Eurovent Industry Recommendation / Code of Good Practice

Eurovent 6/18 - 2022

Quality criteria for Air Handling Units

First Edition

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Document history

This Eurovent Industry Recommendation / Code of Good Practice supersedes all of its previous editions, which automatically become obsolete with the publication of this document.

Modifications

This Eurovent publication was modified as against previous editions in the following manner:

Modifications as against	Key changes
1st edition	Present document

Preface

In a nutshell

The purpose of this recommendation is to provide a comprehensive overview of features that determine highly efficient operation and correct service of air handling units, which in other words are a measure of the AHU quality. The document addresses a wide range of aspects, such as properties of the casing and individual components, energy efficiency and controls requirements, maintainability, and the content of technical documentation. Detailed recommendations based on the expertise and many years of experience of Eurovent members indicate what distinguishes a good air handling unit. The guidelines in this document are intended to help investors, designers and end-users to assess whether the unit meets all practical expectations and requirements.

Authors

This document was published by Eurovent and was prepared in a joint effort by participants of the Product Group 'Air Handling Units' (PG-AHU), which represents a vast majority of all manufacturers of these products active on the EMEA market. Particularly important contribution has been provided by Charlene Lochon (editorial team leader), Andy Bijmans, Kees van Haperen, William Lawrance, Martin Lenz, Igor Sikonczyk, Martin Toerpe and Orkun Yilmaz.

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Important remarks

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Contents

Eurovent 6/18 - 2022 ____ 1
Document history ____ 2
Modifications ____ 2
Preface ____ 2
In a nutshell ____ 2
Authors ____ 2
Copyright ____ 2
Suggested citation ____ 2
Important remarks ____ 2
Contents ____ 3
List of abbreviations and symbols ____ 7
Key referred standards and regulations ____ 7
Foreword ____ 8
1 Casing ____ 8
1.1 Surfaces and materials ____ 8
1.1.1 Flammability ____ 8
Specific Eurovent recommendation ____ 9
1.1.2 Hygiene ____ 9
1.1.3 Corrosion ____ 9
Specific Eurovent recommendation ____ 10
1.1.4 Maintainability ____ 11
Specific Eurovent recommendation ____ 11
1.2 Casing indicator values/mechanical performance ____ 11
1.2.1 Mechanical strength/casing strength ____ 11
Specific Eurovent recommendation ____ 12
1.2.2 Air tightness ____ 12
Specific Eurovent recommendation ____ 13
1.2.3 Filter bypass leakage ____ 13
Specific Eurovent recommendation ____ 13
1.2.4 Thermal transmittance ____ 14
Specific Eurovent recommendation ____ 14
1.2.5 Thermal bridging factor ____ 14
Specific Eurovent recommendation ____ 15

1.2.6 Review EN 1886 15
1.3 Access doors and access panels 15
2 Dampers 16
Specific Eurovent recommendation 16
3 Filters 16
3.1 Filtration efficiency 16
Specific Eurovent recommendation 17
3.2 Design pressure drop 17
3.3 Arrangement and position 17
3.4 Energy efficiency of filters 18
Specific Eurovent recommendation 18
4 Heat recovery systems 18
Specific Eurovent recommendation 19
4.1 Types of heat recovery systems 19
4.2 Frost protection 20
4.3 Moisture recovery 20
4.4 Internal leakages on ERS 20
4.4.1 Limits on EATR and OACF, compensation of air flow 21
Specific Eurovent recommendation 21
4.4.2 Limiting internal leakage 22
4.5 Maintainability and hygienic issues 22
4.6 Additional considerations on HRS section design 22
4.6.1 Drain pan arrangement 22
4.6.2 Rotary heat exchanger diameter and AHU casing cross section 22
5 Coils 23
5.1 Surfaces and materials 23
5.2 Arrangement and position 23
5.3 Hygienic and energy considerations 24
5.4 Additional considerations 24
6 Electric air heaters 25
6.1 Arrangement and position 25
Specific Eurovent recommendation 25
7 Sound attenuators 26
7.1 Surfaces and materials 26

7.2 Arrangement and position 26
Specific Eurovent recommendation 26
8 Humidifiers 26
9 Fans 26
Specific Eurovent recommendation 27
9.1 Surfaces and materials 27
9.2 Arrangement and position 27
9.3 Installation and Accessories 27
10 Energy efficiency 28
Specific Eurovent recommendation 29
11 Control systems 29
11.1 Factory-supplied AHU control system 30
Specific Eurovent recommendation 30
12 Documentation, storage and transportation 30
12.1 What should the manufacturer do before the unit delivery? 30
12.2 What should the manufacturer deliver with the unit? 31
12.3 What are the Directives the manufacturer must comply with at the time of delivery? 31
12.4 What should the customer do before assembling? 31
12.5 Required content of installation, operation and maintenance instructions 31
13 Summary of key Eurovent specific recommendations 33
Casing 33
Dampers 33
Filters 33
Heat recovery systems 34
Electric air heaters 34
Sound attenuators 34
Fans and drives 34
Energy efficiency 34
Control system 34
Annex I 36
Classification according to EN 13501-1 36
Duct leakage classification according to EN 1507 and EN 12237 37
Requirements for SPF_{int} and fan efficiency according to Regulation (EU) 1253/2014 37
Ecodesign requirements according to Regulation (EU) 2019/1781 37

Dimensions of access doors and access panels 38
About Eurovent 39
Our Member Associations 39

List of abbreviations and symbols

AHU	Air Handling Unit
EATR	Exhaust Air Transfer Ratio expressed in % (ratio between the exhaust air amount in supply air and supply air mass flow)
EHA	Exhaust Air (airflow leaving the extract air treatment system and discharged to the atmosphere)
ETA	Extract Air (airflow leaving the treated room and entering the air treatment system)
HRS	Heat Recovery System
IAQ	Indoor Air Quality
OACF	Outdoor Air Correction Factor (ratio between ODA and SUP mass flows)
ODA	Outdoor Air (airflow entering the system from outdoors before heat recovery)
PG-AHU	Eurovent Product Group 'Air Handling Units'
PHE	Plate Heat Exchanger
RHE	Rotary Heat Exchanger
SUP	Supply Air (airflow entering the treated room after heat recovery)

Key referred standards and regulations

[1] EN 13053:2019 - Ventilation for buildings - Air handling units - Rating and performance for units, components and sections

[2] EN 16798-3:2017 - Energy performance of buildings - Ventilation for buildings - Part 3: For non-residential buildings - Performance requirements for ventilation and room-conditioning systems

[3] EN 1886:2007 - Ventilation for buildings - Air handling units - Mechanical performance

[4] EN 308:2022 - Heat exchangers - Test procedures for establishing performance of air to air and flue gases heat recovery devices

[5] Commission Regulation (EU) 1253/2014 of 7 July 2014 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for ventilation units

[6] Commission Regulation (EU) 2019/1781 of 1 October 2019 laying down ecodesign requirements for electric motors and variable speed drives pursuant to Directive 2009/125/EC of the European Parliament and of the Council, amending Regulation (EC) No 641/2009 with regard to ecodesign requirements for glandless standalone circulators and glandless circulators integrated in products and repealing Commission Regulation (EC) No 640/2009

Foreword

The aim of this Recommendation is to inform the reader of what distinguishes a good air handling unit. It reflects the expert opinion of the manufacturers of the Eurovent Product Group 'Air Handling Units' which represents most manufacturers of these products active on the European market. The Recommendation sets minimum quality criteria related to the design, materials and construction of both the casing and components of the unit, as well as its documentation and delivery. The recommended requirements with regard to energy efficiency and control systems are also comprehensively discussed. These criteria apply generally and are recommended for most applications. It must be noted however that these general criteria may not apply to special applications or applications in climate zones very different from most European climate zones.

The recommendation refers to requirements set out in relevant European standards (in particular EN 13053 and EN 1886), legally binding requirements of EU regulations (notably Regulation 1253/2014) and other Eurovent Recommendations.

1 Casing

1.1 Surfaces and materials

The casing of the unit and its panels must meet both the performance properties defined in EN 1886 and the hygiene requirements, which are presented in following section. This applies to both the outer panels and the internal partition panel between the supply and exhaust air.

1.1.1 Flammability

All buildings and their equipment are subject to fire protection regulations to protect goods and occupants. As ventilation and air conditioning systems pass through and supply the entire building, they must under no circumstances intensify or transmit an existing fire to other areas. That is why it is necessary that its heart (the air handling unit and mostly its casing) must be non-flammable.

In Europe, the technical standard EN 13501-1 defines the resistance of a material to fire. This classification compares each type of material in 4 classes from non-flammable to highly flammable. For each class, a material must respond to 3 different requirements: its reaction to fire, its smoke production (criteria S) and its production of flaming droplets (criteria D). Each criterion has different hazard level:

- A to F for the reaction to fire. A is the best quality and has no reactions.
- s1 to s3. s1 is the best quality and produces no smoke by burning.
- d0 to d2. d0 is the best quality and produces no flaming droplets by burning.

