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# Ventilation for buildings - Ductwork - Cleanliness of ventilation systems

Ventilation des bâtiments - Réseaux de conduits - Propreté des systèmes de ventilation

Lüftung von Gebäuden - Luftleitungen - Sauberkeit von Lüftungsanlagen

This draft European Standard is submitted to CEN members for unique acceptance procedure. It has been drawn up by the Technical Committee CEN/TC 156.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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# Foreword

This document (FprEN 15780:2011) has been prepared by Technical Committee CEN/TC 156 "Ventilation for buildings", the secretariat of which is held by BSI.

This document is currently submitted to the Unique Acceptance Procedure.

# 1  Scope

This European Standard applies to both new and existing ventilation and air conditioning systems and specifies the assessment criteria of cleanliness, cleaning procedures of these systems, and the validation of the effectiveness of cleaning applies also to products, which conform to EN 1505, EN 1506, EN 13053, EN 13180 and EN 13403, used in air conditioning and ventilation systems for human occupancy defined in the scope of CEN/TC 156. This European Standard does not apply to installations for industrial processes.

Cleanliness of ventilation systems is considered important for human comfort and health, energy consumption, system service life and for cleanliness of operations or processes carried out in the ventilated area.

Considerations for change of component as an alternative for cleaning (e.g. in case of flexible ducts and air filters) are also included.

This European Standard specifies general requirements and procedures necessary in assessing and maintaining the cleanliness of ducted ventilation, including:

— cleanliness quality classification;

— how to assess the need for cleaning (visual, measurements);

— assessment frequency (general guidance); guidance of system inspections in accordance with EN 15239, and EN 15240 when relevant;

— selection of cleaning method – to be in line with handing over documentation according to EN 12599;

— how to assess the result of cleaning.

This European Standard is a parallel standard to EN 12097, which specifies requirements for dimension, shape and location for access panels for cleaning and service in ductwork systems.

This European Standard is made as an umbrella standard with informative annexes that can be revised, completed and further added in future revisions of this European Standard for specific system types, and products or applications in the system, such as:

— Air Handling Units (AHU);

— filter;

— humidifiers;

— heat recovery units;

— decentralised air treatment units such as fan-coil units, induction units;

— terminal devices;

— kitchen extract equipment.

The main target groups of this European Standard are specifiers of the cleanliness quality classes and cleaning methods primarily system designers who also specify the system of access, building

owners, services companies, maintenance companies, end users and consultancy and control companies.


## 2    Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12599, *Ventilation for buildings — Test procedures and measuring methods for handing over installed ventilation and air conditioning systems*

EN 12792:2003, *Ventilation for buildings — Symbols, terminology and graphical symbols*

EN 14799:2007, *Air filters for general air cleaning — Terminology*


## 3    Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12792:2003 and EN 14799:2007 and the following apply.

**3.1**
**acceptable cleanliness level**
amount of dust or other impurities not to be exceeded, according to the specified measurement method

**3.2**
**acceptable post-clean level**
no loose dust is detected visually on the duct surface after cleaning and the system is capable reaching an acceptable cleanliness level according to a defined measurement method

NOTE    In case of conflict (e.g. between the building owner and the user), or uncertainty objective methods are needed to assess the cleanliness/dirtiness.

**3.3**
**acceptable dust accumulation level (new ductwork)**
acceptable cleanliness level on new ductwork as handed over from builder to user

NOTE    In practice this means the quantity of pollution which is deemed acceptable.

**3.4**
**cleanliness**
state or level of pollution defined as acceptable according to specification and a particular measurement method

NOTE    Cleanliness is not absolute, it is defined by limit values. Dirtiness is the exceeding of such a defined limit value.

**3.5**
**cleanliness quality class**
in the scope of this standard there are three levels of cleanliness quality standards to be applied to various buildings and types of system

    A.  Low

    B.  Medium

**6**

C. High

**3.6**
**visual inspection**
subjective method to evaluate cleanliness level of surfaces

# 4   Symbols and units

For the purpose of this document, the symbols and units given in EN 12792:2003 apply.

