is designed for an application where no filters are need, an adjustment shall be done in the calculation of SFP_{limit} (see below).

1.4.1 Reference working point

The unit shall be evaluated according to its reference working point (flow rate and external pressure difference), defined by the manufacturer, depending on the unit's design provisions. The reference working point is defined in one of the following ways.

- ***General reference working point.*** For balanced NRVUs not designed for a specific working point, the reference working point, both air streams, is defined as 70 % of the maximum airflow and the external pressure difference declared by the manufacturer. It is not allowed to declare any performance data for the unit at higher values of the air flows than the declared maximum air flow.

- ***Specific reference working point.*** For balanced NRVU designed for one or more specific working points, the reference working point is the

[3] Minimum efficiency for the heat recovery unit according to the Commission's proposal

working point at which the NRVU will mainly be used, i.e. at the design air flow rate.

SFP_V shall be calculated at the reference working point (in some cases from measured values e.g. at market surveillance) and compared to a required value for SFP at that working point, SFP_{limit}. The SFP requirements should be a mathematical function that allows for higher SFP values for higher external pressures differences ($\Delta p_{stat,ext,tot}$) and air flows.

1.4.2 *Definition of requirements at Tier 1 and Tier 2*

The mathematical function for the SFP requirement, i.e. the SFP target values, is derived according to below for:

- Tier 1, with the minimum electrical efficiency equal to
  - $\eta_{P2} = 0{,}001 \cdot \Delta p_{stat,fan} \cdot q_v / (0{,}90 \cdot P_{m,ref})$, illustrated in Figure 1;

- Tier 2, with the minimum electrical efficiency equal to
  - $\eta_{P1} = 0{,}001 \cdot \Delta p_{stat,fan} \cdot q_v / (0{,}85 \cdot P_{m,ref})$, illustrated in Figure 2;

Where

- $P_{m,ref}$ is the reference power input
- $\Delta p_{stat,\ fan}$ is the nominal pressure, i.e. the external static pressure difference over the fan [Pa]
- q_v is the nominal airflow (at reference working point)[m^3/s]

The SFP_{limit} function is based on a reference case where the internal static pressure difference is derived according to the following function:

- $\Delta p_{stat,int} = 250 + 50 \cdot \log(q_v + 0{,}1)$

Where $\Delta p_{stat,int}$ represent the internal static pressure drop in the ventilation unit, e.g. over the filters and heat recovery unit (and casing). The pressure drop of any supplementary heat exchanger coil(s) (or other supplementary equipment) shall be allocated to the *external* static pressure difference, and not to the internal static pressure drop. In case a NRVU is designed for an application where no filters are needed (assumed to be an exceptional case), the value of $\Delta p_{stat,int}$ in the equations below shall be reduced by 50 Pa (250 shall be replaced by 200).

The resulting SFP_{limit} values for different flow rates and different values for the external static pressure are given in Figure 1 below for Tier 1 and in Figure 2 for Tier 2. To start with, the SFP_{limit} value for a ventilation unit where the air flow rate and the pressure differences on the supply and extract air side are identical. (The equations below are valid for Tier 1. In Tier 2 η_{P2} is replaced by η_{P1}, i.e. 0,9 is replaced by 0,85).

$$SFP_{limit} = \frac{P_{efm} + P_{sfm}}{q_{max}} = \frac{(\Delta p_{stat,fan}) \cdot 2}{\eta_{P2}}$$

$$\eta_{P2} = \frac{(\Delta p_{stat,fan} \cdot q_v)}{(1000 \cdot 0{,}9 \cdot P_{mref})} = \frac{(\Delta p_{stat,fan} \cdot q_v)}{\left(1000 \cdot 0{,}9 \cdot \left(\frac{\Delta p_{stat,fan}}{450}\right)^{0{,}925} \cdot (q_v + 0{,}08)^{0.95}\right)}$$

$$= \frac{\left(\left(\Delta p_{stat,ext,tot} + 250 + 50 \cdot \log(q_v + 0{,}1)\right) \cdot q_v\right)}{\left(1000 \cdot 0{,}9 \cdot \left(\frac{\left(\Delta p_{stat,ext,tot} + 250 + 50 \cdot \log(q_v + 0{,}1)\right)}{450}\right)^{0{,}925} \cdot (q_v + 0{,}08)^{0.95}\right)}$$

