Hygienic Air Handling Unit Certification Program: the new necessity for a guaranteed indoor air quality

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ABSTRACT

Nowadays, people spend most of their time indoors. Homes, offices, leisure and workplaces must meet people's needs and provide safe, healthy and productive environments. The supply of fresh air plays an important role in achieving these goals. Not only by providing the right temperature and humidity but even more with the purity of the air inside the rooms. A recent study of the World Health Organization showed a significant correlation between yesterday's particulate matters concentration in outdoor air and today's death rate counting 7 million deaths in 2022 caused by air pollution. In recent years, the Ecodesing regulation of the European Union has helped to solve the dilemma between reducing energy consumption and creating a healthy indoor environment by adding highly efficient energy recovery components. However, the variation between the real and the declared performances of air handling units shows a substantial difference between what is expected and the real quality of the air in the market. Eurovent Certita Certification is a third-party certification company that do market surveillance for HVAC products for more than 20 years now. A new Hygienic Air Handling Unit program has been created. This program has 59 additional verification criteria to those of the original AHU program and categorize the unit by number of stars depending on the application. This program provides the insurance that the unit provide the pure air ventilation when most needed.

KEYWORDS

Indoor Air Quality, Air Handling Unit

1 INTRODUCTION

11 March 2020, the date when the World Health Organization (WHO) director announced the beginning of the Covid-19 pandemic (World Health Organization, 2020) is the date that changed the world perception of the importance of the indoor air quality (IAQ) and ventilation inside buildings. Several studies followed later to find the mathematical relation between the outdoor air pollution, the IAQ and the global mortality rates. Vohra et al. (Karn Vohra et al., 2021) showed that the fossil fuel air pollution is responsible for 1 in 5 deaths worldwide. The results of Shetty et al. (Shetty et al., 2021) have concluded that long term exposure to indoor pollution had a significant effect on COPD deaths as well as its symptoms. The study of Ali et al. showed that the high level of indoor air pollution is leading to 3.55 million deaths annually among women and children. While the residential households usually use naturel ventilation or VMC, the air handling unit (AHU) remain the mostly used ventilation system in commercial buildings and hence the efficiency of these systems will have direct effect on the global mortality rates in the upcoming years(Ali et al., 2021).

The AHU was firstly introduced into buildings to provide clean dust free air the building occupants and it was mainly composed of fan and filters. The global need for air-conditioned air leaded the development of these units to be also responsible of heating and cooling, humidifying and dehumidifying and providing more specific filtration such as for hospitals

and white rooms. While including more complex components of these units and so the energy consumption, most of the previous studies focused on increasing the efficiency and reducing the consumption even if this meant sometimes to reduce the filtration capacity. Stephens et al. (Stephens et al., 2010) studied the impact of high efficiency filters on the energy consumption and showed that this theory should not be valid in residential HVAC systems. Moreover, some studies explored the economic model if the employee's productivity when exposed to more filtered air justify the additional on the building energy cost (Bekö et al., 2008). One common conclusion is that improving the air filtration result in an increase in the electrical consumption of the unit dur to the increase in the pressure drop of the filter. This dilemma of the trade off between the efficiency of the unit and the IAQ was the main subject of the previous research era, where the balanced scaled more to reduce the building energy in the absence of any existing regulation for the AHU's in the market.
The AHU is a main player in the IAQ and though the health of the global population. However, regulating and controlling these units in the market present a great challenge for governments worldwide. In difference of the common residential HVAC units where the units are massively manufactured and easier to control, the AHU's are mostly customised units strictly dependent of each building's filtration needs and space limitations. A European association that unit the large players of the HVAC ecosystem provided a part of the solution by providing a detailed guideline(Abreu et al., 2021) of the recommended performances and required filtration for AHU's depending on the application. The other more complicated part of the solution was provided by third party certification that guaranteed the market surveillance of the AHU performances through a well elaborated fishnet that will be explained in this study. Even further in its hygienic AHU option, Eurovent Certita Certification(*AHU | Eurovent Certita Certification*, n.d.) provided the suitable solution to the historical trade-off between the energy consumption and filtration quality by categorising the AHU's depending on the application and though to use the right filter for the right application.
The market status of the AHU's, the certification fishnet and the Hygienic options in addition to the results of 2021 control campaign will be presented in this study.

2 MARKET STATUS OF AHU

To better understand the impact of the performance of the AHU on global health, one should the understand the size of this market. The global air handling units market was valued at 11.6 billion USD in 2021 and is projected to reach 15.9 billion USD from 2021 to 2026 (Market and Markets, 2021). The rising usage of air handling units across various application sectors such as commercial buildings, hospitals, industries, universities, data centers and sever rooms is expected to fuel the growth of the market.
According to Eurovent Market intelligence report 2021 (Eurovent Market Intelligence, 2022) 283604 were sold in Europe in 2021. Offices, health and educations represent 70% of our daily time and 40% of the AHU market share (Figure 2) and while the main sale channel of the AHU is through installers it is crucial to guarantee that the unit have the right performance and it is the best adapted to the application.
One more impact of the COVID 19 pandemic could be seen in Figure 1 where the importance of IAQ and Energy consumption in AHU is considered by the manufacturers as almost equal in 2022 with a small prevalence of Energy consumption. In 2025 slight increase in the importance of IAQ is expected, however, not very significant (+3%) to stimulate an active redesign of the product.