The detailed classification according to EN 13501-1 is presented in

Annex I, Table 10

There are no common EU regulations which require minimum burning protection classes for AHU materials. Instead, each Member State has its own requirements. For example, the minimum requirement in the French national legislation for non-metallic element is B s3 d1 (M1 according to NF P92-507). The minimum requirement in the German national legislation for non-metallic element is A2 s1 d0 (A2 according to DIN 4102-1). The minimum requirement in the Swedish national legislation is A2-s1 d0.

Specific Eurovent recommendation

Eurovent recommends flammability class A1 or A2 – s1 d0 according to EN 13501-1 for the insulation material in AHUs. However, it is up to each manufacturer to ensure that the unit complies with national requirements.

1.1.2 Hygiene

A good indoor air quality promotes health and reduces the risk of infection in rooms. Mechanical ventilation and air conditioning systems and devices have the task of creating a physiologically favourable room climate and a hygienically impeccable indoor air quality. The supply air, which enters the rooms through the systems, should be odourless and harmless to health. Systems must be planned, executed, operated and maintained according to the state of the art in such a way that the growth of microorganisms is avoided.

Some local standards VDI6022 (SWKI VA 104-01, ÖNORM H 6021) or the European standard EN13053 give information about hygienic air handling design, operation and maintenance. For special applications like clean rooms in hospitals or industry there are more detailed recommendations on hygienic AHU design (DIN 1946-4). In addition, Eurovent Certification developed the special programme for Hygienic Air Handling Units (HAHU), which evaluates the hygienic performance of units.

One of the main topics for hygienic air handling design is to have access for inspection and maintenance at all integrated components. Components of air handling units shall be easily accessible for cleaning purposes through access doors.

Metallic material shall be corrosion resistant and non-metallic material should not support the growth of microorganisms in accordance with EN ISO 846:2019 requirements. All interior surfaces of the casing must be smooth and easy to clean.

1.1.3 Corrosion

The best air handling unit needs to be adapted to the environmental atmosphere where the unit is running. The installation place, the quality of the outdoor air, but also the tendency of corrosion by the extract air can affect the lifetime of an air handling unit. Corrosion is a dangerous and extremely costly problem on ventilation systems. The most common kinds of corrosion result from electrochemical reactions.

The risk of atmospheric corrosion and the rate at which this corrosion occurs are primarily dependent on the following parameters:

- The relative humidity of (inside or outside air) where the structure is located
- The risk of condensation (depending on the relative humidity, the temperature of the structure and the speed at which the air is moving)

- The concentration of corrosive pollutants (gases, solids or liquids), such as sulphur dioxide, acids, alkalis or salts

Corrosion can occur on the outer skin of the panel as well as on every metal sheet on the inside of the unit. A general list of materials that are recommended to use for casing construction in outdoor environments of various corrosivity is presented in Table 1. The list is not exhaustive, and it does not exclude the use of other materials that can be demonstrated by the manufacturer to be compliant with the relevant corrosivity category. The table also gives a general description of outdoor environments corresponding to corrosivity categories C2 to CX. For more comprehensive information, including classification of indoor environments please refer to the recommendation Eurovent 6/16-2021.

Corrosivity category	**Corrosion level**	**Typical Outdoor environment (According to EN ISO 12944)**	**Recommended materials for casing construction (outer skin)**
Up to CX	Extreme	Areas with very high humidity, extreme pollution and strong effect of chlorides.	- Composite materials - Stainless steel sheet 316L according to AISI
Up to C5	Very high	Industrial areas with high humidity and aggressive atmosphere. Coastal and offshore areas with high salinity.	- Zinc-Magnesium-coated steel sheet ZM310 according to EN 10346 - Powder coated steel sheet, paint system for C5 according to EN ISO 12944
Up to C4	High	Industrial areas. Coastal areas with moderate salinity.	- Aluminium zinc-coated steel sheet AZ185 according EN 10346 - Coated steel sheet in RC4 category according to EN 10169 (coating > 25 µm) - Aluminium alloys according to EN 573 - Stainless steel sheet 304 according to AISI - Powder coated steel sheet, paint system for C4 according to EN ISO 12944
Up to C3	Medium	Urban and industrial areas with moderate SO2 pollution. Coastal areas with low salinity	- Aluminium zinc-coated steel sheet AZ150 according to EN 10346 - Coated steel sheet in RC3 category according to EN 10169 (coating ≤ 25 µm)
Up to C2	Low	Areas with negligible level of pollution.	- Galvanised steel sheet Z275 (Continuously hot-dip zinc coated low carbon steel, Sendzimir process) according to EN 10346

Table 1. Recommended materials for casing construction in relation to the outdoor environment corrosivity category

Specific Eurovent recommendation

If no particular requirements are given or the environmental corrosivity specification is unknown, the casing materials shall be suitable for:

- **Units for indoor and outdoor installation: Corrosivity category C3**
- **Units operating in corrosive atmosphere: Corrosivity category C4**

Otherwise, the choice of casing materials should be made based on an assessment of the individual working conditions according to Eurovent 6/16.

1.1.4 Maintainability

For good maintainability, different aspects must be taken into account: hygiene, place, safety.

The hygienic criteria of chapter 1.1.2 should be fulfilled. Moreover, every material must be resistant to abrasion, emission free and microbially not metabolizable. Metallic surfaces are recommended. It is better to avoid the use of plastic in the air flow. If it's necessary, every plastic element should have a certificate according to ISO 846 and fulfil a minimum class of 1 for method A (fungi) and C (bacteria).

Each component in the unit should be accessible. This means:

- Every revision area should be accessible with a door. Panels that need to be unscrewed from the outside to access to the maintenance place are not recommended, and panels which can only be unscrewed from the inside are strongly discouraged.
- For big units (height > 1,6m): the revision area should be big enough to let a person enter the unit and work properly. Bent over position for the maintenance team should be avoided.

To ensure a safe maintenance, the casing and its surfaces should not have any sharp metal sheets.

Specific Eurovent recommendation

Every revision area should be accessible with a door.

For the maintenance of the AHU, a neutral cleaning agent or alcohol-based disinfectants should be used on the inner surfaces.

Units with humidification process should be maintained in intervals of maximum 6 month. Units without humidification process should be maintained in intervals of maximum 12 month. In addition, a detailed hygienic check should be carried out every 2 years for units with humidification and every 3 years for units without humidification.

1.2 Casing indicator values/mechanical performance

Casing indicator values must be identified with the extension (R) for real units and (M) for model box according to EN 1886:2007. Compared to a real air handling unit, a model box according EN 1886 only consists of limited parts of the casing construction. These are the elements of the frame (if the construction includes a frame), doors, panels and a filter frame. The model box must also consist of two sections/modules. A model box does not include elements like windows, hoses, piping, dampers etc. It is just to compare different casing constructions regarding various characteristics.

1.2.1 Mechanical strength/casing strength

The unit deflection occurs on the panel when the positive or negative pressure inside is high. To measure it, EN 1886 sets this pressure to a standard of ± 1000 Pa. The deflection of the panel is defined like in Figure 1 below.

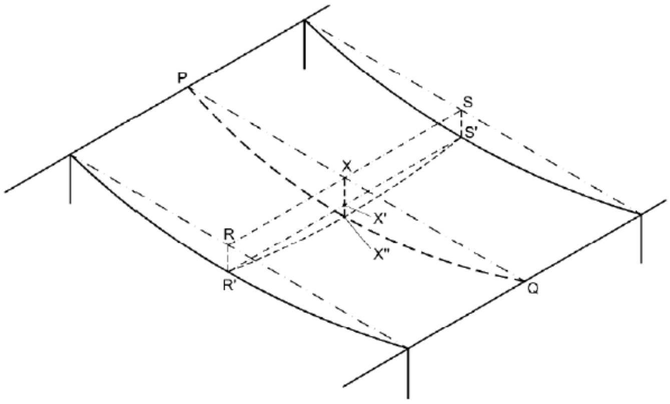

Figure 1. Determination of panel deflection (EN 1886:2007)

X'X" is the deflection in relation to the wall stiffness. XX" is the deflection in relation to the frame and wall stiffness. The table below describes the deflection classes.

Classification according to EN 1886 (1000 Pa)		
Classification	Max. relative deflection [mm/m]	Explanation
D1	4	Robust construction of the panel itself, small deflection in relation with the size of the panel and the pressure inside
D2	10	Minimal recommendation for an air handling unit. Normal deflection of the panel
D3	>10	Not recommended. High deflection of the panel by high pressure.

Table 2. Classification of the casing Mechanical strength class

Specific Eurovent recommendation

As the minimum mechanical strength class, Eurovent recommends D2 (R).