$$SFP_{limit} = \frac{\left(\Delta p_{stat,ext,tot} + 250 + 50 \cdot \log(q_v + 0{,}1)\right) \cdot 2}{\frac{\left(\left(\Delta p_{stat,ext,tot} + 250 + 50 \cdot \log(q_v + 0{,}1)\right) \cdot q_v\right)}{\left(1000 \cdot 0{,}9 \cdot \left(\frac{\left(\Delta p_{stat,ext,tot} + 250 + 50 \cdot \log(q_v + 0{,}1)\right)}{450}\right)^{0{,}925} \cdot (q_v + 0{,}08)^{0.95}\right)}}$$

$$= \frac{2 \cdot \left(1000 \cdot 0{,}9 \cdot \left(\frac{\left(\Delta p_{stat,ext,tot} + 250 + 50 \cdot \log(q_v + 0{,}1)\right)}{450}\right)^{0{,}925} \cdot (q_v + 0{,}08)^{0.95}\right)}{q_v}$$

$$= \frac{2 \cdot 0{,}9 \cdot P_{m,ref}}{q_v}$$

- P_{sfm} is power supplied to the supply air fan in W
- P_{efm} is power supplied to the extract air fan in W
- $P_{m,ref}$ is the reference power consumption for one of the fans (when identical on both sides) in W
- q_v is the nominal air flow at the reference working point (when identical on both sides) in $m^3 \cdot s^{-1}$
- q_{max} is the largest of supply air or extract air flow through the air handling unit in $m^3 \cdot s^{-1}$
- $\Delta p_{stat,ext,tot}$ is the external pressure difference in Pa

However, in most cases the external or static pressure drop and air flow rates are not declared as identical for the supply and extract air side. Then the reference power consumption is calculated for each air side separately and finally the SFP_{limit} value is calculated by using the sum of the two according to the equations below:

$$P_{SUP} = \left(\frac{\left(\Delta p_{SUP,stat,ext,tot} + 250 + 50 \cdot \log(q_{SUP} + 0{,}1)\right)}{450}\right)^{0{,}925} \cdot (q_{SUP} + 0{,}08)^{0.95}$$

$$P_{ETA} = \left(\frac{\left(\Delta p_{ETA,stat,ext,tot} + 250 + 50 \cdot \log(q_{ETA} + 0{,}1) \right)}{450} \right)^{0{,}925} \cdot (q_{ETA} + 0{,}08)^{0.95}$$

$$SFP_{limit} = \frac{1000 * 0{,}9 * (P_{SUP} + P_{ETA})}{q_{max}}$$

Where

- P_{SUP} is power supplied to the supply air fan in W
- P_{ETA} is power supplied to the extract air fan in W
- q_{SUP} is the supply air flow $m^3 \cdot s^{-1}$
- q_{ETA} is the extract air flow in $m^3 \cdot s^{-1}$
- q_{max} is the largest of supply air or extract air flow in $m^3 \cdot s^{-1}$
- $\Delta p_{SUP,,stat,ext,tot}$ is the supply air stream external pressure difference in Pa
- $\Delta p_{ETA,stat,ext,tot}$ is the extract air stream external pressure difference in Pa

If the NRVU is equipped with a rotary heat exchanger then the following aspects shall be included in the evaluation (in accordance with EN13779 Annex D4):

1) Purging air flow including leakage
2) Pressure drop from the extra throttling in the extract air side, for ensuring the correct direction of air leakage.