Figure 2: AHU main applications and sales channel in EU 2021

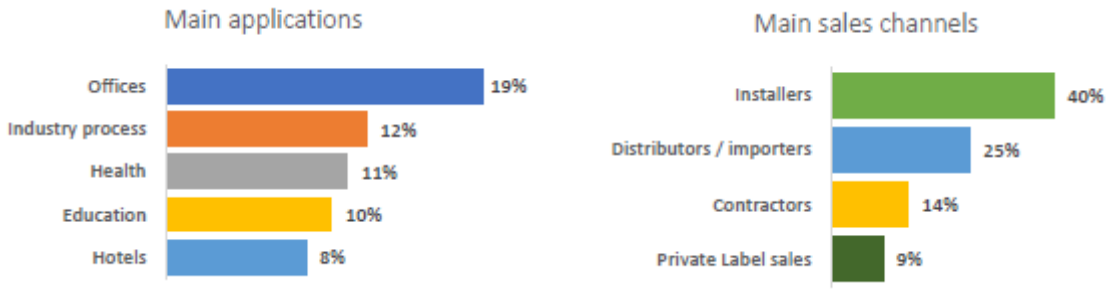
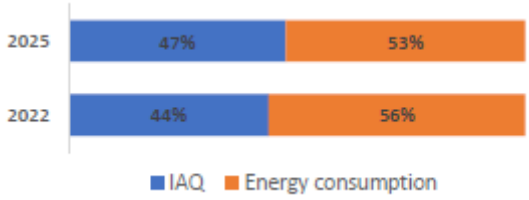


Figure 1: Trade-off between IAQ and Energy consumption



3 CERTIFICATION ROLE

The market surveillance is a key element in the HVAC eco system. For most of the HVAC systems it is the guarantee:

- for the designers that the specifications of the unit provided by the suppliers are compliant with the data sheet
- For the building owner that the declared energy consumption corresponds to the real consumption of the building

For the AHU it is more critical as it also have a great impact on the health of the occupants and the global mortality rates.
In this section the market surveillance process should be explained and the 2021 campaign results should be presented.

3.1 Air Handling Unit Certification Programme

The Ecodesign regulation and the ErP (Energy related Products) directive upcoming policy is to set a new energy efficiency criterion and control the quality of the units allowed to be released in the EU market. Ensuring the market surveillance and controlling the unit in the market is one of the main objectives of the certification fishnet.

3.1.1 Certification process

The program includes more than 10000 certified units. The units' performances and characteristics are verified through the manufacturer documentation and catalogues and audited in the selection software.
After the documentation study, a sampling of units is chosen for testing in independent accredited laboratory under the testing requirements:

- Mechanical characteristics: **EN1886**: Ventilation for buildings - Air Handling Units Mechanical performance
- Rating performances: **EN13053**: Ventilation for buildings - Air Handling Units - Ratings and performance for units, components and sections

The testing procedure for the mechanical characteristics includes:

- Casing strength
- Casing air leakage
- Filter bypass leakage
- Thermal transmittance of the casing
- Thermal bridging factor
- Acoustical insulation of casing

And for performances testing:

- Air flow rate - static pressure - power input (5 points)
- Octave band in-duct sound power level (at the inlet and outlet, with only supply air running)
- Airborne sound power level (only with supply air running)
- Heating capacity (2 conditions) if standard feature of the product range
- Cooling capacity (2 conditions)
- Heat recovery (1 condition)
- Heat recovery pressure drop (on both air sides)
- Pressure drop on water side* (2 conditions)
- Eurovent AHU Energy Efficiency Class

In addition to the product verification and testing, the factory is audited, and the manufacturing process is verified.