1.2.2 Air tightness

The external leakage rate influences different characteristics of the air handling unit. It reduces the useful airflow rate, can have a negative impact on air quality and can decrease the performance of the heat recovery system. The unit should therefore be as airtight as possible.

External leakage can occur by each opening in the unit's surface (e.g. doors, sections, etc.), as well as on the panel sealings and panel screws. The higher the pressure difference between the inside and outside of the unit, the higher the leakage rate. EN 1886:2007 fixes two standard pressures to measure leakages: -400 Pa and +700 Pa.

The table below describes the different leakage classes at a standard pressure of -400 Pa.

Classification according to EN 1886 (-400 Pa)		
Classification	Max. leakage rate [l · s^{-1} · m^{-2}]	Explanation
L1 (R)	0,15	Leak-proof unit. Max. leakage very low at under pressure: a very small amount of air enters the unit through the casing.
L2 (R)	0,44	Minimal recommendation for an air handling unit. Acceptable amount of air enters the unit through the casing.
L3 (R)	1,32	Large amount of air enters the unit through the casing. It can influence the air quality in the unit and contaminate the treated air going in the building.

Table 3. Leakage classes at negative pressure of -400 Pa (EN 1886:2007)

The table below describes the different leakage classes at a standard pressure of +700 Pa.

Classification according to EN 1886 (+700 Pa)		
Classification	Max. leakage rate [l · s^{-1} · m^{-2}]	Explanation
L1 (R)	0,22	Leak-proof unit. Max. leakage very low at over pressure: a very small amount of air exits the unit through the casing. The impact on the air is negligible.
L2 (R)	0,63	Minimal recommendation for an air handling unit. Acceptable amount of air exits the unit through the casing.
L3 (R)	1,90	Large amount of air exits the unit through the casing. It can influence the volume airflow supplied by the unit. The desired quantity of air for the room may not be delivered.

Table 4. Leakage classes at positive pressure of +700 Pa (EN 1886:2007)

It should be noted that the air leakage in the unit is generally much lower than the air leakage in the ducts. Duct leakage classes are standardised in EN 1507 and EN 12237 and summarised for reference in Annex I, Table 11.

Specific Eurovent recommendation

As the minimum casing air leakage class, Eurovent recommends L2 (R)

1.2.3 Filter bypass leakage

As mentioned above, external leakage can influence the grade of contamination in the supply air. Another point is the filter bypass leakage that passes the filter. EN 1886:2007 defines a procedure that includes both. EN 1886:2007 sets maximum filter bypass leakage rates related to the filter class but it still refers to the obsolete EN 779 and not to the EN ISO 16890 classification.

Specific Eurovent recommendation

Eurovent recommends the following maximum filter bypass leakage for EN ISO 16890 rated filters (determined according to the procedure in EN 1886:2007) and for gas-phase filters.

ISO ePM10 50% - 60% and ISO Coarse 30% - 95% 5,0 %

ISO ePM2,5 50% - 60% and ISO ePM10 65% - 95%	**3,0 %**
ISO ePM1 50% - 65% and ISO ePM2,5 65% - 95%	**2,0 %**
ISO ePM1 70% - 75%	**1,0 %**
ISO ePM1 80% - 95%	**0,5 %**
Gas phase (carbon) filter	**0.5 %**

1.2.4 Thermal transmittance

The thermal transmittance class (T) indicates the energy loss of the casing per square metre per 1K difference between the temperature inside and outside the unit. This means that this is a direct energy (heat) loss of the unit.

Thermal transmittance class according to EN 1886	
Classification	Thermal transmittance (U) [W/m²K]
T1	≤ 0,5
T2	0,5 - 1,0
T3	1,0 - 1,4
T4	1,4 – 2,0
T5	> 2

Table 5. Thermal transmittance class according to EN 1886:2007

The impact of the U- value is illustrated in Table 6, which gives the expected heat losses over two winter months for an outdoor unit with an external surface of 20 m² and an average temperature difference of 25K that can typically occur during the two coldest winter months in a cold climate at continuous operation. In practice, the energy losses may vary because a real unit differs from a model box for which the T-value is determined.

U -value [W/m²K]	Heat loss [W]	Energy loss over 2 months [kWh]
0,5 (lower range value for T1)	250	360
1,0 (lower range value for T2)	500	720
1,4 (lower range value for T3)	700	1000
2,0 (lower range value for T4)	1000	1440

Table 6. Heat energy losses throught the casing depending on T value.

Compared to smaller units, larger units must have a better T class. This also applies to units where high temperature differences can be expected over a long period of time.

Specific Eurovent recommendation

The following minimum classes are recommended by Eurovent:

- **T4 (M): units without thermodynamic air treatment**
- **T3 (M): units with cooling or air heating equipment**

1.2.5 Thermal bridging factor

Thermal bridging factor (TB) is a more critical value compared to the above-mentioned T-value, particularly for the suction intake chamber and parts of casing downstream the cooler. The TB value is an indication when condensation can be expected on the outer skin of the unit. It is only an indication because a real unit will differ from a model box from which the TB-value is derived. Although the TB value is meant to determine the temperature on the outer surface of the unit, based on the TB value, the internal temperature and the ambient temperature, the TB value can also be used as an approximate indicator when to expect condensation on the inside of the unit at low ambient temperature.

Thermal bridging class according to EN 1886	
Classification	Thermal bridging factor (k_b)
TB1	0,75 - 1
TB2	0,6 – 0,75
TB3	0,45 – 0,6
TB4	0,3 – 0,45
TB5	< 0,3

Table 7. Thermal bridging class according to EN 1886

Specific Eurovent recommendation

The following minimum TB classes for European climates are recommended by Eurovent:

For outdoor units:

- **TB2 for units in a colder climate (ODA < -7°C in winter)**
  with humidity in ETA > 40%
  or
  with humidity in SUP > 40% (e.g. in case of a humidifier used in winter)
- **TB3 as a minimum requirement**

For indoor units:

- **TB2 for air temperature inside the unit below -7°C and room condition up to 22°C and 40% RH***
- **TB3 for unconditioned room**

*For other climates and conditions, a condensation risk assessment may be needed to determine the required TB value.

1.2.6 Review EN 1886

The European standard EN 1886: 2007 is currently under review. Once the revised standard is adopted, the recommendation will be updated accordingly.

1.3 Access doors and access panels

Doors to components posing a danger must be openable only with a tool and must bear a warning sign showing the danger (for example on fans). If this is not possible, personal injury due to accidental contact with moving parts must be prevented by means of adequate guards.

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Access doors of large (walk-in) units with an internal hight of 1.6m or more must be openable from the inside. Doors on the positive pressure side of the fan must be protected against uncontrolled abrupt opening, posing a risk of injury.

Fan, filter, humidifier, and heat recovery components must be designed in such a way that they are accessible for maintenance and cleaning through doors or access panels from the air inlet side or the outlet side. For small, non-walk-in units, the size of the door must be the size of the unit to ensure effective maintenance.

The dimensions of openings corresponding to level 1 as presented in Table 14 in Appendix A should be considered as the minimum requirements for providing maintenance access and space.

Panels should be removable from the outside. Every door and panel must meet the same requirement as other parts of the casing. Floors must be without grooves, thresholds or indentations so that they can be wipe-cleaned without leaving any residue.

2 Dampers

The primary function of the dampers on an AHU is to shut off the system during its standstill to avoid uncontrolled penetration of the unit interior by ambient air. If the AHU is not fitted with speed-controlled fans, dampers may be used to adjust the airflow by providing an additional pressure loss. However, this way of control is not energy efficient. Dampers are also used to control the recirculation rate and the airflow through the by-pass.

Specific Eurovent recommendation

Eurovent recommendations regarding dampers are as follows:

- **Air leakage class 2 (acc. EN 1751) for dampers that are closed while the system is in operation, (e.g. mixing dampers or bypass dampers)**
- **Air leakage class 3 (acc. EN 1751) for supply air and exhaust air dampers in applications with high hygiene requirements**
- **Air velocity across the damper: max. 8 m/s (except for recirculation and bypass dampers)**
- **Location for outdoor units: inside the casing, unless an external design damper is used**

3 Filters

Filters in the air handling unit have two main functions: to clean the outdoor air supplied to the building and to keep the internal components of the air handling unit clean. Filter in air handling units must be tested in accordance with EN ISO 16890 and they must be marked individually and visibly. The necessary filter stages are related to the outdoor and designed supply air quality.

3.1 Filtration efficiency

The required supply air filter class depends on the hygienic requirements of served rooms (SUP category) and the outdoor air contamination (ODA category). It shall be in accordance with Table 8 derived from the comprehensive Eurovent 4/23 Recommendation on ISO 16890 rated filter selection.

