EUROVENT/ CECOMAF

EUROVENT 12/1 - 1996

PRODUCT RELATED INDOOR AIR QUALITY

Preventing indoor air quality problems from ventilation and air conditioning equipment and installations

QUALITE DE L'AIR LIEE AUX PRODUITS

Prévention des problèmes de qualité de l'air intérieur dans les installations de ventilation et de climatisation

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EUROVENT 12/1

Third Edition 1996

This document has been prepared by the EUROVENT Working Group « WG 12 ».

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1 INTRODUCTION

This document summarizes the work of EUROVENT working group "Indoor Air Quality". This group, with experts from manufacturers and manufacturers' organizations, has analyzed the existing knowledge about product-related indoor air quality problems, in order to give practical advise how to eliminate those problems in ventilation and air-conditioning installations - to improve the indoor air quality. This document takes into account all validated knowledge about health aspects.

Avoiding indoor air quality (IAQ) problems caused by products used in ventilation and air conditioning, such as air handling units, room air conditioners, ducts, ductwork as a whole, terminal devices, air filters etc. is rather a problem of system design, installation and maintenance than of the products themselves.

However, the product manufacturer is often blamed in case indoor air quality problems occur. The importance of the hygiene of ventilation and air conditioning has increased also in legislation, e.g. the Construction Products Directive issued by EU Commission.

In the light of this, EUROVENT (European Committee of air handling and air conditioning equipment manufacturers) established in 1990 their own working group EUROVENT WG 12 "Indoor air quality".

The first edition of EUROVENT WG 12/1 was published in 1992. Certain paragraphs and whole subclauses have been utilized in European Standardization, in order to give product manufacturers and users proper tools to fulfil hygiene requirements of the installations. This revised edition refers to these documents, many of them still officially unnumbered.

This edition is presented in a new structure, and some additional maintenance aspects have been presented.

The next steps will be to put out a target table for good IAQ, and for specific product families to summarize and to advise to find practical tools for designers, manufacturers, end users etc. how to meet in practice the agreed target values.

2 SCOPE

This Document applies to air handling equipment and components. It gives general practical information for preventing indoor air quality problems from such equipment and installations during design, construction and operation.

3 DESIGN, INSTALLATION, COMMISSIONING, OPERATION AND MAINTENANCE, CONTROLS

3.1 GENERAL

The ventilation and air-conditioning systems shall be designed, manufactured and installed in such a way that cleaning of all internal surfaces and components are possible.

According to recent investigations, there are indications that the air distribution system, and almost any of its components aswell, may become a source of odours and IAQ problems in the building. This usually happens only if the system is not properly designed, built and maintained. However, odours are generally a matter of comfort and less often an indicator of a real health risk. For products, attention should be paid on quality control in both manufacturing and installation.

At least for the following components attention shall be paid on problem elimination in material choice, design, installation, commissioning and operation: heat recovery devices, coils, filters, humidifiers, fan coil units, sound attenuators, ducts and air terminal devices.

Air handling units and room air conditioners generally have two or more of the mentioned components installed in a casing.

Closing off the system may cause a risk of backdraught, i.e air flow into reverse direction, resulting in transport of impurities and in problems with condensation. When different ventilation systems exist in the same building, they should be able to run without critical interference. In practice, the most problematic cases of backdraught occur in residential building partially equipped only with mechanical ventilation (e.g., kitchen hood fans plus natural ventilation in other rooms, open fireplaces with mechanical exhaust). When the fan is in operation, the natural exhaust air duct may become a supply air duct.

Guidance on system hygiene is under preparation in CEN TC 156/ WG 7, the present draft referred here as prEN XXXA. Guidelines for good practice for duct treatment during the installation process and for facilities for cleaning exist in many European countries, and a European Prestandard (prENV 12097) has been approved in January 1996.

3.2 DESIGN

Guaranteed quality of all products used in the system is a necessity, including certified performance when possible. Use of "wild" products must be avoided. At the design stages, the following shall be documented (see also prENV 12097):

- performance criteria for components.

- location and sizes of access openings and doors, and of components to be dismounted for cleaning, taking into account thermal insulation, hours of operation, condensation risks etc.