# 5   Criteria for cleanliness and assessment

## 5.1   General

The key issue is to design, build and maintain the whole ventilation system so that it can be kept clean enough during the whole lifetime of the installation. The following requirements, as well as the methodology described in Clause 5, applies to the ductwork but can be also applied to air handling units (according to EN 13053) and entire systems (see EN 13779:2007, Annex A) Therefore it is necessary to specify the cleanliness quality class from the beginning and include in the specification both design and installation issues and means to maintain a sufficiently clean ventilation system for its whole lifetime. The design and installation issues shall include (as a minimum):

—  cleanliness quality class;

—  cleanliness criteria and measurement method;

—  production of the system components;

—  delivery to site;

—  site storage;

—  installation;

—  protection of components after installation;

—  handing over the system according to EN 12599

NOTE    Annex A presents, as a common classification, three classes of cleanliness, application examples for ductwork, and recommendations for the frequency of regular inspections in accordance with EN 15239.

## 5.2   Assessment of the need for cleaning

Inspection of functionality and cleanliness of ventilation system is a part of proper maintenance of the ventilation systems. Mostly the inspection of the cleanliness may arise from two purposes:

—  to check if ventilation system is dirty and needs to be cleaned (exceeding of a "target level" of cleanliness);

—  to evaluate cleanliness after the cleaning work (to check cleaning work).

The assessment methodology is presented in 6.2.

For existing buildings, the inspection shall include a study of the existing documentation and recommendations to complete and update the documents.

## 5.3 Design and handing over information

In the handing-over documents the cleanliness quality class, cleanliness criteria and measurement methods shall be specified, recommendations for cleaning methods and guidelines for reaching the points to be cleaned shall also be given.

The design information shall give consideration to the expected cleaning method. Where the system has been designed to be cleaned by wet cleaning methods, warning regarding conditions and restrictions of use should be given. For example wet methods are applicable only where ducts are sufficiently moisture-tight, internal surfaces are smooth, and slope and drainage arrangements have been provided so that fluid and contaminant can be evacuated.

A sufficient number of access doors shall be provided in the ductwork. Additionally special care shall be taken regarding obstacles to cleaning such as dampers, sound attenuators etc., which are mounted in the ducts. In many cases additional access doors are needed after or before such obstacle, which then can be cleaned carefully. Requirements for location of and distance between access doors are presented in EN 12097 and EN 13779.

## 5.4 Determination of cleaning interval

The cleaning interval shall in principle be defined by reference to the cleanliness or dirtiness of the system. Cleanliness or dirtiness shall in the first instance be assessed visually and this may be confirmed by means of measurement – see Annex A.

The inspection interval to determine the need for cleaning may be defined in the system documentation in order to assist with maintenance planning or design considerations related to cleaning methods.

NOTE        Further guidance can be found from REHVA and EVHA Guidelines and also from national guidelines, e.g. VDI 6022 or HVCA TR19.

## 5.5 Assessment of the result of cleaning

Methods for assessment of the need for cleaning can be also applied for assessment of the result of cleaning.

The preferred method of post-clean verification is given in Annex A.

See also 7.1.

# 6 Methodology

## 6.1 General methodology

Figure 1 presents a procedure to control and maintain cleanliness of ventilation system. It does not include the design stages or selection and specification of the system, or any of its components.

The system shall be first checked visually, both in assessing the need for cleaning and in verification of the result of cleaning. Objective measurements are needed if the visual inspection results in disagreement or uncertainty about cleanliness or need for cleaning. See Figure 1 for an explanatory flow-chart.

Objective measurements may be defined in advance as part of the cleaning or inspection plan.