	Supply air

Outdoor air			SUP 1* $PM_{2,5} \leq 1,25$ $PM_{10} \leq 3,75$	SUP 2* $PM_{2,5} \leq 2,5$ $PM_{10} \leq 7,5$	SUP 3** $PM_{2,5} \leq 3,75$ $PM_{10} \leq 11,25$	SUP 4 $PM_{2,5} \leq 5$ $PM_{10} \leq 15$	SUP 5 $PM_{2,5} \leq 7,5$ $PM_{10} \leq 22,5$
Category	$PM_{2,5}$	PM_{10}	ePM_1	ePM_1	$ePM_{2,5}$	ePM_{10}	ePM_{10}
ODA 1	≤ 5	≤ 15	70%	50%	50%	50%	50%
ODA 2	$\leq 7,5$	$\leq 22,5$	90%	70%	70%	80%	50%
ODA 3	$> 7,5$	$> 22,5$	90%	80%	80%	90%	80%

Table 8. Recommended min. ePM_x efficiency depending on ODA and SUP category (annual mean PM_x values in µg/m³)

* For more than one filtration stage, minimum ISO ePM1 50% class applies to the final stage

** For more than one filtration stage, minimum ISO ePM2.5 50% class applies to the final stage

Additional considerations

- **To ensure the cleanness of the unit interior and its components, the class of the first stage filter (on the outdoor air inlet) should be minimum ISO ePM10 50%**
- **If a supply air humidifier is applied in the unit (exception: steam humidifiers), it is recommended to have at least two filter stages, and the humidifier should be fitted between the first and second filter stage. The minimum recommended second stage filter is ISO ePM2,5 60%. It must be noted that the second stage filter should not be placed directly downstream the humidifier and a minimum distance between both components results from the required absorption length, which depends on the humidifier type.**
- **Recirculation air, if applicable, should be filtered with minimum ISO ePM10 50% class**

Specific Eurovent recommendation

If no ODA and SUP categories are specified, it is recommended to use

- **ISO ePM1 50% on the outdoor air inlet (first filtration stage)**
- **ISO ePM1 80% in the supply air (second filtration stage, if applicable)**
- **ISO ePM10 50% on the extract air inlet**

3.2 Design pressure drop

The design filter pressure difference for determining the fan operating point and power input is calculated as:

$\Delta P_{FIL} = 0.5\ (\Delta P_{clean} + \Delta P_{final})$

Following EN 13053:2019, the final pressure difference is determined depending on the filter class as:

For ISO Coarse	the smaller value of either adding 50 Pa to the clean filter pressure difference or three times the pressure difference of clean filters
For ISO ePM1, ISO ePM2,5, ISO ePM10	the smaller value of either adding 100 Pa to the clean filter pressure difference or three times the pressure difference of clean filters

3.3 Arrangement and position

The filters in the air handling unit should be arranged on the supply air side directly at the inlet and outlet of the unit. On the extract air side, it should also be at the inlet of the unit.

The ODA filter should operate under dry conditions (no water particles entering the AHU). To prevent water droplets from wetting the filter, the ODA opening should be equipped with a watertight louvre, and, if needed, with a droplet eliminator in a drain pan fitted upstream the ODA filter. For extreme humid conditions (fog and small droplets in the air), the louvre and droplet eliminator are not sufficient to prevent the filter from becoming wet. In such cases, a heater to dry the air (for instance a water coil without fins) should be installed before the filter.

Filter maintenance should be easy and always from the dusty side of the filter or by pulling the filter out using a filter quick release system. Inspection of filter stages must also be easy by opening maintenance doors or having inspection glasses with lights inside the unit.

The mounting of filters should meet the filter bypass leakage requirements as stated in section 1.2.3.

Air handling units in special applications needs adapted filter arrangements. For example, filtration of extract air from kitchens needs a grease separator, and ventilation system with high hygienic requirements on the supply air side might need a HEPA filter stage. If the HEPA filter has to be placed in the AHU, it should be installed only in special frames because of the lower bypass-leakage allowed. This installation must be validated according to EN ISO 14644-3.

Filter materials and all other material like sealings must not be a nutrient for micro-organisms. Due to hygienic aspects, bag filters should be installed in the air handling unit in such a way, that the bags will not lie on the bottom of the unit.

Filter pressure difference must be monitored and displayed according to Regulation (EU) 1253/2014. Filter difference pressure gauge should work without any barrier fluid.

Filters used in AHUs should preferably have the standard sizes as per EN 15805.

3.4 Energy efficiency of filters

In addition to efficient particle separation, filters play an essential role in energy consumption and have a significant impact on the overall energy efficiency of the AHU. This is because the average pressure difference of filters over their service life accounts for an increasing share of the total pressure drop in air handling units and HVAC systems. A high energy efficiency filter will not reach the final pressure drop recommended in EN 13053 (see 3.2) when it needs to be changed for hygienic reasons (typically after one or two years). Obviously, the lower the final pressure drop of a filter at the moment of its replacement, the lower the energy consumption of the unit.

The comprehensive methodology to evaluate the energy efficiency of air filters is laid down in Eurovent 4/21 recommendation. Based on that methodology, the energy efficiency is classified within the Eurovent certification programme for air filters.

Specific Eurovent recommendation

Minimum filter energy efficiency class: C

4 Heat recovery systems

Bidirectional ventilation should be fitted with heat recovery (HRS) in buildings requiring heating and/or cooling. It is the best way to reduce the energy consumption of a unit in terms of heating or cooling. That is why the implementation of a HRS in a ventilation unit is demanded by many regulations and standards. The most important one is the Ecodesign Regulation (EU) 1253/2014. It has been in force since 2016 and obliges any AHU manufacturer to incorporate a HRS that meets minimum requirements for temperature efficiency and thermal bypass.

In accordance with Regulation (EU) 1253/2104, the minimum temperature efficiency depends on the type of HRS. Rotary and plate heat exchangers must meet a dry temperature efficiency of 73% and run-around coils of 68%. To avoid freezing in wintertime and overheating in summertime, a thermal bypass of the ERS is also required. Without fulfilling these two requirements, the air handling unit cannot be CE marked and placed on the EU market. For rotary heat exchangers, rotor speed control is sufficient to meet the thermal bypass requirement.

Specific Eurovent recommendation

The ERS must meet the minimum requirements of Regulation (EU) 1253/2014

4.1 Types of heat recovery systems

The three main types of heat recovery systems used in air handling units are the following:

Rotary heat exchangers

This type of HRS features a high temperature efficiency (typically up to 85%) and very compact dimensions. In addition, rotary heat exchangers recover moisture (latent energy) which is measured by humidity efficiency. The humidity efficiency and its seasonal average value depends on the rotor design (higher for sorption rotors and lower for condensation rotors). Another advantage of rotary heat exchangers is that they start to freeze at considerably lower temperatures compared to other types of HRS. In case of an adverse configuration of AHU fans and incorrect set up during the commissioning of the unit, rotary heat exchangers are prone to air leakage between the extract and supply sides (EATR and OACF). With the correct configuration of fans and other appropriate measures, leakages are minimised (see also section 4.4). However, compared to other types of HRS, rotary heat exchangers feature higher air leakage and are not recommended for use in systems with very high hygienic requirements where any air recirculation is not allowed.

Plate heat exchanges

This type of HRS requires no additional electricity consumption because it has no drive elements. For small air handling units, counterflow plate heat exchangers are typically used, which can achieve very high temperature efficiency (usually up to 85%). As counterflow PHEs are only available up to a certain size, for larger units it is common to use plate cross flow exchangers, which achieve a lower efficiency. The efficiency can be significantly increased by combining two cross flow heat exchangers in series. The drawback of high efficiency plate heat exchangers is frosting, which occurs at higher outdoor temperatures compared to rotary heat exchangers. In case of so called enthalpic exchangers with moisture permeable plates (typically counterflow), humidity is also recovered. The freezing temperature of enthalpic exchanger is lower compared to exchangers without moisture recovery. The high pressure difference between air sides can cause deformation of the plates and lead to added pressure drop. The air leakage of plate exchangers is lower compared to rotary heat exchangers. In case of high-quality PHEs it can be as low as 0.1% of the nominal air volume flow (at 250 Pa pressure difference). However, a high pressure difference can lead to increased leakage in PHEs. It should also be noted that a defective sealing around the plate heat exchanger can affect the internal leakage more than the leakage of the exchanger itself.

Run-around coils

If supply and exhaust coils are built into two separate units, there is no risk for of air leakage and contamination. Temperature efficiency is lower compared to other type of exchangers (up to 70%). The electricity consumption of the waterside pump decreases the overall HRS efficiency. Typical applications are systems with very high hygienic requirements (unacceptable leakage between supply and extract air) or remote location of supply and extract air unit.

Other HRS types

There are other types of heat recovery systems, such as heat pipes and alternate mass accumulation systems. These are less commonly used on the market but must also meet a temperature efficiency of 73%.

4.2 Frost protection

Heat recovery systems, especially those without moisture recovery capability, are subject to freezing at low outdoor temperatures. Freezing leads to the reduction of energy recovered from the extract air but also to a decrease in airflow and its misbalancing. In the worst case, physical damage to the exchanger may occur. The main tasks of the frost protection system are to identify the onset of freezing, protect the heat exchanger from freezing and minimise use of energy for defrosting.