- access routes for cleaning and maintenance; access to shafts and suspended ceilings

- recommended method for cleaning, possible restrictions to wet cleaning methods or other methods taking into account e.g. the size of access doors, duct pressure, tightness

- maintenance routes to components which may require changing, or removal and replacement, e.g. filters

- basic service instructions located on the units and components, special instructions for components which require checking of position or functions, e.g. flow controllers, dampers and terminal devices.

- instructions for re-adjustment and balancing, or for checking the balance of the system after cleaning

- maintenance plan, including the manufacturers' instructions for regular maintenance of the components.

3.3 INSTALLATION

In order to ensure proper cleanliness of the installation after manufacturing of components, it is in most cases necessary to protect the components, equipment and installation against dust, moisture, mechanical damages etc. The cleanliness of the installation shall also be checked in different stages of construction. The following checklist gives the most common measures needed, and it shall be applied and precised for specific products, especially for ductwork and air terminals, and for each installation taking into account the quality level required. More details, and procedures valid for the whole installation, are presented in prENV 12097.

- checking and, if necessary, cleaning the products leaving the manufacturer's premises

- delivery to construction site, e.g. bagging or sealing for transportation

- storage on construction site, and working area for installation; warm, dry, clean, dust free

- protection of installed parts of the systems before the installation is complete

- inspection, and cleaning whenever necessary, before the installation is covered (e.g. ducts in shafts or in suspended ceiling) and finally before starting the whole system.

3.4 COMMISSIONING

At the commissioning stage, the installation and documentation shall be checked, see 3.2 and 3.3. Special attention shall be paid on the checking of locations of and access to the access doors and openings and maintenance routes. The operation, service and maintenance persons shall be trained during the different phases of commissioning, as appropriate.

Special attention shall be paid on checking the cleanliness, if it has not been possible or practicable to fulfil the whole checklist presented in clause 3.3. The whole commissioning procedure is described in prEN XXXB, in preparation in CEN TC 156.

3.5 OPERATION, CONTROLS AND MAINTENANCE

These include:

- daily operation
- service
- cleaning
- controls of the system

Energy conservation aspects of HVAC systems usually require the use of an appropriate control system. Closing off the HVAC system for unoccupied hours or at the occupants' demand may induce health hazards or other problems, as follows:

- risk of backdraught, see 3.1

- if the HVAC system is not controlled by an air sensing device (e.g. CO_2 or VOC concentration), restart of the system shall occur in prior to the reoccupation of the premises, and usually one air change will take place before occupation and cooling is resumed.

- closing off the system should be carried out after the occupants have left the building in order to flush the building and exhaust the pollutants.

Facilities for modulating the air flow rates should not destabilize the ductwork, and induce a higher air flow rate in other rooms or increase the noise level. Air flow regulators are a good solution.

When the ventilation system is used for night free cooling, the balance between latent and sensible loads should be positive. If not, ventilation should be at the minimum specified flow rates in order to reduce the humidity load and the next days cooling requirements. A humidity or enthalpy control a solution to this potential problem.

In order to facilitate the maintenance of filters, a differential pressure sensor should be installed in the control system in order to indicate clogging of equipment.

It is recommended that the positioning of variable and modulating dampers be evaluated and modified. A feedback pot in the control equipment is an advantageous solution.

All installations shall be inspected regularly. Some components, e.g. filters often require service, maintenance or changing, more frequently than it is necessary to check the whole system. During these frequent operations it is recommended to at least quickly check the cleanliness of visible components (coils, plenums, dampers etc).

The cleanliness of the installation shall be checked visually, and if there are observations of high accumulation of dust, grease, debris etc., the installation shall be cleaned (entirely or relevant parts). The functioning of the system after cleaning shall be inspected.

The following maximum intervals for system inspection are recommended. However, national regulations for health of fire safety, demands of higher level of IAQ, system functioning and/or cleanliness may require more frequent inspection and cleaning than recommended below.