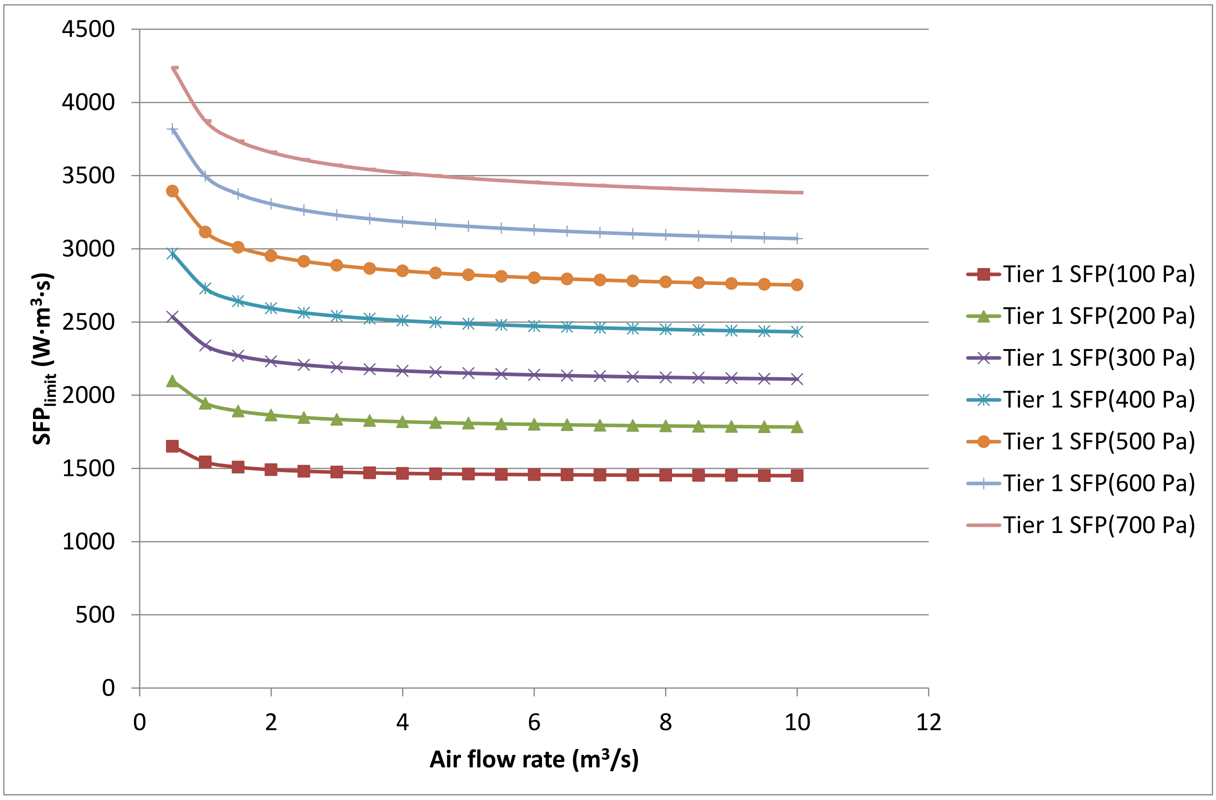

Figure 1.*SFP_{limit} values as a function of air flow rate and external static pressure difference in Tier 1 (for equal flow rates and pressure differences on the supply and extract air side).*