NOTE        REHVA Guideline and some national guidelines like VDI 6022 and FiSIAQ Guideline give more detailed guidance on product selection and specification from the hygienic point of view.
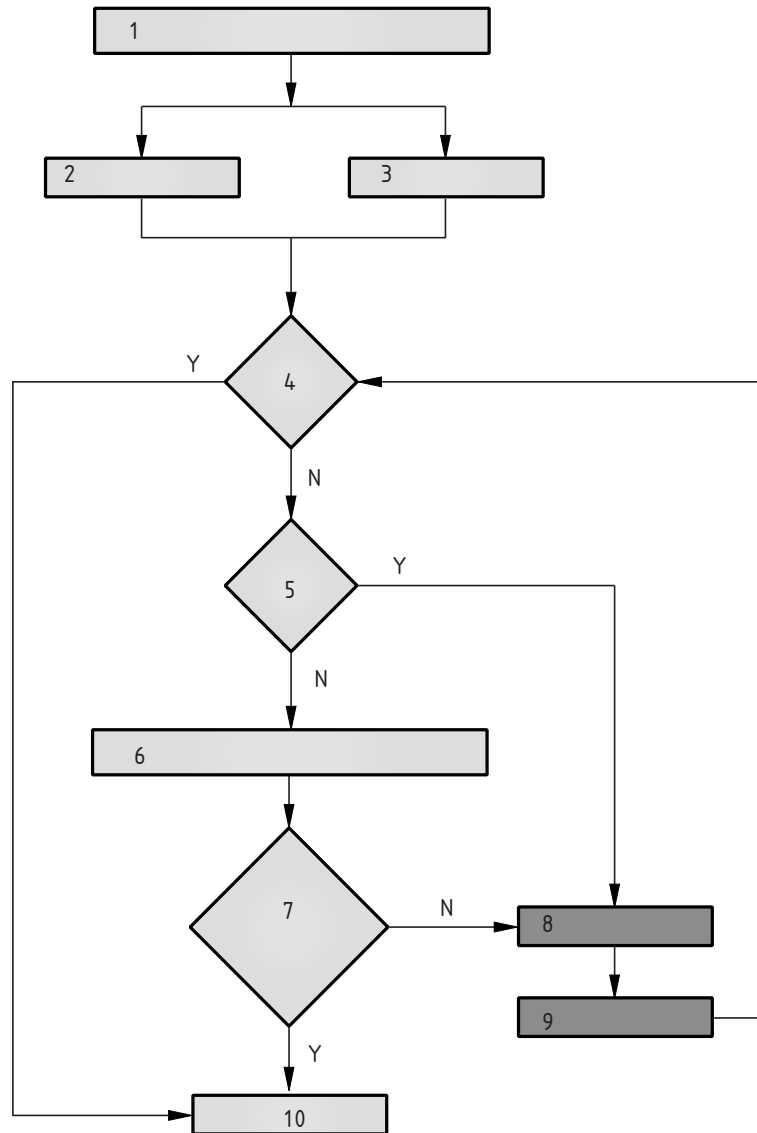
**Key**

1 control and maintenance of cleanliness of air handling system

2 commissioning

3 periodic inspection

4 visually clean?

5 clearly unclean?

6 objective measurements

7 acceptable cleanliness level

8 cleaning

9 verification

10 documentation

Y yes

N no

**Figure 1 — Schematic flow chart for procedures to maintain cleanliness of ventilation system**

If the components are certified for cleanliness or the cleanliness after production is otherwise verified, and if the cleanliness instructions are properly documented, the commissioning may be reduced to checking the documentation and spot checking of the system cleanliness (compliance with the documentation). See also 6.2.2.

The methods applied for objective measurements and verification need to be consistent so that the result of inspection is acceptable and give reliable grounds for decision making to order cleaning work of the system when needed. Verification after cleaning is needed for quality control of the cleaning work, and to verify the cleaning result.

NOTE 1   Annex H describes the preferred method of objective measurements.

NOTE 2   An example of acceptable levels of cleanliness (or dirtiness) is explained in Annex F.

Objective methods are needed if any guidelines or demands on cleanliness are set in official or in voluntary documents. The methods to evaluate the cleanliness vary, and thus target values given for the cleaning shall be accompanied by a description of the measurement method. Certain rare visible signs like visible microbial growth are enough to reveal the need for cleaning. For systems (consisting dust with less potential health risks) affected by dust the visible signs are not so clear and evaluation of the need by measurement may be needed to find out whether the ventilation system should be cleaned or not. Suspected instances of hazardous dusts such as asbestos and radiological materials need specialist investigation and should be dealt with separately.

## 6.2   Assessment of the need for cleaning

### 6.2.1   General

Assessment of the characteristics of the contamination of the system is important in order to define the cleaning method to be used.

System components are considered to be polluted when visual inspection and analytical verification give evidence of unacceptable dust level, microbial or other contamination. Assessment will be carried out through inspection. Dust accumulation, the type of pollutants, such as "bacterial growth should determine the need for cleaning, cleaning methods to be used and the required environmental controls.

Elements to be inspected for cleanliness start from the outdoor air intake and should include at least:

— Air Handling Units (AHU's). AHU's assessment should include all their components and sections: outdoor air intake, any mixing sections fan section, filters, plenums, heating and cooling coils, condensate trays, sound attenuators, heat recovery section, and humidifier section including droplet eliminators;

— supply air ductwork, including all types of terminal devices and terminal units, sound attenuators, duct-mounted heating and cooling coils, dampers and valves;

— extract air ductwork, including all types of components;

— return and recirculation ductwork, including all types of components;

— fresh air intake ductwork.