- one year: ventilation for kitchens in professional use, in heavy industries like painting lines, wood processing facilities, waste conveying, centralized cleaning systems; for rooms for handling paints and solvents, heavily used smoking rooms

- five years: ventilation systems for restaurants (excl. kitchens), laboratories, schools, sporting facilities, hospitals, kindergartens, hotels, smoking lounges

- ten years: other installations, e.g. residential and office ventilation

For buildings not mentioned, apply the list above taking into account the level of contaminant production indoors, level and time of occupancy including type of activity. The intervals may be changed according to experiences from the first inspection, and should be reconsidered whenever the usage or occupancy is changed.

4 HOW TO ELIMINATE PRODUCT-RELATED PROBLEMS

4.1 FANS

There are no major indoor air quality problems concerning fans, provided that they are properly maintained and kept clean. Emissions from fan motors, belt drives etc. are regardea as a minor source of problem, especially if there is a second filter downstream.

4.2 DUCTWORK

Some materials used in the ductwork may as themselves cause health risks, others only if the design, installation and maintenance are poor. Most of the materials are neutral, but the dust accumulated on surfaces may generate odours in certain conditions.

In the so-called integrated structures (e.g. if hollow cores of concrete slabs are as themselves utilized as ducts), the risks are obvious. The surface of concrete or masonry duct is generally rough and not so easy to clean, and also the access of cleaning may be very poor. Also "installation floors" may become subject for accumulation of dirt.

Sheet metal ducts are smooth and easy to clean, but some problems may arise if they are dusty and if condensation occurs. The disadvantages of closing off the ventilation system for nights and weekends are obvious, as well as the importance of proper location and insulation of ducts.

Ductwork components should be designed and located so that proper maintenance is possible without obstructions. Special attention shall be paid to all dampers, hangers and supports, duct joints, sensors inside the duct, etc. It is advisable to design overall ductwork so that all components requiring cleaning and maintenance are located close to each other.

Details are presented in prENV 12097.

4.3 AIR TERMINAL DEVICES

The fouling of air terminal devices has been mainly regarded as an aesthetic problem. It is often mainly caused by the secondary air flow, i.e dust in room air. Exhaust air terminal devices must be easily removable for cleaning, and in such a way that their position (opening) does not change. Supply air terminals (especially VAV and other terminal units) may include components which require cleaning, easy access is then necessary.

To prevent erosion and transmission of particles the insulation inside connection boxes should be covered by a protective coating.

4.4 AIR FILTERS

Filters should be selected both to protect the components of ventilation system and to ensure the indoor air quality. Filters may also make a negative contribution to the IAQ. Once filters start collecting dust, they can in specific conditions become a source of odours. Therefore regular changing is important. The changing interval is normally determined by the final pressure drop, to be defined case by case. It is also important to prevent condensation in the filter.

Air filters should be specified and selected both to protect the components of the ventilation system and ensure indoor air quality.

High-grade filters are able to remove pollens and other allergens which may be present in the air. They can intercept and catch bacteria and even viruses, and can remove irritants such as tobacco smoke. Carbon filters are capable of removing odours and other gases.

However, better quality filtration carries with in an economic penalty in terms of higher initial cost and increased operating cost due to the greater resistance of higher efficiency filter absorbing more fan power; replacement cost is also higher, The cost for higher efficiency filtration should be compared to the cost for cleaning the installation.

As the main purpose of the filters is to keep the designed airflow by keeping the installed components clean, filters class F7 (EU7) should normally be installed as first component in the supply air system for general ventilation. If necessary a second step filter class F 8/9 (EU8 or 9) could be installed after the sound attenuator. If there is an unusual quantity of large particles in the air a prefilter (class G2 to F5) can be necessary. The influence of outdoor air quality to filter selection is discussed in a standard currently in preparation in CEN TC 156/ WG 7 (here referred as prEN XXXA).

Components of the air exhaust system may also be protected by class F7 (EU7) filters.

4.5 HEAT EXCHANGERS: COILS AND HEAT RECOVERY UNITS

In heating coils, the only potential problem is odours caused by accumulated dirt. In cooling coils, condensation brings additional risks for growth of bacteria. Proper drain trays, sloped to prevent stagnant water, with sufficient access to clean the coils and drain trays, and limited air velocity in the coil are simple means to eliminate the risks.