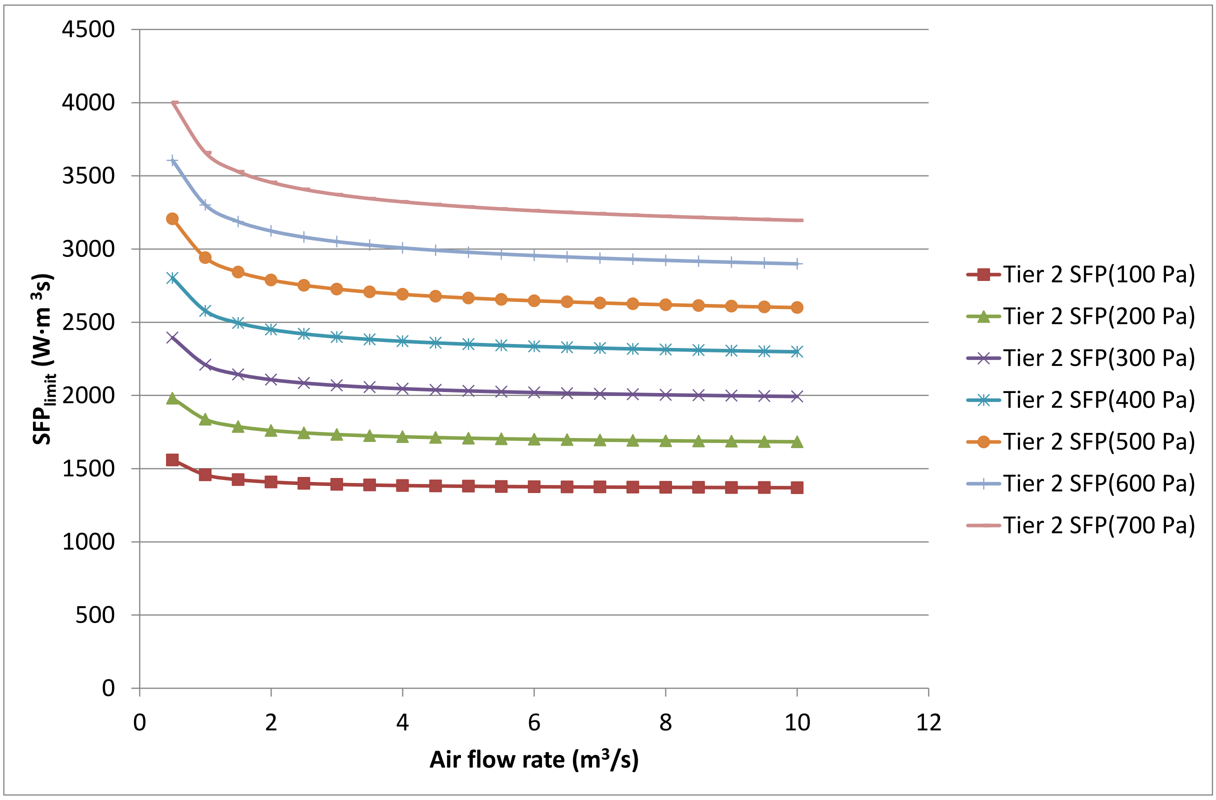

Figure 2.*SFP$_{limit}$ values as a function of air flow rate and external static pressure difference in Tier 2 (for equal flow rates and pressure differences on the supply and extract air side).*

1.5 Example using SFP and illustrating the shortcomings of the requirement based on $P_{m,\,ref}$

In Figure 3 and 4 below two different AHU (balanced NRVU) are described. Both have the minimum electrical efficiency corresponding to the ecodesign requirement for Tier 2 ($0{,}001 \cdot \Delta p_{stat} \cdot q_v / (0{,}85 \cdot P_{m,ref})$). Note that the pressure drop of the heat exchanger coil(s) of 50 Pa is allocated to the *external* static pressure.