### 6.2.2   Inspection plan

The inspection plan consists of the following information:

— review plan and reports, including cleanliness quality class and measurement methods;

— determining which systems will be inspected;

— determining where to inspect and sample (see note);

— choosing equipment and tools.

Additionally, the inspection plan describes the requirements of the specific qualification and experience for inspectors before they are authorised to carry out inspection work. The assessment frequency shall be specified.

NOTE 1   There are two types of inspection, according to EN 15239: pre-inspection including mainly collection of documentation and brief visual look, and full inspection on site.

For new buildings, owner, specifier and builder may agree a particular inspection plan to suit their requirements.

NOTE 2   Recommendations for assessment frequency are given in Annex A. To obtain objective results a representative number of samples from representative parts and sites in the ventilation system should be selected for evaluation of the cleanliness of the whole system. A good rule of thumb for choosing sites or taking samples is to select areas where the dust deposits are obvious, or liable to cause reduced indoor air quality (IAQ) For inspecting and sampling, the ventilation system can be divided in two parts, the ductwork and the rest of the system. Before inspection or sampling, the sites should be selected at random with the aid of the design documents. The sampling sites in the ductwork should be selected from the main duct starting from the AHU, main ducts, and branch ducts. The sampling sites should include straight duct lengths and ducts with changes of direction or terminations. In the rest of the system, filters or humidifiers give usually a good indication of the cleaning needs.

NOTE 3   System cleanliness inspections should also make reference to other parts of the as described in 6.2.1, and with particular reference to critical components such as filters and wet areas.

## 6.2.3   Evaluation methods of dust accumulation

Different methods to evaluate cleanliness of ventilation systems are available.  The simplest methods are based on more or less subjective visual observation of the cleanliness of ventilation system combined with use of some special instrumentation. The advanced techniques are able to give relatively accurate results that are comparable to given limit values.

NOTE     The various methods available are discussed in Annex H. In Annex A preferred measurement methods and limit values are given which relate to various cleanliness quality classes, and to post-clean verification of cleanliness.

## 6.3   Cleaning plan

If, as assessed according to 6.2, cleaning is needed, a cleaning plan shall be provided. The cleaning plan shall include:

— a summary of the assessment including the list of the systems and parts that need to be cleaned;

— detailed time schedule of cleaning;

— cleaning methods to be applied;

— description of how access will be gained to ducts and equipment not visible in the rooms (ducts, air handling units);

— list of components to be removed for cleaning, and components to be replaced (when relevant);

— protection of the rooms in which the cleaning equipment is used;

— how and when the occupants are informed (including protection and safety considerations);

— microbiological considerations when relevant, including considerations for the use of disinfection;

— criteria to assess the need for involvement of a specialist on microbiological issues; technical data, including an estimate of the present level of dust and impurities, and target levels for cleanliness after cleaning; see Annex A;

— evaluation methods for cleanliness after cleaning.

One example of technical cleaning plan is presented in Annex B.

## 6.4  Cleaning methods

Cleaning methods shall be sufficient to achieve the required level of cleanliness without damage to the system, to building users' health and safety, and to the environment generally.

NOTE    Specific guidance about cleaning methods can be found in guidebooks published both nationally and on an EU basis such as those from REVHA and EVHA.

# 7    Evaluation and reporting

## 7.1    Evaluation of cleaning

The final evaluation of cleaning shall be made after all parts of the ductwork or system subject to cleaning have been assessed as visually clean.

Objective verification of post-clean cleanliness shall be carried out where necessary or as a result of dispute or uncertainty.

The preferred method and limit value for post-clean verification of cleanliness is given in Annex A. Other methods may be selected voluntarily by agreement of parties to a cleaning contract.

## 7.2    Cleaning report

A report shall be prepared and signed. The report shall include at least the following details:

Details of the object (building, ventilation system, etc.):

— the address, name, or other unique identifier of the property;

— the owner or manager of the building;

— the date of the inspection, cleaning and evaluation.

List of the documents provided, including documentation of the product certificates and manufacturer's or supplier's instructions, whenever available.

Details of the systems inspected:

— physical descriptions of the systems subject to inspection and cleaning;

— inventory of equipment.