For effective frost protection control:

- The rotary heat exchanger must have a variable speed drive
- The plate heat exchanger must have coupled modulating dampers at the exchanger and bypass inlets

More comprehensive information on appropriate frost protection strategies and measures is provided in Eurovent 6/17.

4.3 Moisture recovery

Rotary heat exchangers with sorption wheel and enthalpic plate heat exchangers with permeable membrane provide moisture recovery in addition to sensible heat recovery. These types of exchangers are highly recommended for applications with indoor humidity control, i.e. for AHUs fitted with dehumidification cooling coil or/and humidifier, since moisture recovery can significantly reduce seasonal energy consumption for dehumidification and humidification of supply air. The cost and environmental effectiveness of moisture recovery should be determined on a case-by-case basis by means of an LCC / LCA analysis.

4.4 Internal leakages on ERS

Heat recovery systems with the potential to transfer pollutants and/or odours from the extract air to the supply air are not permitted in applications where any air recirculation is not allowed. Potential leakage through the HRS can be limited or eliminated by appropriate measures. The main one is the correct positioning of fans. Comprehensive information about the correct AHU design to limit internal leakages can be found in Eurovent 6/15 recommendation.

The following indicators defined in EN 308 and EN 16798-3 can quantify the amount and the direction of internal leakages inside the unit in the ERS section:

- Exhaust Air Transfer Ration (EATR): percentage of exhaust air transfer into the supply air side, mainly due to carryover.
- Outdoor Air Correction Factor (OACF): ratio of the entering outdoor mass airflow rate and the leaving supply mass airflow rate and which provides information about the leakages between the air flows.

OACF is classified in EN 16798-3 as follows:

	OACF	
Class	Leakage from ODA to EHA	Leakage from ETA to SUP
1	1,03	0,97
2	1,05	0,95
3	1,07	0,93
4	1,10	0,90
5	Not classified	

Table 9. OACF classification acc. EN 16798-3:2019

4.4.1 Limits on EATR and OACF, compensation of air flow

Internal leakages described by EATR and OACF values, deteriorate the quality of supply air and/or reduce the energy efficiency of the ventilation system. For some types of heat recovery systems, in particular rotary heat exchangers and periodic heat recovery systems, it may not be possible to eliminate internal leakages completely. In such cases, it is necessary to compensate air flow in order to maintain correct IAQ and to balance the supply and the extract air in the building.
EATR results in the amount of outdoor air effectively supplied to the building being lower than the design value. To counteract the problem, the following guidelines from Eurovent 6/15 apply:

For **EATR < 1%** at design conditions, no additional compensation action is required

For **1% ≤ EATR ≤ 5%** at design conditions, nominal supply flow rate shall be increased with the EATR percentage ($SUP_{corr} = SUP \cdot (1 + EATR)$) to compensate for the exhaust air leakage at design conditions and ensure the required supply flow rate (required design outdoor flow rate) to be delivered. Nominal extract air flow rate shall be increased with the EATR percentage ($ETA_{corr} = ETA \cdot (1 + EATR)$) to maintain the pressure balance in the building. This compensation is possible only if the extract air fulfils the category ETA1 (acc. EN 16798-3:2017). In case of worse quality of extract air, EATR < 1% is mandatory.

EATR > 5% is not acceptable at all. Even if the extract air quality were good, the compensation would be so high that it would affect the designed ductwork and all elements.

Whereas, mainly due to energy reasons, **OACF** must be within the range of 0.90 to 1.1 (OACF class 4 of EN 16798-3:2017).

The OACF and EATR have a direct impact on the energy consumption of the fans and their effect should be included in the power consumption calculation. A guideline on how to calculate the performance of an air handling unit with consideration of leakages can be found in Appendix I to Recommendation Eurovent 6/15.

Specific Eurovent recommendation

At design operating conditions:

- **OACF within the range of 0.95 to 1.1 (OACF class 4 of EN 16798-3:2017)**
- **EATR ≤ 5%**
- **For 1% ≤ EATR ≤ 5%, nominal supply flow rate shall be compensated as per Eurovent 6/15**

4.4.2 Limiting internal leakage

Internal leakage is more common in rotary heat exchangers than in other HRS. It can be minimised by the following measures:

- Correct position of supply and exhaust fans (in principle both fans downstream the exchanger)
- Limiting pressure difference between supply and exhaust air side across the exchanger by means of pressure balancing devises (dampers, pressure taps)
- Correct location and setting of purge sector

Detailed guidelines on these measures are provided in recommendations Eurovent 17/11 and Eurovent 6/15.

4.5 Maintainability and hygienic issues

For hygienic and maintainability reasons, the following features should be provided:

Rotary heat exchangers:

- Cleaning function during exchanger downtime (periodic change of the wheel position when the exchanger is not operated for a longer period).

Plate heat exchangers:

- Plate heat exchangers with perpendicular distance between air inlet and outlet planes exceeding 1200 mm should have a plate spacing of more than 3,0 mm (including material thickness) that enables cleaning. Alternatively, the use of blocks is recommended as it means installed in segments'.

4.6 Additional considerations on HRS section design

4.6.1 Drain pan arrangement

Meeting high requirements on temperature efficiency has an impact on the extract air. The humid and warm air from the building passing through the HRS is cooled and can reach the saturation curve, where condensation occurs. For that reason, it is necessary to place a drain pan under the plate exchanger and run-around coil on the exhaust air side to evacuate the condensate. The drain pan may also be needed for rotary heat exchangers in extremely humid conditions. The drain pan should not be part of the bottom panel unless it has the same quality and insulation as the rest of the casing. The pan should be sloped towards the condensate outlet and allow complete drainage. In applications with extremely high exhaust air humidity, excess condensed moisture can pass through the exchanger to the supply air side. In such cases, placing a drain pan under the HRS also on the supply air side should be considered. For cold climate in winter, this condensate can freeze on its cold side. The use of a thermal bypass is therefore necessary.

4.6.2 Rotary heat exchanger diameter and AHU casing cross section

Where the rotor diameter is larger than the cross section of the unit, and there is no sufficient space upstream and downstream to allow a uniform airflow over the exchanger, so that a section of the rotor face area is blocked, it is necessary to compensate the performance data provided by the manufacturer of the rotor. This means that the temperature efficiency will be lower, and the pressure drop will be higher than the standard data for the actual diameter. To find the compensation factors, testing will be necessary. The same may apply, when the position of air inlets and outlets, or/and internal obstacles disturb the uniform airflow through the rotor.

5 Coils

5.1 Surfaces and materials

For most general ventilation and air conditioning applications in non-corrosive environments, the following coil materials are sufficient:

Heating coils:

- Fins: Aluminium
- Tubes: Copper
- Headers: Coated black steel, galvanised steel or copper
- Housing: Galvanised steel

Cooling coils:

- Fins: Aluminium or pre-coated aluminium
- Tubes: Copper
- Headers: Copper
- Housing: Galvanised steel

For industrial applications and for corrosive environments other materials may need to be used depending on the specific process requirements and corrosivity category. Guidance on materials to be used for elements of heating and cooling coils operating in corrosive environments are given in Eurovent 6/16 Recommendation.

5.2 Arrangement and position

Heating and cooling coils:

- It is necessary to seal cooling coils with gaskets to the unit casing to prevent bypass leakage and avoid condensation downstream. Sealing of heating coils is not essential, as long as the temperature sensor for the control measures the true mixed condition.
- Coils must be accessible from at least one side (air inlet or air outlet).

Cooling coils:

- Cooling coils must be fitted with a corrosion-resistant drip pan e.g. min. AISI 316 (stainless steel 1.4301) or a corrosion-resistant aluminium alloy (minimum AlMg), which has a gradient towards the drain to permit unhindered drainage of the condensate.
- The drip pan should not be part of the bottom panel, unless it has the same quality and insulation as the rest of the casing.
- A direct connection of the drainage outlet to the wastewater system is not permitted.
- The drainage outlet must be fitted with a self-filling water trap with non-return valve.
- No moisture can carry over to the components or sections downstream of the coil.
- Droplet eliminators are recommended if the air velocity over the coil is above 2.5 m/s. They shall be designed in a way that they are easy to remove and dismantle without affecting any of the other unit components.
- The connecting pipes shall be insulated where they pass through the casing, so that there will be no condensate from them.
- For hygiene reasons, cooling coils with dehumidification shall not be arranged immediately upstream of air filters or silencers. Fans or heaters shall be installed in between to limit the relative humidity.

Heating coils:

- In cold climate, where the temperature can be close to zero or sub-zero, water heating coils must be protected against freezing (for instance on the air side with a thermostat and a capillary downstream the coil, or on the water side by a temperature sensor inserted in the lowest pipe of the coil). A control function must shut down the unit if a risk of freezing is detected in order to prevent more sub-zero air reaching the coil and allowing the heating liquid to warm the coil up.