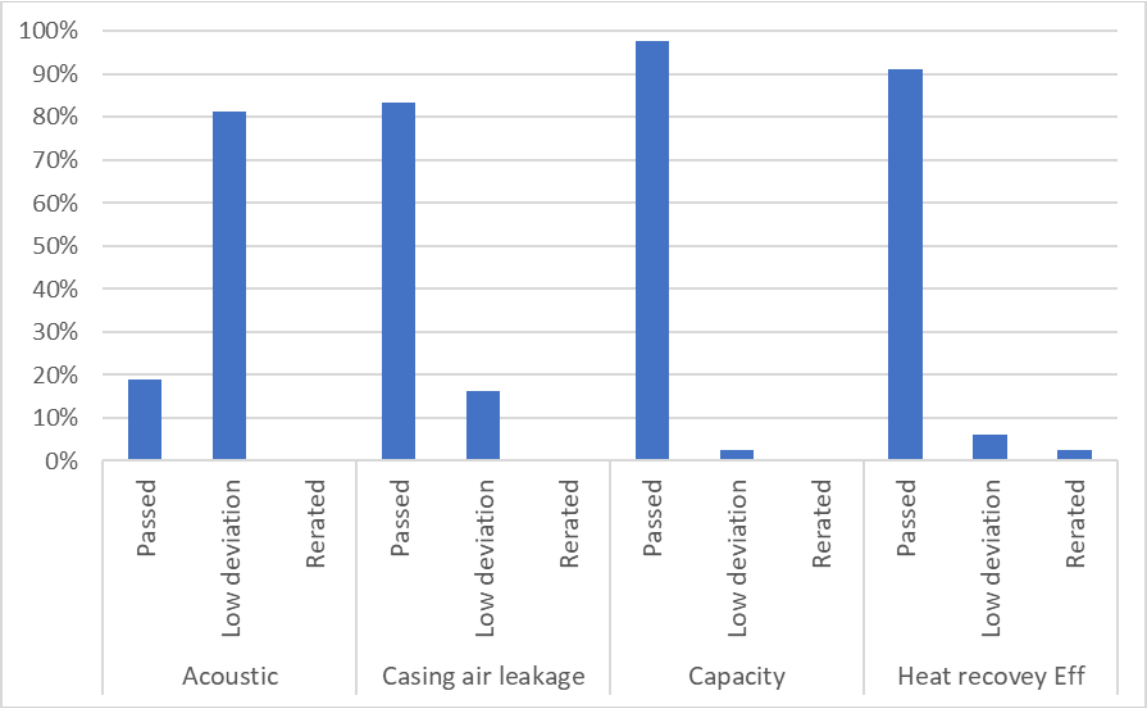
3.1.2 Results of the 2021 campaign

174 units has been tested for the 2021 certification campaign. And 186 factories have been audited.

Figure 3 show an extraction of the failed performances for the Acoustic, the Casing air leakage, the capacity (heating and cooling) and the heat recovery efficiency of the tested air handling units.

Each of the tested performance have a specific acceptance criterion for the deviation and the rerate, such as 3 dbA for acoustic, same class for the casing air leakage, and 3% for heat recovery efficiency. When the performance deviation is above these limits, the performance should be rerated. For the performances presented in Figure 3 3% of the declared heat recovery efficiencies has been rerated to the real tested value while all the tested capacities, casing air leakage and Acoustic performances are within the acceptable deviations limits.

Figure 3: example result of performances for 2021 campaign.



3.2 Hygienic Air Handling Unit programme

To answer to the trade off between the energy consumption and the IAQ, the hygienic option has been added to the AHU certification programme. The main objective of this programme is to categorise the AHU into three categorize from the least hygienic with one star, to the best hygienic with three stars. In fact, the need for better filtration depends on the application. In an operation room in the hospital the need filtration is far greater than that in an ordinary office, and though choosing the unit performance depending on it is application is the perfect solution for the historical trade off.

3.2.1 Levelling requirements:

The hygienic option of the AHU programme proposes 3 levels of certification defined as Level 1 to Level 3. The higher the rating, the more hygienic the AHU unit.
As a reference only:

- Level 1 would be appropriate for schools, offices and hotels
- Level 2 for hospital (except rooms with high hygienic requirements)
- Level 3 for food processes, pharmaceutical, white rooms, operating theatres and equivalent

The study to determine the star level of the unit includes 59 requirements which includes the whole process of the manufacturing of the unit starting from the planning and up to delivery:

3.2.1.1 Planning

R1. Coating, paints and sealing materials releasing harmful substances or odors are not allowed. Likewise, insulating materials, porous linings, or seals used within the airflow are prohibited.

Level 1, 2 & 3: Requirement applied

R2. Cleaning methodology, general arrangement and dimension of the AHU including location of doors and/or hatches shall be including in the IOM (Installation, Operation and Maintenance Manual) of the product.

Level 1, 2 & 3: Requirement must be included in the IOM of the product.

3.2.1.2 Manufacture

R3. All surfaces which are in contact with air stream shall be cleaned and particles removed after manufacture (e.g. with electrical broom, steam or mop)

Level 1: Procedure shall be included in the quality system of the manufacturer.

Level 2 & 3: Level 1 and Final disinfection requirement after mounting the modules of unit (before installing the filters) on site must be included in the IOM.

3.2.1.3 Shipment

R4. Flat packing delivery of units is not allowed.

In order to comply with restricted buildings accesses or transportation limits, units might be delivered in sections, blocks or sub-assemblies to be assembled together on site. In that case, the assembly method shall be explained in the IOM or the site assembly to be performed by personal trained by the manufacturers.

Level 1, 2 & 3: Procedure shall be included in the quality system of the manufacturer.

In case of blocks or sub-assemblies' delivery, requirements must be included in the IOM of the manufacturer or evidence showing that a qualified person is in charge of the assembly shall be provided.

R5. After manufacture, the AHU shall be fully dry, clean and properly packed with weather protection in order to protect the unit during shipment. The same rule applies for the components.

Level 1, 2 & 3: Procedure shall be included in the quality system of the manufacturer.

R6. Every component of the ventilation system shall be protected from potential damage and contamination after manufacture and this until the installation on site of the unit.

Level 1, 2 & 3: Procedure shall be included in the quality system of the manufacturer.

R7. Every component shall be covered before shipment to avoid any dust infiltration. Manufacturer shall ensure that the components are in clean and dry conditions.

Level 1, 2 & 3: Procedure shall be included in the quality system of the manufacturer.

R8. During the on-site storage every door, hatch and other type of openings (if applicable) shall be sealed.

Level 1, 2 & 3: Requirement must be included in the IOM of the product.

R9. Manufacturer shall ensure that no residue remains within the air flow after manufacture.

Level 1, 2 & 3: Procedure shall be included in the quality system of the manufacturer.

3.2.1.4 Unit Housing

3.2.1.4.1 Metallic Materials

R10. Metallic material shall be corrosion resistant, minimum requirements for internal surfaces are described under each "Level".

Internal surfaces include the following:

a) Inside panels / door metallic surface

b) Metallic parts which hold components (rails, holding constructions, etc.). Housings of the components (filter frame, coil frame, heat exchanger frame, fan frame)

c) Ventilation component itself (coil fins, heat exchanger fins, fan's impeller)

d) Motors

Fixing elements should correspond regarding corrosion resistance to the surfaces as indicated above.