Methods and equipment used for cleaning, and assessment before and after cleaning (visual, measured):

— results of assessment before cleaning;

— scope of cleaning (entire system/ part of system);

— results of assessment after cleaning;

— documentation of the methods and equipment;

— recommendations (inclusive recommended time for next assessment and cleaning).

# Annex A
## (informative)

# Cleanliness quality classes

## A.1  General

This annex gives a summary of three cleanliness quality classes. It is a key issue to pay attention to cleanliness in design of systems and especially in component selection and specification. It may be modified to take better into account some existing national guidance such as FiSIAQ guideline and VDI 6022. Application examples are presented in A.2, and more specific applications in Annexes C and D.

The following four major contaminants from all components may deteriorate IAQ and should be limited:

— residues of lubricant oils from duct manufacture;

— dust accumulated during manufacture and installation or debris from construction;

— dust accumulated during operation;

— deposited micro-organisms, particularly when toxigenic species are present and conditions are favourable for their survival and growth during storage, installation and operation.

## A.2  Application in general

These levels of cleanliness quality class should be generally applied as follows:

**Table A.1 — Typical applications of cleanliness quality classes**

| Quality Class | Typical examples |
|---|---|
| Low | rooms with only intermittent occupancy e.g. storage rooms, technical rooms |
| Medium | offices, hotels, restaurants, schools, theatres, residential homes, shopping areas, exhibition buildings, sport buildings, general areas in hospitals |
| High | general working areas in industries, Laboratories, treatment areas in hospitals high quality offices |

## A.3  Assessment frequency recommendation

Assessment frequency described on Table A.2 should be considered as the minimum recommendations and the necessity of increasing them will depend on the environment conditions, on the activity and on mechanical and human conditions in both building and its surroundings.

In most cases inspection frequency should be specified rather than cleaning frequency since changing and unknown conditions may alter the actual required cleaning frequency. Inspection should be regular, cleaning subject to inspection

**Table A.2 — Recommended inspection intervals according to cleanliness quality class, in months**

|  | AHU | Filters [a] | Humidifiers | Ducts | Terminals |
|---|---|---|---|---|---|
| Low | 24 | 12 | 12 | 48 | 48 |
| Medium | 12 | 12 | 6 | 24 | 24 |
| High | 12 | 6 | 6 | 12 | 12 |

Air handling units equipped with humidification or adiabatic cooling systems, or located in mild and wet weather conditions should be assessed at least twice a year, whatever the use of the building.

[a]    Filters should be inspected and maintained according to the manufacturer's recommendations, with these intervals as the minimum ones.

## A.4  Cleanliness class quality measurements

The preferred measurement method is derived from the Finnish vacuum test method whereby a gravimetric result is achieved – see Annex I for details of the preferred test method.

This method is suitable for circular, flat-oval and rectangular sheet metal duct types.

For internally-lined (or other irregular, porous surface) ductwork, the gel tape method is preferred, and further work is necessary to establish limit values using this method, however voluntary agreements may be made using this method.

To comply with the cleanliness quality classification samples should show results below the limit values given in Table A.3.

NOTE    See also REHVA: Cleanliness of Ventilation Systems 2007, Figures 15 and 16 for illustration of visual comparison to measured levels.

**Table A.3 — Acceptable cleanliness levels**

| Cleanliness quality class | Acceptable cleanliness level Supply ductwork | Acceptable cleanliness level Recirculation or secondary air ductwork |
|---|---|---|
| Low | < 4,5 g/m$^2$ | < 6,0 g/m$^2$ |
| Medium | < 3,0 g/m$^2$ | < 4,5 g/m$^2$ |
| High | < 0,6 g/m$^2$ | < 3,0 g/m$^2$ |

## A.5  Unacceptable fouling – Extract

For dry dust-affected extract ductwork (where the air is discharged to atmosphere) less stringent limit values are applied.

Extract systems should be cleaned when airflow through the system reduces by 15 % or more.

If such measurement is not practicable, then the gravimetric dust level measurement may be used. An extract duct should be cleaned when the dust level exceeds 9.0 $g/m^2$ using the Finnish vacuum test method.

## A.6  Acceptable dust accumulation level (new ductwork)

Acceptable dust accumulation (new ductwork) defines acceptable cleanliness levels on new ductwork as handed over from builder to user. In practice this means the quantity of fouling which is deemed acceptable.