5.3 Hygienic and energy considerations

Insufficient distance between the fins of the coil can result in its frequent fouling with dust particles and hinder its cleaning. A small fin spacing also means a higher pressure drop and consequently increased energy consumption. The same goes to a high pressure drop on water side. It is therefore recommended to observe the following limits.

The distance between the fins of the coils:

- Cooling coils that can dehumidify: 2,5 mm
- Cooling coils that do not dehumidify: 2,0 mm
- Heating coils: 1,8 mm

Pressure drop on the water side (not applicable to run around coils):

- Cooling coils: 40 kPa
- Heating coils: 18 kPa

5.4 Additional considerations

- Connection pipes of water coils should be equipped with draining and vent taps
- If a water heating coil is protected against freezing by a thermostat and a capillary downstream the coil, there must be free access to the capillary.
- For the multi-stage DX cooling coil, the tubes of its circuits should be interlaced.

6 Electric air heaters

Electric heaters can be used in AHUs, just as hot water heaters, for heating up the air. This can be the air after the heat recovery, to reach the required supply air temperature as well as preheater upstream the ODA filter or heat recovery system to prevent freezing of these components. Electrical heaters used to be considered suitable for small AHUs (low capacities) to make an all-electrical AHU, which simplifies installation on site. The inferior primary energy factor for electricity compared to natural gas made electric heaters a rare option for large AHUs. In view of the green energy transformation and phasing out of fossil fuels, with electricity increasingly generated by renewable sources, this approach may be revisited.

When using an electrical heater, the following must be taken into account:

- The heater must be equipped with two temperature safety thermostats.
- Auto reset: for the 'low' air temperature cut off. This to protect the AHU and its components.
- Manual reset: for 'high' air temperature cut off. To protect the electrical heater and the wiring.
- The controls of the unit must be equipped with an air flow control. The electrical heater can only be switched on when air is flowing through the unit.
- Step control: each stage is either switched completely on or completely off, depending on the required heating capacity. As a consequence, the heating capacity is always a bit higher or lower than the required capacity, so the supply air temperature is always deviating from the required set point temperature.
- Modulating control: each stage will receive a modulating signal depending on the required heating capacity. With modulating control, the required supply air temperature is achieved. It is preferred over the step control.
- The controls of the unit must ensure that when the electrical heater is stopped the fan should continue running for a sufficient period of time to cool the heater.

In general, the electrical heater has its own power supply from the mains, because of the high electrical load. It goes without saying that this power supply must be foreseen with its own maintenance isolator and protected with the right fuses, depending on the power of the individual steps in the electrical heater.

6.1 Arrangement and position

If the heater is designed in such a way that flammable material such as dust or fluff could accumulate in the heater then the heater needs to be protected by a filter upstream. The surface of some electric heaters can reach very high temperatures. For these heaters it is necessary to ensure that adjacent components are not put at any risk of catching fire.

Specific Eurovent recommendation

For energy efficiency reasons, electric heaters > 2 kW should have modulated output control

7 Sound attenuators

7.1 Surfaces and materials

Surface material must be permanently abrasion-resistant, resistant to the cleaning processes (e.g. glass fibre) and non-moisture absorbent.

7.2 Arrangement and position

Attenuators should preferably be located in the air handling unit, directly near the fan, and between the first and second filter stage. They must not be placed directly downstream of a dehumidification cooler where there is a risk of droplet entrainment and downstream of a steam humidifier or 'atomising' type humidifier. In environments with polluted outdoor air, the silencer should be placed downstream of the filter.

Specific Eurovent recommendation

Splitters must be demountable for cleaning

8 Humidifiers

Humidifiers shall not be placed directly upstream of filters or attenuators. All components must be demountable. All parts in contact with water must be accessible for inspection and cleaning and consisting of corrosion-resistant and disinfectant-resistant material. Only humidifier water containing bacteria in a concentration that is not detrimental to health is used for air handling purposes. Other general and specific construction requirements laid down in EN 13053 must be observed.

9 Fans

Fans force air flow in HVAC systems. Of all the other components, usually fans are responsible for the main electricity consumption and noise generation. For this reason, the proper selection of fans is crucial to optimise these parameters while supplying the necessary air flow.

Centrifugal (radial) fans are typically used in air handling units. Their types can be classified by:

- Blades (forward curved, backward inclined, backward curved or airfoil)
- Housings (housed fans or plenum fans)
- Transmission type (belt-driven, direct-driven)
- Construction (single fan, multiple-fan arrays)

Direct driven fans eliminate transmission losses. Free running plug fans provide a compact design of the unit (short distance to upstream and downstream components) and good hygienic properties (easy access for impeller cleaning).

To ensure high system efficiency, the speed of fans must be controlled according to the demand. Using speed control only to set the nominal airflow during commissioning is not sufficient to achieve significant energy savings.

Specific requirements for fans in air handling unis regarding the efficiency and speed control are defined in Regulation (EU) 1253/2014. The Regulation lays down limits for the maximum SFP_{int} value for fans in BVUs and UVUs, and a minimum efficiency for fans in UVUs. The Regulation also requires that all ventilation units, except the dual use units, shall be equipped with a multi-speed drive or variable speed drive fans. Ventilation units which do not meet the requirements cannot be placed and put into service on the EU Market.

An overview of SPF_{int} and minimum efficiency requirements for fans installed in NRVUs in accordance with Regulation (EU) 1253/21014 is presented in in Annex I, Table 12.

In turn, the ecodesign requirements for motors which drive fans in air handling units are laid down in Regulation (EU) 2019/1781. The regulation specifies the minimum energy efficiency class (IE) of a motor depending on its rated output and number of poles. The regulation also specifies the minimum energy requirements for variable speed drives.

An overview of ecodesign requirements for electric motors and variable speed drives in accordance with Regulation (EU) 2019/1781 is presented in Annex I, Table 13..

Specific Eurovent recommendation

Recommended fan and drive type for use in air handling units:

- **Direct driven, free running, backward curved or airfoil fan**
- **AC IE4, EC and PM variable speed motors**
- **Speed of fans needs to be controlled according to the demand**

9.1 Surfaces and materials

Fan impeller and all fan support structures (such as base-frame, installation rails, etc.) should be protected against corrosion. Gliding surfaces of the pull-out rails must be corrosion-resistant and abrasion-resistant, e.g. stainless steel.

9.2 Arrangement and position

The arrangement of the fan in the air handling unit casing shall ensure an even inflow and outflow of air.

Fans should be positioned in a way to minimize leakage over the heat recovery components. Refer to the Recommendation Eurovent 6/15 for more information about the correct AHU design to limit internal leakages.

There must be good access for service and maintenance.

Depending on how the fan is built into the unit, some system effects have to be taken into account (e.g. distance between impeller and walls, distance between upstream and downstream components and fan). This effect will give additional pressure loss on the fan curve.

9.3 Installation and Accessories

Fans shall be balanced at least with grade G6.3 in accordance with ISO 21940-11:2016. It is better to balance the impeller inclusive the motor as one combination. A better balancing grade will lead to low residual vibrations in the unit. If the residual vibrations are considered too high with respect to ISO 14694, isolation elements such as springs should be provided to minimise this effect.

For AHUs without an integrated control system, a lockable maintenance switch should be installed near the fan.

Equipotential bonding should be maintained in design or installation.

Components at risk, e.g. fans on spring isolators, shall be protected by safety devices during transportation. A label should be attached to the unit stating that such devices shall be removed upon installation.

10 Energy efficiency

The overall energy efficiency of the air handling unit depends on many factors, which in turn are related to the specific application and climate. In general, these factors can be grouped as follows:

Electricity consumption

The fans consume the vast majority of the electricity in an AHU. The power consumption is determined by the airflow, total pressure and overall efficiency of the fan including motor and drive. Modern fans are generally highly efficient and the key to reducing power consumption for a given airflow is the reduction of pressure. A simple and comprehensive indicator of the air transportation efficiency in a ventilation system is the total specific fan power (SFP), which is a ratio of electric power input needed to transport 1 m^3/s of air, typically expressed in $W/(m^3/s)$. Usually, it is determined for validation (v) conditions, meaning the pressure drop for clean filters and dry operation. SFP takes into consideration the pressure drop of all internal AHU components and the external pressure drop in the ductwork. Since the ductwork pressure drop is out of the AHU supplier's control, SFP_V cannot be used to evaluate solely the efficiency of the AHU, but of the entire system. However, assuming proper design of the ductwork, SFP_V can be considered as a measure of the AHU energy efficiency quality. Another indicator, that allows evaluation of the air handling unit regardless of the ductwork pressure drop, is the internal specific fan power (SFP_{int}). In contrast to SPF_V, it considers only the electric power input related to the internal pressure of all ventilation components of the AHU, which include filters, HRS and related casing. For units placed on the EU market, SPF_{int} must meet requirement of Regulation (EU) 1253/2014.