If coating or painting is used, refer to coating section (R1)

Level 1 & 2: Minimum materials resistance according to corrosivity class C3 in accordance with EN ISO 12944-2:1998 or aluminum

AND Drain pans shall be in stainless steel with at least 18% Cr and 8% Ni (for instance EN steel 1.4301 - AISI 304; minimum corrosion resistance class CRC: II (2) according EN 1993-1-4:1995 EUROCODE 1-4) or aluminum (at least AlMg; in accordance with DIN 1946/4-6.5.1:2018)

Level 3: Minimum materials resistance according to corrosivity class C4 in accordance with EN ISO 12944-1:2017 or aluminum

AND Floor and drain pans shall be in stainless steel with at least 18% Cr and 10% Ni (for instance EN steel 1.4401 - AISI 316; minimum corrosion resistance class CRC: II (2) according EN 1993-1-4:1995 EUROCODE 1-4) or aluminum (at least AlMg; in accordance with DIN 1946/4-6.5.1:2018)

3.2.1.4.2 Non-Metallic Materials

R11. For all non-metallic parts excluding paints, cables and control equipment but including sealants, gaskets, filters, etc. (non exhaustive list) with surface in contact with the air > 5 cm^2 (summed up surface per each part type). Proof by test reports from hygiene institute as per EN ISO 846:2019 shall be presented. The maximum allowed growth rate for microorganisms according to Table 4 and 5 of ISO 846:2019 is 1 (0, 1a, 1b or 1c are accepted) and C (no growth or slight growth).

Level 1 *&* *2*: Requirement applied

Level 3: Requirement applied and the cabling to electrical components shall not cross another section (or component space) than the space dedicated to this specific component.

R12. Porous or open cell materials as linings, insulating materials (except acoustic baffles) sealants and rubbers in contact with the airflow are not permitted.

Level 1, 2 & 3: Requirement applied

3.2.1.5 General AHU Arrangement

R13. The H-AHU certification is related to AHU within the scope of theTechnical Certification Rules ECP 05, but with the following exclusions:

a) For the H-AHU certification are considered only floor mounted AHU with horizontal air flows (no vertical units).

b) For the maintenance are considered only AHU with lateral inspection doors / hatches.

Level 1, 2 & 3: Requirement applied

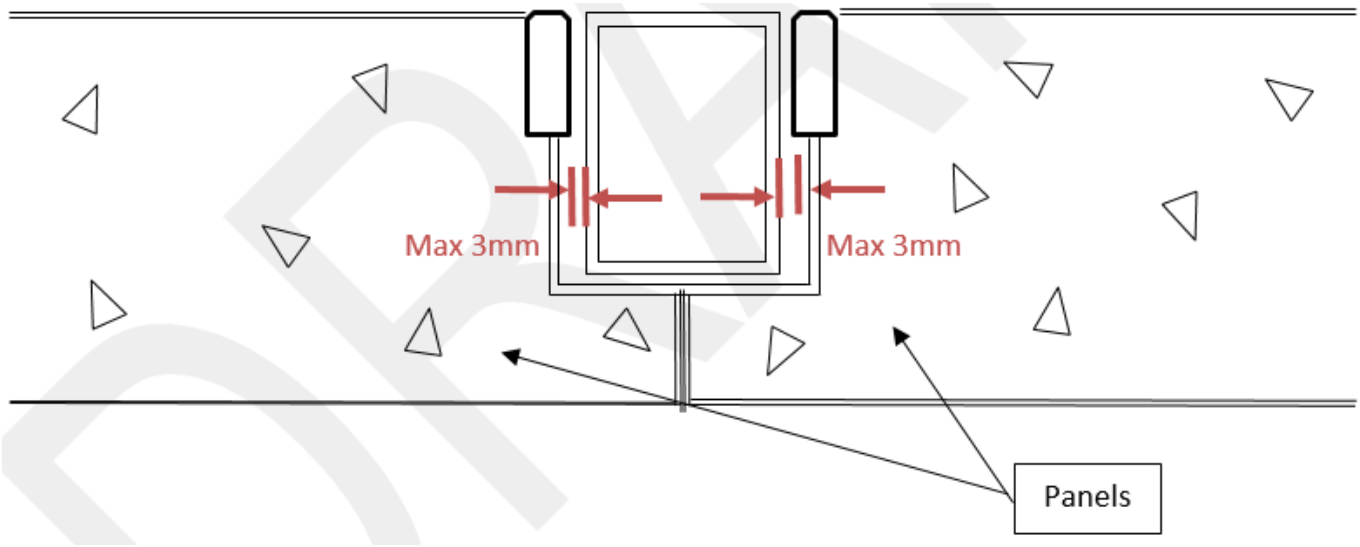
R14. Every component selected in the software (air filters, heat exchangers (energy recovery systems and coils, droplet separators, fans, humidifiers, dehumidifiers, silencers, *dampers*) shall be installed within/inside the AHU.

Level 1, 2 & 3: Requirement applied

3.2.1.6 Inner Casing Surface

R15. Except for doors and hatches grooves, joints and gaps between panels and gaps between panels and frame profiles shall have maximum width of 3mm (Figure 4).