**Table A.4 — Acceptable dust accumulation levels in new ductwork**

| Cleanliness quality class | Acceptable dust accumulation level<br><br>Supply, recirculation or secondary air ductwork | Acceptable dust accumulation level<br><br>Extract ductwork |
|---|---|---|
| Low | < 0,9 $g/m^2$ | < 1,8 $g/m^2$ |
| Medium | < 0,6 $g/m^2$ | < 1,8 $g/m^2$ |
| High | < 0,3 $g/m^2$ | < 0,9 $g/m^2$ |

## A.7  Acceptable post-clean level

After cleaning the ductwork, and other relevant, surfaces should be visibly clean and capable of meeting the required acceptable post-clean level.

For most normal duct cleaning work, the preferred method of establishing acceptable post-clean level is to use the vacuum test method – see Annex I for technical details. The post-clean level should be less than 0,3 $g/m^2$.

NOTE    Other criteria may be voluntarily agreed such as chemical standards e.g. absence of chlorides after fire restoration work, freedom from asbestos fibres, microbiological or radiological contaminants.

# Annex B
## (informative)

# Example of cleaning plan

This annex presents one example (according to UNE 100012) of a cleaning plan for dry dust. The cleaning plan is needed in case the assessment reveals a need for cleaning. The tasks listed in the right column are always optional, and also other tasks may be included in the cleaning plan.

The plan is not exhaustive and new technologies may be available to ensure acceptable post-clean level.

| CLEANING PLAN (example) | | |
|---|---|---|
| **WORK** | **TARGET** | **TASKS** (examples; the list of tasks is drawn up case by case as the result of assessment) |
| **1** **Cleaning of coils** | Achieving iesign air volume and thermal exchange | 1 Brushing and vacuum<br>2 Detergent/solvent application<br>3 Brushing<br>4 Rinse with pressurized water<br>5 Compressed air |
| **2** **Drainage/ condensate tray cleaning** | Removing the focus of infection and nutrients that support microbial pollution | 1 Brushing and vacuum to dry<br>2 Detergent application - Disinfection product.<br>3 Brushing<br>4 Rinse and dry |
| **3** **Fan cleaning** | Achieving design air volume and a reduction of the dirtiness of the System downstream | 1 Brushing and vacuum<br>2 Detergent/solvent application<br>3 Brushing<br>4 Rinse and dry<br>5 Compressed air<br><br>For all blades and casing NOTE   Designer may need to provide access to fan blades. |
| **4** **Panels cleaning** | Avoiding airborne particles to go into the ductwork | **\*Metallic:**<br>1 Brushing and vacuum to dry<br>2 Detergent application- Disinfection product.<br>3 Brushing<br>4 Rinse and dry<br><br>**\*Lined with porous insulators**<br>1 Brushing and vacuum to dry<br>2 Sealer product application for fibre sealing |
| | | 1 Manual brushing |

| 5 | Anti corrosion treatment | Avoiding corrosion or corrosion increasing | 2 | Mechanical brushing |
| | | | 3 | Vacuum suction of the total oxide dust |
| | | | 4 | Anti corrosion product application |

| 6 | System disinfection | Reducing microbial Pollution to a defined level | 1 | Disinfection product spray or gas |
| | | | NOTE | Careful risk assessment is necessary. to demonstrate the safety of the procedure for workers, system users, environment and the system itself. |

| AIR CONDITIONING SYSTEMS CLEANING PROTOCOL | | | | |
|---|---|---|---|---|
| | **WORK** | **TARGET** | | **TASKS** |
| 1 | Cleaning of the extract air ducts | Removing dust<br><br>Always begin from the end of the air duct, if the system is to be re-used during the course of the work | 1 | If not is possible to access through exisiting openings such as access panels and other openings, then install new access |
| | | | 3 | Direct vacuum extraction, or dislodging by means such as brushing or compressed air in combination with air/dust extraction |
| 2 | Cleaning of extract air terminals | Removing dust | 1 | Disassembly where necessary |
| | | | 2 | Brushing and vaccuming 3. Compressed air |
| | | | 4 | Detergent/solvent if necessary and |
| | | | 5 | Rinse and dry if wet methods used |
| | | | 6 | Re-assembly |
| 3 | AHU cleaning | Removing dust | 1 | Apply the air conditioning system cleaning protocol |
| 4 | Diffusers cleaning | Removing dust | 1 | Disassembly where necessary |
| | | | 2 | Brushing and vaccuming 3. Compressed air |
| | | | 4 | Detergent/solvent if necessary and |
| | | | 5 | Rinse and dry if wet methods used |
| | | | 6 | Re-assembly |
| | | Removing dust | 1 | If not is possible to access through existing openings such as access panels and other openings, then install new access |
| 5 | Supply air duct | Always begin from the | 3 | Direct vacuum extraction, or dislodging |