Optimal control of AHU operation

Understood as an appropriate adjustment of capacity to the current demand. For this assessment, classes of the AHU control system functionality defined in EN 15232 or EN 16798-3 apply. More comprehensive information can be found in Eurovent 6/17.

Recovery of thermal energy and moisture

Temperature efficiency (η_t) and moisture efficiency(η_x) and the efficiency class (H) of heat recovery components according to EN 13053.

Effective and leak-free air delivery (minimised air leakage)

Air leakages, in addition to the deterioration of indoor air quality (IAQ), result in increased energy consumption for transport and handling of air which does not serve ventilation purposes. Apart from the casing airtightness addressed in paragraph 1.2.2, internal air leakage may be relevant. It is characterised by the EATR and OACF indicators defined in EN 308:2022. Comprehensive information on these indicators, as well as methods to limit internal leakages can be found in the Eurovent 6/15.

Energy efficiency of air filters

Pressure drop of the filter increases over its service life due to clogging by dust. Thus, the actual energy consumption related to the filter depends on the average value of the clean filter and final (at filter exchange) pressure drop. The average pressure drop is a measure of filter energy efficiency, which is defined in Eurovent 4/21 and implemented in the ECC Certification Program 'Air Filters'.

Eurovent Energy Efficiency Class

To provide for a consistent and harmonised assessment of the overall energy efficiency of AHUs, Eurovent Certita Certification has developed a comprehensive indicator that takes into consideration most of the above factors. The Eurovent Energy Efficiency Class is used for rating products covered under the ECC AHU certification programme.

Specific Eurovent recommendation

The following general minimum requirements regarding energy efficiency are recommended:

- **SPF_{int} < SPF_{int_limit} according to Regulation (EU) 1253/2014**
- **SFPv within the range of 1300 and 1800 W/(m^3/s)**
- **Control system covering a function level 3 or higher according to EN 15232 or IDA-C5 /C6 according EN 16798-3 (either installed by AHU manufacturer or on site)**
- **Temperature efficiency η_t according to Regulation (EU) 1253/2014**
- **Efficiency class of the HRS: H2 (acc. EN 13053)**
- **EATR < 5% (where applicable)**
- **OACF with the range of 0.95 and 1.05 (where applicable)**
- **AHU technical data (including SPF_{int}) shall be reported including the impact of leakages (EATR, OACF) according to Eurovent 6/15**
- **Energy efficiency of ePM1 / ePM2,5 / ePM10 filters: Class C**
- **Minimum Eurovent Energy Efficiency Class: B***

* The Energy Efficiency Class recommendation is valid for units that operate in European outdoor air conditions and in most applications (offices, hospitals, schools, shopping malls etc.). For special applications (specific industrial applications, humid and warm climates, etc.) lower classes might lead to a better overall efficiency. It is recommended to use exact life cycle cost (LCC) tools to verify the most efficient solution for each specific application.

11 Control systems

The primary role of the control system is to manage all functions of the AHU and other components of the ventilation system to provide optimal Indoor Environmental Quality (IEQ). From a ventilation and air conditioning perspective, the main indicators of IEQ include indoor temperature, indoor humidity and Indoor Air Quality (IAQ).

An important task is to ensure good IEQ at the lowest energy consumption. In general, it means proper adjustment of system components to the actual demand, considering their interoperability. Specifically, it involves accurate control of temperature, humidity and airflow – Demand Controlled Ventilation (DCV) in individual zones of the building, as well as stepless and optimised control of the components' output. More broadly, it also means effective communication with the power grid to optimise energy consumption on a wider scale.

Another significant feature of the control system is energy monitoring and logging, to enable analysis and adjustment of energy usage.

Finally, the control system must ensure safe operation and use of the equipment, as well as cyber security of the IT network. The latter involves compliance of the controllers with IT security protocols in accordance with relevant ISO and EU standards.

For more comprehensive recommendations on AHU control systems please refer to Eurovent 6/17

11.1 Factory-supplied AHU control system

To provide the most effective and energy-efficient control of the AHU operation, thorough expertise on AHU characteristics and other system elements is essential. HVAC equipment manufacturers are most knowledgeable in this regard. For this reason, using a factory-fitted smart control system for the AHU is the best option in most cases. Thus, the share of units delivered with integrated or co-supplied controls is constantly rising. Eurovent Market Intelligence statistics reflect this trend well. While in 2014 this share was approximately at 40%, in 2020 it reached already around 70%. In addition to most optimised operation, integrated and co-supplied systems can considerably facilitate commissioning, service and maintenance.

Specific Eurovent recommendation

The following general minimum requirements regarding control system are recommended:

- **Communication with Building Management System (BMS) via analogue and/or digital signals**
- **Management of ventilation air volume through DCV depending on IAQ determined by at least one sensor (function level 3 or higher according to EN 15232 or IDA-C5 /C6 according EN 16798-3)**
- **Variable fan speed control**
- **Air filter pressure drop monitoring**
- **Continuous control of heat recovery efficiency depending on the currently demanded supply air temperature**
- **Monitoring of core performance parameter and statuses, including:**
    - **Malfunction of fans and heat recovery systems**
    - **Current temperatures, airflows and power consumption**

12 Documentation, storage and transportation

12.1 What should the manufacturer do before the unit delivery?

- Assemble the whole unit or the spare parts (flat pack delivery is not recommended)
- Clean the unit and its component
- Secure the moving types of the unit
- Check the production quality
- Protect the unit and its component against dust, dampness and weather conditions

12.2 What should the manufacturer deliver with the unit?

- Technical data sheets and drawings (as described in the OM AHU)
- Spare parts list
- Instructions for installation, commissioning and maintenance
- CE conformity declaration for the concerned directive
- CE mark for units which are defined as machinery (and not partly completed machinery)
- Warnings and name plate on the unit

12.3 What are the Directives the manufacturer must comply with at the time of delivery?

- Machinery Directive (MD)
- Ecodesign Directive (ErP)
- Electromagnetic Compatibility Directive (EMC)
- Low Voltage Directive (LVD)
- Pressure Equipment Directive (PED), if applicable

The location (within the EU), configuration and application do not affect the requirement to comply with MD, LVD, ErP, EMC. If the configuration does not include a pressure vessel then there is no need to include PED but that should be the only exception. It is up to the manufacturer to identify which directives apply. The conformity for each directive is listed on the EU declaration of conformity. Outside of the EU there are other laws and regulations to comply with.

12.4 What should the customer do before assembling?

- Check the technical data sheet and the unit drawings
- Check the instructions for installation, commissioning and maintenance
- Check the CE conformity declaration
- Check the warnings on the unit
- Check the fixing point for lifting devices

- If the unit is stored on site before assembling, it should remain dry and clean
- Check if the floor or support construction on which the unit will be mounted is in one horizontal plane

12.5 Required content of installation, operation and maintenance instructions

- Area of application
- Accessories
- Taking unit out of service during maintenance/servicing.
- Storage, transport and installation:
- Storing units and components
- Building site transport of units and components
- Fixing points for lifting devices (illustrated by drawing)
- Transport guarding devices
- Installation of units indoors and outdoors
- Foundations
- Impact sound isolation
- Air connections
- Water connections
- Wastewater connections (condensate, wastewater, overflow,
- Siphon/condensate tray
- Media connections (hot water, cold water, refrigerant, steam)
- Filters
- Space requirement for operation and maintenance
- Commissioning and maintenance/servicing
- Maintenance (type and frequency) for each component in the form of a table
- Inspections (type and frequency) for each component in the form of a table
- Repair operations
- Cleaning agents, disinfectants
- Address of manufacturer

13 Summary of key Eurovent specific recommendations

Casing

- **Flammability class A1 or A2 – s1 d0 according to EN 13501-1 for the insulation material in AHUs. However, it is up to each manufacturer to ensure that the unit complies with national requirements.**
- **Units for indoor and outdoor installation: Corrosivity category C3**
- **Units operating in corrosive atmosphere: Corrosivity category C4**
- **Minimum mechanical strength class D2 (R)**
- **Minimum casing air leakage class L2 (R)**
- **Min. thermal transmittance T4 (M) for units without thermodynamic air treatment**
- **Min. thermal transmittance T3 (M) for units with cooling or air heating components**
- **Thermal bridging class for outdoor units**
  - **TB2 for units in a colder climate (ODA < -7°C in winter)**
    with humidity in ETA > 40%
    or
    with humidity in SUP > 40% (e.g., in case of a humidifier used in winter)
  - **TB3 as a minimum requirement**
- **Thermal bridging class for indoor units**
  - **TB2 for air temperature inside the unit below -7°C and room condition up to 22°C and 40% RH**
  - **TB3 for unconditioned room**