Figure 4: Gaps between panels and frame profiles schematic



Level 1, 2 & 3: Requirement applied

R16. Except for doors and hatches grooves, joints and gaps between panels and also gaps between panels and frame profiles at the floor shall be sealed to create a smooth and closed surface

Level 1: No Requirements

Level 2 & 3: Requirement applied

R17. Except for doors and hatches grooves, joints and gaps between panels and also gaps between panels and frame profiles at the complete inner casing surface shall be sealed to create a smooth and closed surface

Level 1 & 2: No requirements

Level 3: Requirements applied

R18. Sealants for lids, hatches and doors for IMC shall be located directly at the inside casing surface to avoid any gap or groove.

Sealants for lids, hatches and doors shall be easily replaceable or otherwise installed in a mechanically protected position.

Sealants fixed by direct chemical bonding (FIPFG: Formed in Place Foam Gaskets) are considered as not replaceable. For proper mechanical protection these sealants shall be applied on the lid, hatch or door leaf (but not on the door frame).

Mechanically fixed sealants (inserted in or clamped on a profile) are considered as replaceable, thus they can be located on the lid, hatch or door leaf as well as on the frame.

For the sealants of lids, hatches and doors the requirements of *R11 and R12* shall be fulfilled independently from the surface of the sealant in the airstream.

For the fixation of sealants for lids, hatches and doors:

Level 1 & 2: Mechanical fixing (inserted in or clamped on a profile) or direct chemical bonding (FIPFG: Formed in Place Foam Gaskets) or fixation by a bi -adhesive film or a glue are allowed.

Level 3: Mechanical fixing (inserted in or clamped on a profile) or direct chemical bonding (FIPFG: Formed in Place Foam Gaskets) are allowed. Sealants fixed with a bi adhesive (film or a glue) are not allowed.

R19. To reduce the risk of injuries for the maintenance staff and to ensure safe and proper cleaning at the inside of the AHU, fasteners (e.g. self-tapping screws ...) shall not point inside the unit, sharp edges and open rivets are not allowed inside the housing.

Level 1, 2 & 3: Requirement applied

3.2.1.7 General Requirements to the Casing for Inspection, Maintenance and Cleaning (IMC)

R20. The design shall be such that a maintenance person can reach manually at any inner casing surface for:

a) Cleaning with a sponge, a mop or similar. No residue shall remain after cleaning.

b) Access to all components and relating fixing elements.

For the necessary IMC works, any component (air filters, heat exchangers (energy recovery systems and coils, droplet separators, fans, humidifiers, dehumidifiers, *dampers,* silencers, water trays of humidifiers and condense trays of cooling sections or energy recovery systems) in the air stream shall be easily accessible (*R22 & 0*) (installed in the AHU) **OR** alternatively quickly removable (*R21*).

In any case, sufficient space (*R23*) shall be available in the AHU allowing proper IMC. The underlined notions are specified in the following requirements (*R21*, *R22*, *0* and *R23*).

Level 1, 2 & 3: Requirement applied

R21. Any component as defined under *R20* shall be quickly removable.

A component designed for the purpose of IMC as "quickly removable" shall have a weight of maximum 25 kg.

Quickly removable means that after opening the access door or hatch, the component is directly removable within a short time.

Note: For that reason, a water or a refrigerant coil cannot be claimed as "quickly removable". It is not allowed, that other installations (cables, instruments…) hinder the quick removal of the component.

Level 1, 2 & 3: Requirement applied

R22. Any component as defined under *R20* shall be easily accessible:

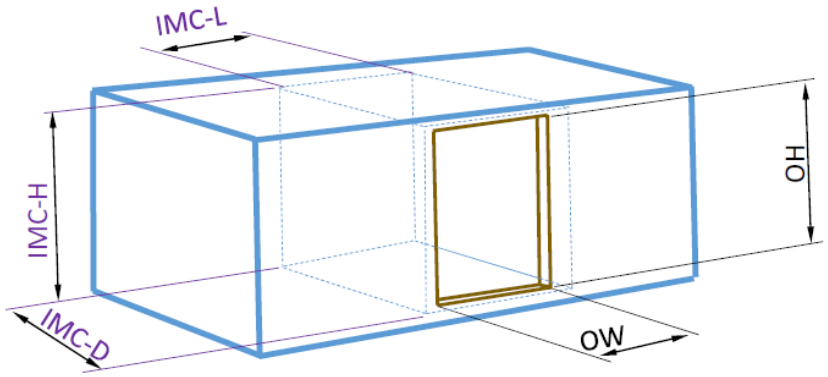
AHU components require a quick and easy access to the unit inside through access openings. As access opening for IMC is accepted only a (quickly removable) hatch or a hinged door, according to the following definition:

c) The opening of any access opening with hinge (door or hatch) shall be possible within 20 seconds.

d) For hatches (not hinged access doors) the maximum allowed weight is 25 kg and the maximum allowed width of the hatch is 600 mm (except for silencers). The hatches shall be equipped with handles for proper handling.

e) For minimum free opening width [OW as per Figure 5] and minimum free opening height [OH according Figure 5] of the access opening, please refer to the certification manual.

Figure 5: Opening dimensions – IMC dimensions



IMC-D: IMC Depth
IMC-H: IMC Height
IMC-L: IMC Length

OW: Opening Width
OH: Opening Height

Note: Panels which shall be unscrewed for the access are not accepted. At access openings, no installations shall be fixed (cables, instruments....) which hinder the quick opening.