In heat recovery units, special attention must be paid in avoiding air leakages from exhaust air into supply air in case that the exhaust air is so polluted that it cannot be utilized as recirculated air. The key issue is to arrange the pressure conditions of the two airstreams, so that the supply air side is always at a higher pressure relative to the exhaust air side. This is particularly important in the case of thermal wheels.

Recommendations on pressure conditions are under preparation in CEN TC 156/ WG 7, see prEN XXXA. The details of hygiene aspects for coils are documented in prEN XXXY, currently in preparation in CEN TC 156/ WG 5.

4.6 AIR HANDLING UNITS, ROOM AIR CONDITIONERS

The guidance given above for each individual component shall be taken into account when components and sections for air handling units and airconditioners are specified. To guarantee easy access for cleaning both the components and the casing, the units shall be equipped with access doors, which already is a common practice adopted by major European manufacturers.

The unit casing shall be airtight enough to prevent dust penetration with the leakage air after the filter section. Therefore, the airtightness required shall be in relation to the filter class. The filter bypass leakage should be so low that, taking into account also the casing air leakage, the dust penetration will be limited so that the filter class is met. See prEN 1886.

Penetration of water in any form into the unit from the outdoors shall be prevented by protecting the opening and limiting the air speed in the opening. Also condensation inside the unit must be avoided.

Requirements for cleaning and service for air handling units, including their components and sections, and machine rooms are presented in prEN XXXY.

4.7 FAN COIL UNITS

To avoid the problems presented herein, class F5 to F7 (EU5 to EU7) filters are recommended. If low performance filters are used due to limited available fan pressure, the following recommendations are valid:

- heat exchangers should have fine smooth surfaces, free of burrs, in order to avoid dust and lint accumulation.

- regular cleaning should be carried out one to three times a year depending on the condensate and environmental conditions. The unit should be accessible for inspection and maintenance (it is preferable to have a single-row coils rather than multi-row coils).

In a cooling mode, it is preferable to avoid condensation by ventilating the room using a dehumidified air supply and by limiting the coil surface temperature above the dew point, (to account for latent heat load of occupants, 2 g water/kg dry air at 0,01 m^3/s supply air rate).

In the heating mode, it is preferable to keep the coil surface temperature as low as possible to minimize burning and gassing of dust oil, insulating and sealing material.

The condensate drain tray must be kept completely dry in periods of no condensate formation in order to destroy microorganisms and to avoid biofilms. It must be corrosion-free, with good accessibility for cleaning, and should be of sufficient size to collect all condensate and to avoid spillover.

Outside air intake should be avoided because of humidity, freezing and pressure balance in building, If necessary, it must be filtered (G1, G2) and a weather guard used to eliminate droplets. Return air intake should not be too close to the floor and should have low face velocity.

4.8 HUMIDIFIERS

The main recommendations are the following:

- choose evaporative type whenever possible
- if spray type is used, choose effective droplet eliminators
- use reliable control equipment to avoid condensation in ductwork and room,
- avoid organic dust in humidifier by using effective filters
- follow instructions regarding service, maintenance and water treatment

The details of hygiene aspects are documented in prEN XXXY.

4.9 COOLING TOWERS

In order to avoid IAQ problems, the following steps can be summarized:

- Proper location and installation
- Controlled water condition, and water treatment when needed
- Cleaning of the cooling water system and regular biocide treatment
- Regular maintenance.

1) Location and installation

The cooling tower must be situated so that air from the tower discharge does not enter open windows or intakes to ventilation equipment. In addition, the cooling tower should have high efficiency drift eliminators in order to minimize the amount of water carried in the outgoing air stream. It should also be ensured that sufficient space for proper maintenance of the cooling tower is available. Piping layouts should be kept as simple as possible for easy cleaning and flushing. Deadlegs and loops or bypasses with little flow must be avoided, and the system should incorporate adequate bleeding facilities. A drainage point at the lowest level of the system is needed and an adjacent fuse water supply is required for general cleaning and hosing down of the components parts.