Dampers

- **Air leakage class 2 (acc. EN 1751) for dampers that are closed while the system is in operation**
- **Air leakage class 3 (acc. EN 1751) for supply air and exhaust air dampers in applications with high hygiene requirements**
- **Air velocity across the damper: max. 8 m/s (except for recirculation and bypass dampers)**
- **Location in outdoor units: always inside the casing, unless an external design damper is used**

Filters

- **ISO ePM1 50% filter on the outdoor air inlet (first filtration stage)**
- **ISO ePM1 80% filter in the supply air (second filtration stage, if applicable)**
- **ISO ePM10 50% filter on the extract air inlet**
- **Minimum Eurovent filter energy efficiency class: C**

Heat recovery systems

- The HRS must meet the minimum requirements of Regulation (EU) 1253/2014
- OACF within the range of 0.90 to 1.1 (OACF class 4 of EN 16798-3:2017)
- EATR $\leq$ 5%

Electric air heaters

- Electric heaters > 2 kW should have modulated output control

Sound attenuators

- Splitters must be demountable for cleaning

Fans and drives

- Fan type: direct driven, free running, backward curved or airfoil fan
- AC IE4, EC and PM variable speed motors
- Speed of fans needs to be controlled according to the demand

Energy efficiency

- $SPF_{int} < SPF_{int\_limit}$ according to Regulation (EU) 1253/2014
- SFP_v within the range of 1300 and 1800 $W/(m^3/s)$
- Control system covering a function level 3 or higher according to EN 15232 or IDA-C5 /C6 according EN 16798-3 (either installed by AHU manufacturer or on site)
- Temperature efficiency η_t according to Regulation (EU) 1253/2014
- Efficiency class of the HRS: H2 (EN 13053)
- EATR < 5% (where applicable)
- OACF with the range of 0.95 and 1.05 (where applicable)
- AHU technical data (including SPF_{int}) shall be reported including the impact of leakages (EATR, OACF) according to Eurovent 6/15
- Eurovent energy efficiency of ePM1 / ePM2,5 / ePM10 filters class: minimum C
- Eurovent AHU Energy Efficiency Class: minimum B

Control system

- Communication with Building Management System (BMS) via analogue and/or digital signals
- Management of ventilation air volume through DCV depending on IAQ determined by at least one sensor

- **Variable fan speed control**
- **Continuous control of heat recovery efficiency depending on the currently demanded supply air temperature**
- **Monitoring of core performance parameter and statuses, including:**
  - **Malfunction of fans and heat recovery systems**
  - **Current temperatures, airflows and power consumption**

Annex I

Classification according to EN 13501-1

Classification according to EN 13501-1			
Material property	**Reaction to fire**	**Smoke production**	**flaming droplets**
Non-flammable	A1	-	-
	A2	s1	d0
Hardly flammable	B	s1	d0
	C	s1	d0
	A2	s2 s3	d0
	B	s2 s3	d0
	C	s2 s3	d0
	A2	s1	d1
	A2	s1	d2
	B	s1	d1
	B	s1	d2
	C	s1	d1 d2
	A2	s3	d2
	B	s3	d2
	C	s3	d2
Normal flammable	D	s1 s2 s3	d0
	E	-	-
	D	s1 s2 s3	d1
	D	s1 s2	d2

		s3	
	E	-	d2
Highly flammable	F	-	-

Table 10. Classification of reaction to fire according to EN 13051-1:2018

Duct leakage classification according to EN 1507 and EN 12237

Classification according to EN 1507 and EN 12237		
Classification	Max. leakage rate [l.s-1.m-2]	Max. test pressure [Pa]
A	$0{,}027 \cdot P_s^{0{,}65} \cdot 10^{-3}$	500
B	$0{,}009 \cdot P_s^{0{,}65} \cdot 10^{-3}$	1000
C	$0{,}003 \cdot P_s^{0{,}65} \cdot 10^{-3}$	1000
D	$0{,}001 \cdot P_s^{0{,}65} \cdot 10^{-3}$	2000

Table 11. Classification of air leakage in ventilation ducts

Requirements for SPF_{int} and fan efficiency according to Regulation (EU) 1253/2014

NRVU Requirements	UVU	BVU
Fan Efficiency - η_{vu} P≤30 kW P>30 kW	>42%+ 6,2% ln(P) >63,1%	
Specific Fan Power (SFP)	SFP int < 230 W/(m3/s)	
Specific Fan Power (SFP) $q_{nom} < 2$ m³/s Round-around HRS $q_{nom} \geq 2$ m³/s		1.600+E−300* q_{nom}/2−F 1.300+E−F
Specific Fan Power (SFP) $q_{nom} < 2$ m³/s Other HRS $q_{nom} \geq 2$ m³/s		1.100+E−300* q_{nom}/2−F 800+E−F

Table 12. Ecodesign energy requirements for fans in NRVUs according to Regulation (EU) 1253/2104

Ecodesign requirements according to Regulation (EU) 2019/1781

Year of Enforcement	Minimum Efficiency Performance			
	Motors [1], [2]		VSD	
	Eff. class	Power range	Eff. class	Power range
2021	IE2	3~ 0.12-0.75 kW	IE2	0,12-1000 kW
	IE3	3~ 0.75-1000 kW		
2023	IE2	1~ ≥0.12 kW	IE2	0,12-1000 kW
	IE3	3~ 0.75-75 + 200-1000 kW		
	IE4	3~ 75-200 kW		

[1] For 3-phase motors, 2/4/6 poles and from 2021 also 8 poles. MEPS for 1-phase motors and increased safety 3~ Ex eb motors is IE2 from 2023. IE4 applies for 2,4 and 6 pole motors only.

[2] Motor part load losses for VSD operation must be provided starting 2022-07-01.

Table 13. Ecodesign energy requirements for electric motors according to Regulation (EU) 2019/1781

Dimensions of access doors and access panels

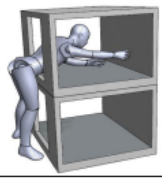
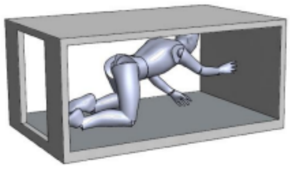
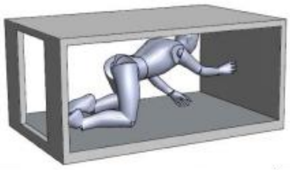
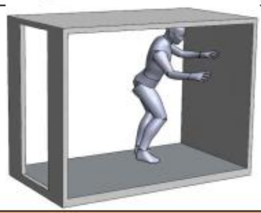
AHU SECTION SIZE (+- 1%)		ALL LEVELS		LEVEL 1	LEVEL 2	LEVEL 3
Internal unit depth (= IMC-D) per air stream	**Internal unit height (=IMC-H) per air stream**	**Designed type of IMC** (after entering the unit, all relevant inner surfaces shall be reached with the hand)		**Minimum IMC length IMC-L** (For quickly removable components: including free space when component is removed)		
< 800mm	> 300 mm and <1900 mm	Standing outside and **entering the unit with the arm or with arm plus the shoulder**		250 mm	400 mm	550 mm
≤1000mm	>400 mm and < 1900 mm			400 mm	400 mm	550 mm
<1300mm	>550 mm and ≤1300 mm	Standing outside and **entering the unit with the upper part of the body.**		400 mm	400 mm	700 mm
Any	>600 mm and <=800 mm	Entering the unit partially or with the full body by **crawling and working in lying position.**		500 mm	500 mm	700 mm
Any	>800 mm and <=1600 mm	Entering the unit by **crawling on the knees and working in sitting, kneeling or squatting position.**		500 mm	500 mm	700 mm
Any	>1600	Entering the unit **by access on the feet and working in standing or at least bended position.**		400 mm	500 mm	550 mm

Table 14. Levels of access and space defined in the Eurovent Certified Performance (EPC) programme for Hygienic Air Handling Units (Appendix H of ECP-05 AHU for HAHU)

About Eurovent

Eurovent is Europe's Industry Association for Indoor Climate (HVAC), Process Cooling, and Food Cold Chain Technologies. Its members from throughout Europe represent more than 1.000 organisations, the majority small and medium-sized manufacturers. Based on objective and verifiable data, these account for a combined annual turnover of more than 30bn EUR, employing around 150.000 people within the association's geographic area. This makes Eurovent one of the largest cross-regional industry committees of its kind. The organisation's activities are based on highly valued democratic decision-making principles, ensuring a level playing field for the entire industry independent from organisation sizes or membership fees.

Our Member Associations

Our Member Associations are major national sector associations from Europe that represent manufacturers in the area of Indoor Climate (HVAC), Process Cooling, Food Cold Chain, and Industrial Ventilation technologies.

The more than 1.000 manufacturers within our network (Eurovent 'Affiliated Manufacturers' and 'Corresponding Members') are represented in Eurovent activities in a democratic and transparent manner.

→ For in-depth information and a list of all our members, visit www.eurovent.eu

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