Level 1, 2 & 3: Requirements applied

For any component defined under *R20*, an easy access shall be ensured **from both sides** (upstream and downstream):

For components, which are quickly removable according to *R21*, the component itself is deemed to be accessible from both sides. Nevertheless, the relating guides or frames, the casing ranges directly upstream and downstream of the component and any instruments installed inside the chamber of the relating component shall also be accessible for these quickly removable components.

For any component considered as quickly removable according to R21 the empty space of the component itself can be utilized as part of the inspection section of the non-removable components located next to a quickly removable component.

Level 1: No requirements

Level 2 & 3: Requirement applied

R23. *Sufficient space*: To allow the necessary IMC work, sufficient space shall be available.

Level 1, 2 & 3

R24. Droplet separators downstream cooling coils shall be easily accessible and quickly removable or alternatively have an access door and plenum between cooling coils and droplet separator. In case that there is no compliant space between cooling coil and droplet separator and the droplet separator itself is easily removable, the length (in air direction) of the removed droplet separator can be used as available length for IMC of the cooling coil.

Level 1, 2 & 3: Requirement applied

R25. For easy removal of droplet separators, these shall be side removable in parts with maximum weight of 25 kg and maximum width of 1000 mm.

Level 1, 2 & 3: Requirement applied

3.2.1.8 Requirement regarding filter maintenance

R26. Filter change shall be possible from the dirty air side or by side removal. The installed filter frame shall correspond to the filter class installed and the manufacturer shall be certified minimum for the installed filter bypass leakage. In any case the requirements for sufficient space and easy access for IMC shall be maintained.

Level 1: Requirement applied

Level 2 & 3: Requirement applied and the complete filter(s) frame shall be sealed to the casing frame.

R27. Filter chambers shall be accessible for the IMC works. For unit with internal heights > **1600** mm; the access from both sides (upstream and downstream the filter) shall be possible. For that reason an access door on clean air side is mandatory. This requirement is achieved by default for side removable filter.

Level 1, 2 & 3: Requirement applied

R28. During filter maintenance gasket shall be checked and changed if necessary.

Level 1, 2 & 3: Requirement to be included in the IOM.

3.2.1.9 Other requirements related to casing

R29. To avoid condensation, the certified model box shall have a minimum thermal bridging class of **X**.

Level 1&2: X = TB3

Level 3: X = TB2

R30. The certified model box shall have at least a tightness class of **X** *and the Real Unit shall have at least a tightness class of* ***Y***.

Level 1 & 2: X = L2 (M) & Y = L2 (R)

Level 3: X = L1 (M) & Y = L1 (R)

R31. All drain pans, condense trays and water tanks shall have a sufficient slope from any point of the bottom to the drain tube. The requirement is deemed to be fulfilled, if after filling them with 5 l/m² water, minimum the percentage **X** has been drained off over a period of 10 minutes.

Level 1, *2 & 3*: X = 95% (25 cl/m² of remaining water)

Note: The manufacturer shall provide the appropriate material to test this requirement during the audit

R32. Drain pipes of unit shall have a diameter of at least 40 mm and sufficient slope and run via a siphon with free discharge into the sewer system. A backflow protection is mandatory for negative pressures. In case it is not provided by the manufacturer, it shall be stated in the IOM.

Level 1, 2 & 3: Requirement applied

R33. Drains with positive and negative pressure levels shall be constructed separately with each having an individual siphon.

Level 1, 2 & 3: Requirement applied

R34. All connecting pipes passing through the casing where there is a risk of condensation shall be insulated.

Level 1, 2 & 3: Requirement applied.

3.2.1.10 Air Treatment

3.2.1.10.1 Filter

R35. A minimum ePM10 50% filtration stage shall be installed before the first component of any air stream (except dampers or filter pre-heater)

***Level 1, 2 & 3**: Requirement applied*

R36. Air filters shall be selected and arranged in order to ensure a good incoming air quality (as a minimum). The filter efficiency according to EN 16890:2016of the filters shall be certified by a certification body accredited ISO 17065:2012.

Level 1 *& 2*: The filtration efficiency at 0.4 µm of all filters installed shall be equivalent to an ePM10 50% filter on the exhaust side and to an ePM1 50% filter on the supply side.

Level 3: The filtration efficiency at 0.4 µm of all filters installed shall be equivalent to an ePM10 50% filter on the exhaust side and to an ePM1 85% filter on the supply side.

R37. Manufacturer shall ensure that closed cell gasket is used and that the seal is properly fastened. The section related to non-metallic materials (test reports from hygiene institute according EN ISO 846:2019) shall be applied.

Manufacturer shall ensure that closed cell gasket is used and that the seal is properly fastened.

Level 1 & 2: Requirement applied

Level 3: Level 1 & 2 requirements **and** the gasket shall be either fixed on the filter frame and changeable or on the filter cell.

R38. Bag filter must be in vertical position (this requirement does not apply to rigid filters). It shall be clearly indicated in the IOM that the filter shall always be in a vertical position, it is also recommended to put a label on the unit.

Level 1, 2 & 3: Requirement applied

R39. To facilitate the maintenance of the air filter the following information shall be permanently indicated on the air-filter chamber:

- Dimensions
- Filter class:
    - For medium and fine filters, it shall be according to EN 16890:2016.
    - For high efficiency filters it shall be according to EN 1822:2019.
- Number of air filters
- Actual air volume of the installed system
- Final pressure drop based on the fan's characteristics.

Level 1, 2 & 3: Requirement applied

R40. Each filter stage shall be equipped with a differential-pressure gauge. The measuring display device shall be easily accessible and easily readable by future users.