2) Water conditioning

Special efforts are needed to keep the circulating water in good condition. First of all, it is essential that an adequate bleed or blowdown rate be installed to avoid excessive concentration or impurities. In cases where water has a tendency to scale or to corrode, water treatment if recommended. Regardless of the quality of the circulating water, it is always recommended that biocidal treatments be installed, and if the water carries sludge, an adequate filtration system should also be installed.

3) Cleaning

Cleaning and biocide treatment of the cooling water system is required:

- when the cooling system is first brought into service,
- at the end of the cooling season or prior to prolonged shutdown,
- after the annual shutdown or after an extended shutdown period, and prior to being put back into service.

The cooling system must be completely drained at the end of the cooling season or before an extended shutdown. The drain should be left open.

4) Regular maintenance

To ensure optimal performance of the cooling equipment and to avoid unwanted contamination, a regular maintenance programme must be established and carried out. Typical maintenance programmes should be provided by the manufacturers of cooling towers. To provide evidence that the maintenance programme has been carried out, it is recommended that the maintenance engineer keep a maintenance logbook to register all maintenance activities and findings.

4.10 SOUND ATTENUATORS

The material which makes up sound attenuators is porous and fibrous. To prevent erosion and transmission of particles, the material should be covered with a protective coating ensuring "permanent cleanliness". A decrease in performance due to the protective coating must be taken into account. It is important to respect the manufacturer's recommended air velocity and minimal distances between the sound attenuators and the machine which generates humidity.

REFERENCES

prEN 1886. Ventilation for buildings. Air handling units. Mechanical performance.

prEN XXXY. Ventilation for buildings. Air handling units. Ratings and performance, components and sections.

prEN XXXA. Ventilation for buildings. System performance.

prEN XXXZ. Ventilation for buildings. Measurements and instruments for starting and handing over the system.

prENV 12097. Ventilation for buildings. Ductwork. Requirements for ductwork components to facilitate maintenance of ductwork.

ANNEX

HYGIENIC ASPECTS CONSIDERED IN STANDARDIZATION

In Western Europe, harmonization in legislation concerning technical products has increased very rapidly during the last few years. This process concerns all industries and includes enormous standardization work. As a manufacturers' organization, EUROVENT is involved in many standardization activities, directly through official liaisons with several Technical Committees, and indirectly through active input by many experts in several Working Groups.

Possibly the most important normative document concerning HVAC products is the Construction Products Directive (CPD), agreed in EC level in the end of 1988 and implemented in national legislation in EU and EFTA countries. Many HVAC products are already regulated in Europe by other directives, too: machinery safety, electromagnetic compatibility, low voltage etc.

Standardization, with an original target in removing technical barriers of trade, is going on in full speed. Still a large majority of all standards is developed on voluntary basis, starting of industry's own interest to promote fair competition.

Since some years ago, links between standards and legislation have been under preparation, but in the field of ventilation and air conditioning, these preparations have not yet reached an active finalization stage.

Standards which, by a mandate, are linked to legislation (directives) are called harmonized European standards. The European Committee of Standardization, CEN, is the organization which produces European Standards (EN's), both harmonized standards and other standards (on voluntary basis). CEN has 18 members: The National standardization organizations of EC and EFTA countries. The standardization work in CEN is carried on in approx. 250 Technical Committees (TC's), under which there are several Working Groups (WG's) .

In the CPD, six essential requirements are given for products intended to be used in buildings. One of these essential requirements is Hygiene, Health and the Environment, others concern different safety aspects, energy economy and protection against noise.

Standardization Committee CEN TC 156, Ventilation for buildings, is active in the standardization of ventilation and air conditioning products and systems. The work has started in 1989 on voluntary basis, and presently is carried on in 9 WG's. In the future it seems obvious that a major part of their work will become mandated, which in practice will mean revision or restructuring of standards drawn up on voluntary basis, and possibly some completely new standards.

EUROVENT Document 12/1 -92 has so far been utilized in drafts dealing with the requirements for ductwork and its components to facilitate maintenance and cleaning (prENV 12097, prepared by WG 3), and in drafts dealing with hygienic aspects in air handling units (WG 5) and the whole installation (WG 7 "System Performance").

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