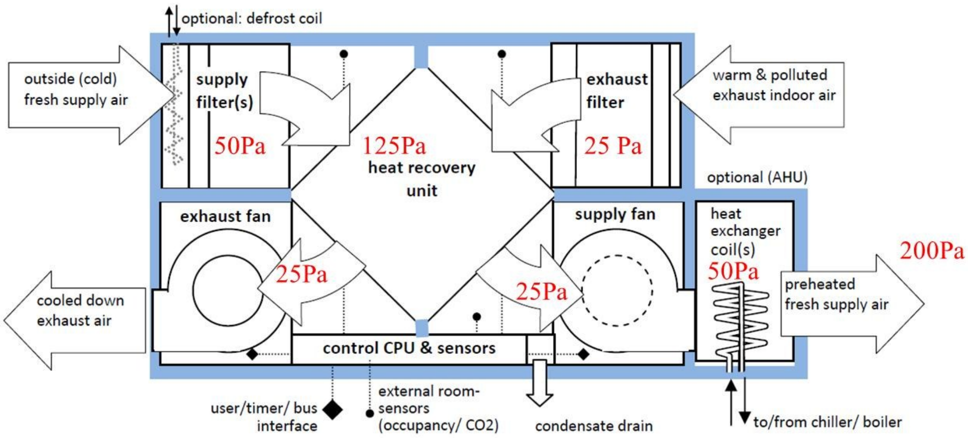

Figure 3. *Schematic picture of AHU1*

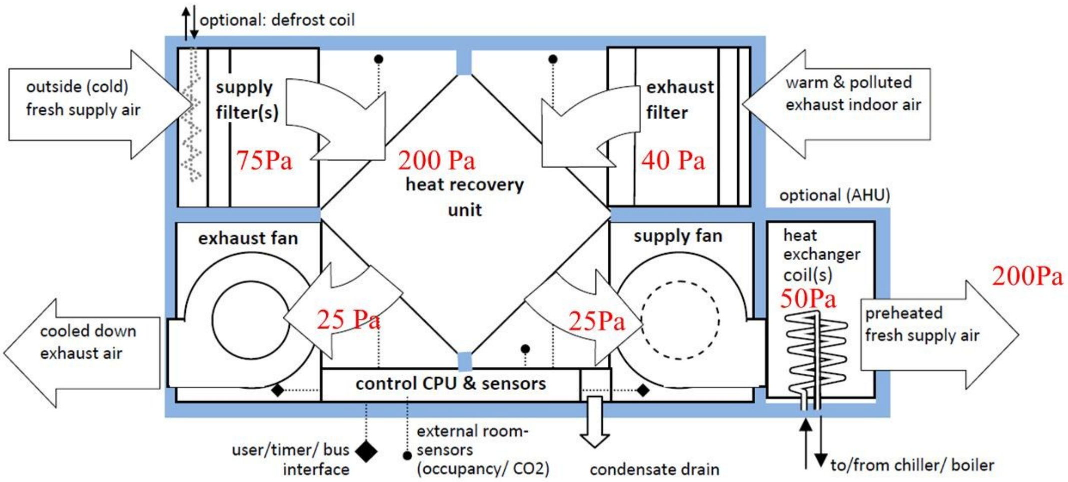

Figure 4. *Schematic picture of AHU2*

The two different units are described in the Table below:

	AHU1 (Figure 3)	AHU2, (Figure 4)
$\Delta p_{stat,ext,tot}$	250 Pa	250 Pa
$\Delta p_{stat,int,tot}$ (supply air)	200 Pa	300 Pa
$\Delta p_{stat,}$ (supply air)	450 Pa	550 Pa
$\Delta p_{stat,int,tot}$ (extract air)	200 Pa	265 Pa
$\Delta p_{stat,}$ (exhaust air)	400 Pa	515 Pa
q_V (q_{max} according to EN13779)	0,9 m^3/s	0,9 m^3/s
$\eta_{fan,supply}$ (corresponding to 0,85· $P_{m,ref}$)	0,49	0,49
$\eta_{fan,extract}$ (corresponding to 0,85· $P_{m,ref}$)	0,48	0,49
P_{sfm} (absorbed by the supply fan)	0,834 kW	1,004 kW
P_{efm} (absorbed by the extract fan)	0,748 kW	0,945 kW
SFP_V	**1757 W·m^{-3}·s**	**2165 W·m^{-3}·s**
SFP_{limit}	**2043 W·m^{-3}·s**	**2043 W·m^{-3}·s**

This example clearly illustrates that the requirement given in the working document will not result in the design of overall energy efficient products, only efficient fans. Even though the Commission’s proposal requires a maximum value of the air velocity it lacks requirements on the pressure drop over the heat recovery unit.

2 Preliminary comments on the Commission's "Draft Working Document Ventilation Units"

2.1 Scope and definitions

Sweden supports the proposal for dividing ventilation units into RVU- Residential Ventilation Units and NRVU – Non Residential Ventilation Units. Sweden fully supports that RVU receive both ecodesign requirements and energy labelling. Sweden suggests further to expand the system boundaries for NVRU:s from fan and motor to include the whole unit, i.e. fan, motor and internal pressure drop (heat exchanger and filters) by introducing SFP based requirements cf Part 1.

2.2 Ecodesign requirements for RVU - Residential Ventilation Units

General

Unidirectional units should be more clearly differentiated from balanced ventilation units. It is now unclear which requirement applies to unidirectional units and which applies to balanced units. It is also undefined when it is possible to use unidirectional units – it seems always possible to exchange a balanced unit with a unidirectional unit but the aim of the regulation is saving in both space heating and electrical energy.

In addition we propose that the requirement that all balanced ventilation units shall have a "*by-passable* heat recovery system" is revised to "*thermally by-passable* heat recovery system". The reason for this is that other means to control the efficiency of the heat recovery system are possible and are of concern for example for regenerators and run-around systems. The SFP requirements described below shall be fulfilled also when the air flow is by-passed (i.e. the pressure drop of the by-bass shall not be higher than through the heat exchanger.) It should also be required that control system of the unit avoids harmful freezing of the unit at low outdoor temperatures below zero °C.