Level 1 & 2: For each filter a visual signaling or an alarm in the control system is mandatory. For units to be installed outdoor liquid manometer is not allowed.

Level 3: For each filter an alarm in the control system is mandatory. For units to be installed outdoor liquid manometer is not allowed.

Note**:** Should the control system be delivered by the manufacturer, the requirements apply. Should they not, the requirement shall be written in the IOM.

R41. The supply side shall be filtered by two filter stages.

Level 1: No requirements

Level 2 & 3: Requirement applied **and** the first stage of filter class shall be at least **M5**.

Note: if a third stage filter is required, it can be present within the unit or outside the unit. Therefore, this is not in the scope of this programme.

R42. Recirculated air shall be filtered with the same requirement as defined under R35 for supply air filter.

Level 1 & 2: Requirement applied

Level 3: No recirculated air shall be allowed.

3.2.1.10.2 Cooling and Heating Coil

R43. For energy and hygiene reasons the distance between the fins of the coolers that can dehumidify shall be at a minimum **Y** mm, otherwise, the distance between fins shall be at a minimum **X** mm.

Note: This applies also to cooling coil within run around coil

Level 1 & 2: X_{min} = 2.0 mm and Y_{min} = 2.5 mm

Level 3: X_{min} = 2.5 m and Y_{min} = 3.0 mm

R44. Air heaters, which are used for drying before the first filter stage, shall guarantee a minimum distance between the fins of at least 4 mm.

Level 1, 2 & 3: Requirement applied

R45. The fins shall have a thickness of X.

Level 1, 2 & 3: X_{min} = 0.10 mm

R46. For hygiene reasons, coolers with dehumidification shall not be arranged immediately before air filters or silencers. Fans, heaters *or droplet separators* shall be installed in between to limit the relative humidity.

Selection software to alert the user that cooler with dehumidification shall not be arranged immediately before air filters or silencers.

Level 1, 2 & 3: Requirement applied

3.2.1.10.3 Humidifier

R47. For clean application humidifier shall be installed with at least an element (Coil, fan, heat exchanger, droplet separator) between humidifier and final filter or silencers.

A maximum of 90% RH is allowed before each filter section or silencer.

Level 1, 2 & 3: Requirement must be included in the IOM of the product.

3.2.1.10.4 Dehumidifier

R48. Any solid or liquid absorbent shall be harmless, a test report showing the compliance of the product used shall be provided.

Filtration downstream the desiccant unit shall be minimum **X.**

Level 1 *&* *2*: Requirement applied and X = ePM1 50%

Level 3: Requirement applied and X = ePM1 85%

R49. No moisture can carry over to the components or sections downstream of the coil.

Selection software to alert the user that cooler with dehumidification shall not be arranged immediately before air filters or silencers.

Level 1, 2 & 3: Requirement applied

3.2.1.10.5 Heat Recovery System (HRS)

R50. The coils in the run around coils shall comply with the requirements of coils.

Level 1, 2 & 3: Refer to *3.2.1.10.2*.

R51. Heat exchangers shall be easy to clean and to disinfect in order to avoid any kind of contamination.

Level 1, 2 & 3: Requirement applied

R52. Cross contamination

Level 1: For rotary heat exchanger, cross contamination between extract air and supply air at design condition shall be limited to EATR ≤ 5%. To assess EATR, both the leakage across the heat recovery device and, if applicable, the leakage across partition walls between supply part and extract part shall be considered.

Evaluation of the leakage: Leakage shall be based on the calculated operating pressure in the unit sections at design pressure drop for components and design external pressure. External pressure in the calculation is set at 50 Pa at the non-building side (if ducted) and the remainder at the building side (EN 13053:2019 §5.2.3.1.1.1)

OR The final supply air shall be filtered as the supply air defined under IV.3a

OR The return air shall be filtered as the supply air defined under IV.3a.

OR No requirement if the air handling unit is equipped with a recirculation damper.

Level 2: For rotary heat exchanger, cross contamination between extract air and supply air at operational condition shall be limited to EATR ≤ 5%. To assess EATR, both the leakage across the heat recovery device and, if applicable, the leakage across partition walls between supply part and extract part shall be considered.

Evaluation of the leakage: Leakage shall be based on the calculated operating pressure for worst possible operational conditions. Worst possible operational conditions exist when pressure differential between supply part and extract part are the lowest:

- For the supply part the highest pressure drop of components upstream the fan and lowest pressure drop for components downstream the fan shall be considered for components with variable pressure drop (filters, dry/wet heat exchangers).
- For the extract part the lowest pressure drop of components upstream the fan and highest pressure drop for components downstream the fan shall be taken for components with variable pressure drop.

System failure do not have to be considered. External pressure in the calculation is set at 50 Pa at the non-building side (if ducted) and the remainder at the building side (EN 13053:2019 §5.2.3.1.1.1)

OR The final supply air shall be filtered as the supply air defined under IV.3a

OR The return air shall be filtered as the supply air defined under IV.3a.

OR No requirement if the air handling unit is equipped with a recirculation damper.

Level 3: For rotary heat exchanger, cross contamination between extract air and supply air at operational condition shall be precluded (EATR = 0%).

A positive pressure between supply side and extract side shall be ensured for the heat recovery section and, if applicable, partition walls between the two air streams.

Rotary heat exchangers shall be equipped with a purging sector with sufficient purge angle adapted to the nominal rotor speed.

A pressure control system with differential pressure sensor accross the sections with the lowest possible pressure difference shall safeguard this requirement.