| **cleaning** | beginning of the air duct, if system is to be re-used during the course of the work | by means such as brushing or compressed air in combination with air/dust extraction |
| | | 1   If not is possible to access through existing openings such as access panels |
| | | 5   Sealing of duct in the case of being porous. |
| Post-clean verification | To confirm that expected outcome has been achieved and to record system condition of Cleanliness | Verify that acceptable post-clean level has been achieved |
| | | 1. Visual inspection |
| | | 2. Vacuum test to confirm measured level |

# Annex C
## (informative)

# Air Handling Units – specific guidance

## C.1  General

In manufacturing and construction, special attention should  be paid on the following aspects:

— complete cleaning before shipment;

— during transportation and storage, sealing of the AHU in such a way that contamination is avoided;

— preserve units during installation in such a way that contamination is avoided;

— inspection and cleaning after installation.

The following examples of material, access and installation requirements, based on EN 13053, are for normal (e.g. residential, office) and advanced cleanliness quality classes (e.g. hospitals) applications. For each criterion they can be applied independently of each other.

## C.2  Recommendations for all cleanliness quality classes

### C.2.1  Casing, including accessibility/access doors

EN 13053:2006, 6.2 gives requirements and recommendations for AHU casing, taking also into account hygiene and cleanliness aspects, including the following aspects:

— construction and materials;

— accessibility to all components for cleaning and maintenance;

— protection of components from the weather.

The ingress of unfiltered air through casing leakage can cause hygiene problems. The following tightness classes are therefore recommended as a minimum (classes according to EN 1886).

**Table C.1 — Recommended minimum tightness class**

| Cleanliness quality class | Recommended minimum tightness class |
|---|---|
| Low | L3 (A) |
| Medium | L3 (A) |
| High | L2 (B) |

## C.2.2 Filters

The recommendations given in Annex D apply also for filters and filter sections in air handling units.

## C.2.3 Humidifiers

The recommendations given in Annex E apply also for humidifiers and humidification sections in air handling units.

## C.2.4 Coils

EN 13053:2006, 6.4 gives requirements and recommendations for heating and cooling coils in AHU's, including:

— construction of the coils, including maximum recommended fin depth and minimum distance between fins;

— special requirements for cleanliness of cooling coils that are designed to dehumidify, including location, materials, accessibility etc.

If the inspection reveals a need for cleaning, the coil surfaces are cleaned according to the instructions. If no instructions are available, it is preferred to use dry methods, such as vacuum cleaning or pressurized air. The result of cleaning can be assessed either by visual inspection or, if feasible, checking the coil pressure drop at the operating air flow.

For cooling coil sections, the same requirements for drainage, cleaning, materials and disinfection apply as for humidifiers, see Annex E.

## C.2.5 Sound attenuators

See EN 13053:2006, 6.10.

## C.2.6 Fan position and cleaning, including fan motors

The position of the fans in the air-handling unit is important so that proper pressure conditions are maintained to avoid any risks of leakage of contaminated air. This is especially important for units where transfer of particles and gases are possible within the heat recovery section.

The fans and fan motors are cleaned by dry methods: brushing, vacuum or compressed air.

## C.2.7 Drainage and prevention of condensation

Penetration of rain or snow into the unit should be prevented by protecting the outdoor air openings against rain and snow and having low air speed into outdoor air openings. In cold climates it can be necessary to have a water-tight plenum section between the outdoor opening and the unit (or the first section) which guides the water immediately out of the building and/or is connected to drain.

NOTE    Cold bridges in cabinets introduce a risk of condensation on the inner or outer surfaces, depending on which side of the unit is colder. The bridging factor class, as defined in EN 1886:2007, Clause 7, should therefore be selected to take into account the climatic conditions in which the unit is expected to operate.