SPI requirements

It is not totally clear if the SPI value shall be calculated for each fan separately in a balanced ventilation unit or if it shall include the total effective power input to both fans. We recommend that it shall include the electric power input to both fans. However, in such case, the difference between SPI for unidirectional ventilation units and balanced ventilations units should be greater. The former should not be more than half the values of the latter, and preferably less, since there are two fans and a heat recovery heat exchanger in the balanced ventilation unit and most often only one fan in the unidirectional. However, here it is not clear whether unidirectional ventilation units **with** heat recovery are included or not, e.g. units where heat from the exhaust air is recovered in a liquid coupled heat exchanger or in the evaporator of an exhaust air heat pump. This should be clarified.

SPI, the specific power input, is also expressed in a questionable way. We propose that SPI is replaced by the SFP value (expressed in $W/(m^3/s)$) according to European Standard EN 13779 (definition and general calculation in the main standard, detailed calculation in Annex D), and determined (for a product) in certain specified pressure conditions and air flow. We also miss the information about whether or not any auxiliary energy is taken into account, e.g. if and how the electric power of the rotary heat recovery motor, pumps or controls is taken into account.

Presupposing that effective power of both fans shall be included in the SPI or SFP value for balanced ventilation units and that no heat recovery shall be included for the unidirectional units, Sweden proposes the values below. These are in the same range as the requirements for ventilation system in present Swedish Building Codes in the first Tier and somewhat lower in the second Tier.

Sweden proposes: that the SPI requirements are modified as follows:

- **Tier 1**: the text **"***[...] SPI shall be less than or equal to 0,23 W/m³/h for unidirectional ventilation units and 0,35 W/m³/h for balanced ventilation units;*" is replaced by *"[...] SPI (or SFP) shall be less than or equal to 0,14 W/m³/h (0,50 kW/m³/s) for unidirectional ventilation units and 0,56 W/m³/h (2,0 kW/m³/s) for balanced ventilation units (at reference flow rate and an external pressure difference of 50 Pa)* "

- **Tier 2**: the text *"[...] SPI shall be less than or equal to 0,18 W/m³/h for Exhaust Ventilation Units and 0,28 W/m³/h for Balanced Ventilation Units;*" is replaced by *"[...] SPI or (SFP) shall be less than or equal to 0,43 kW/m³/s (0,12 W/m³/h) for Unidirectional Ventilation Units and 1,8 kW/m³/s (0,5 W/m³/h) for Balanced Ventilation Units (at reference flow rate and an external pressure difference of 50 Pa)".*

2.3 Ecodesign requirements for NRVU - Non Residential Ventilation Units

Sweden proposes that the text "*all Ventilation Units shall be equipped with a multi-speed drive or a variable speed drive*;" is replaced by "*all* ***Balanced*** *Ventilation Units shall be equipped with a multi-speed drive or a variable speed drive*".

Regarding the text "the *energy efficiency of heat recovery systems (HRS) shall be at least 64%*". We suggest that it is clarified if this relates to enthalpy efficiency or to temperature efficiency.

Note that a requirements of 64% (tier 1) and 71% (tier 2) would exclude liquid-coupled coil and cross-flow exchangers. The former one is needed where 100% security against cross-contamination is required or where the supply air and exhaust air do not pass directly next to each other.

2.4 Energy labelling of Residential Ventilation Units

ANNEX II Energy efficiency classes

Since the energy efficiency classes are based on SEC values which in turn are a function of SPI and the definition of SPI is not totally clear, there is a possibility that the limits for the different classes should be revised.

ANNEX III The label

Sweden proposes that it shall be possible to show the specific energy efficiency (SEC) class for all the three climate zones on the label. The reason is that an A-class unit in an average climate may be a G-class unit in cold climate or even inoperative due to freezing.

ANNEX VI Measurements and calculations

The calculation of SEC does not take into account the advantages of developed control strategies of high-tech residential ventilation units in cold climates. The proper functioning at temperatures below zero affects the energy efficiency of ventilation radically. This phenomenon will be even more important the higher thermal efficiencies will be.