If a lower value is measured than the minimum permissible value set at 50 Pa, the control system will proportionally (further) close an extract air inlet damper and/or generate an alarm.

The system shall be evaluated as described under level 2.

OR No requirements if the two airstreams are fully separated by individual casings and split heat recovery.

3.2.1.10.6 Fans

R53. Fans and fan drives shall be used rather than belt drive fans.

If a belt drive fans or fans with housing are used refer to *3.2.1.7* for cleaning and maintenance.

In case of use of a V-belt driven fan (exception: flat-belt drives), an additional filtration stage shall be installed immediately downstream of the fan (before any other component). The filtration efficiency of this filtration stage shall be at least equal to the highest filtration efficiency installed upstream of the fan (with a minimum of ePM10 50%).

An inspection window plus inspection light for checking the visual aspect of the belt shall be installed (for any type of belt).

Level 1: Requirement applied

Level 2 & 3: Requirement applied and the inspection window and inspection light is mandatory for any type of fans for units with an internal height above 1.3 m.

R54. Fans shall be easily accessible for maintenance as described under *3.2.1.7*.

Definition of removable fan:

- All screws or similar fixings visible when opening door or hatch.
- Enough space for screws or fixing to be loosen and replaced with a simple tool (spanner, screwdriver, etc. or no tool at all) unless a special tool is provided by Manufacturer.
- Withdrawal of the fan can be performed by maintenance personal only, without the help of an electrician (No need to undo electrical connection, only mechanical disassembly and only opening of electrical socket is allowed).

If fans can be removable no additional requirements, otherwise following requirements applied:

Level 1: Fan shall be accessible from one side according for 'Access and Space'.

Level 2&3: In case of plug fan only:

- On supply side: fan shall be accessible from both sides with at least half of the IMC-L downstream after the motor for 'Access and Space' upstream the fan.
- On extract side: fan shall be accessible from both sides, at least half of the IMC-L downstream after the motor for 'Access and Space' upstream the fan. If the fan is the last component before the damper, an access shall be ensuring for 'Access and Space' only upstream the fan.

For any other type of fans, fans shall be accessible from both sides for 'Access and Space'.

If no electrical connection is delivered with the fan and the variable speed drive (VSD), then the requirement shall be included in the IOM.

R55. If the water drain of a fan with housing is sealed it shall be easily accessible for cleaning and maintenance purposes. If not, the fan shall be removable.

- Plug is visible when opening the door or hatch.
- Enough space for plug to be open and removed with a simple tool (spanner, screwdriver, etc. or no tool at all), unless a special tool is provided by Manufacturer.
- Possibility to mop and wipe water below the fan (Min space about 3 cm below fan).

Level 1, 2 & 3: Requirement applied

R56. Fans with housing shall have an easily removable inspection lid (applicable for nominal impeller diameters greater than 400mm):

- Lid and all its fixings visible when opening the door or Hatch (Units with air flow height below 1,6 meter) **OR**
- When entering the unit (Units with air flow height larger or equal to 1.6 meter) enough space to open and close latch with a simple tool (spanner, screwdriver, etc. or no tool at all) unless a special tool is provided by Manufacturer.

Level 1, 2 & 3: Requirement applied

3.2.1.10.7 Silencer

R57. Supply air shall be filtered upstream the silencer with minimum ePM10 50% filter.

Level 1: No requirements

Level 2 & 3: Requirement applied

R58. Material lined with sound-absorbent components shall be abrasion resistant, harmless and shall resist to cleaning (e.g. fiber glass).

Proof by test reports from hygiene institute as per EN ISO 846:2019 shall be presented.

Certificate or technical report from supplier to be provided for fiber-glass compliance.

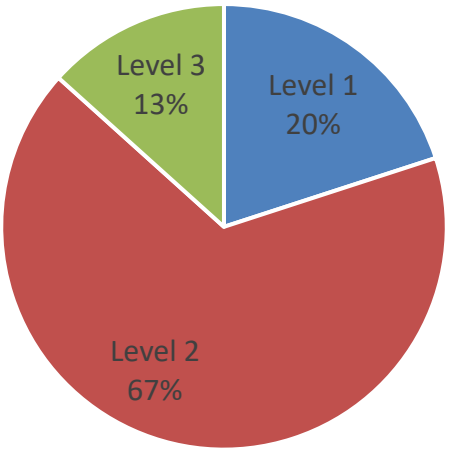
Level 1, 2 & 3: Requirement applied

3.2.2 2021 Campaign results

In 2021, 30 AHU units has been submitted for the Hygienic qualification. As Figure 6 shows, 20% of the units have the level 1, 67ù have the level 2 and 13ù have the level 3. This allows

any end user to filter the search of the unit depending on the required level of hygiene for a specific application, in addition it provide all the 59 requirement information.

Figure 6: 2021 campaign test results



4 CONCLUSIONS

Defining the rules and regulations for performances and efficiencies of any HVAC system including the air handling units is the responsibility of governments through internal or European regulations. However, ensuring the market surveillance of this type of units specially with a market with more then 11 billion USD size and growing requires third party entities experienced in the sector. In addition, the increasing interest of reducing the energy consumption of air handling unit for several reasons (net zero building objectives, the energy crises, energy cost), the COVID 19 pandemic increased the interest on the effect of IAQ on the human health. Eurovent Certita Certification in its certification programmes provided the both solutions to guarantee the performance of the unit and the hygienic level.

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