## C.3 Units for advanced cleanliness quality class

EN 13053:2006, Clause 7 gives extended hygiene requirements for air handling units for special applications, including:

— accessibility for cleaning purposes;

— smoothness of surfaces;

— inspection windows and lights;

— drainage and prevention of condensation.

## C.4 Inspection aspects

The condition of the filters and the filter section, so It is recommended to look at filters and filter sections, as well as humidifiers and humidifier sections at the early stage of the system inspection for cleanliness, because the condition of these components is generally a good indicator of need for cleaning. See also Annexes D and E.

# Annex D
## (informative)

# Filters – Specific guidance

Filter clogging and/or bad filter efficiency have a negative impact on indoor air quality, and increase energy consumption of the ventilation system. The side wall on the service side of the filter section should be equipped with an inspection door. The width and height of the door should be greater than the external dimensions of the replaceable filter elements. There should be sufficient free space to the side of the access door, and immediately upstream of front access filters, to allow unrestricted access for filter removal and replacement.

The condition of the filters and the filter section is generally a good indicator of need for cleaning, so it is recommended to ensure that filter quality, integrity of fitting and maintenance is assessed at the beginning of the inspection. Filters should be removed for AHU cleaning, preferably also replaced in connection with AHU cleaning. After the AHU cleaning, cleanliness, fitting and function of filters should be checked. See EN 13779 and EN 13053 for further guidance.

# Annex E
## (informative)

# Humidifiers – Specific guidance

The cleanliness of humidifiers and associated sections (of AHU or duct) is critical to good hygiene because the ready availability of moisture will strongly encourage microbiological growth. The condition of the humidifiers is a good indicator of need for cleaning, so humidifiers should be checked at an early stage of the inspection may also be started from the humidifiers.

For humidifiers for normal applications, the requirements and recommendations presented in EN 13053:2006, 6.8 apply. These include:

⎯ selection of materials;

⎯ air filtering upstream and downstream;

⎯ limit values for bacteria content;

⎯ water treatment;

⎯ overflow;

⎯ use of disinfectants;

⎯ arrangements to avoid droplet impingement;

⎯ surface finishing of the humidifier casing;

⎯ inspection and maintenance, including recording.

For additional aspects for humidifiers for special applications, EN 13053:2006, 7.5 apply.

# Annex F
## (informative)

# Ductwork – Specific installation guidance

## F.1 Acceptable dust accumulation (new ductwork)

Acceptable dust accumulation (new ductwork) defines acceptable cleanliness levels on new ductwork as handed over from builder to user. In practice this means the quantity of fouling which is deemed acceptable.

**Table F.1 — Acceptable dust accumulation levels in new ductwork**

| Cleanliness quality class | Acceptable dust accumulation level Supply, recirculation or secondary air ductwork | Acceptable dust accumulation level Extract air ductwork |
|---|---|---|
| Low | < 0,9 g/m$^2$ | < 1,8 g/m$^2$ |
| Medium | < 0,6 g/m$^2$ | < 1,8 g/m$^2$ |
| High | < 0,3 g/m$^2$ | < 0,9 g/m$^2$ |

Construction sites are inevitably dusty workplaces and so there are severe practical difficulties in keeping duct systems clean. If defined levels of cleanliness are required, then it is often necessary to carry out deliberate post-installation cleaning immediately before commissioning, in order to achieve defined, measurable levels of cleanliness.

## F.2 Protection, Delivery and Installation (PDI)

Guidance is given below regarding the preparation and protection of ductwork during manufacture and installation with a view to minimising unnecessary contamination of duct systems.

**Table F.2 — Recommendations concerning protection, delivery and installation**

| PDI Level | Factory seal | Protection during transit | Protection during site storage | Site clean | Cap off on site | Post-installation clean |
|---|---|---|---|---|---|---|
| Basic PDI | No | No | No | No | Risers only | No |
| Intermediate PDI | No | No | Yes | Yes | Yes | Not unless shown to be necessary |
| Advanced PDI | Yes | Yes | Yes | Yes | Yes | Yes |

**Basic level**

**Condition of ducts ex works:** Ductwork leaving the premises of the manufacturer may include some or all of the following:

— internal and/or external self-adhesive labels or marking for part(s) identification;

— exposed mastic sealant;

— light zinc oxide coating on the metal surface;

— a light coating of oil an machine formed parts;

— minor protrusions into the airway of rivets;

— screws, bolts and other jointing devices;

— internal insulation and associated fixings;

— discoloration marks from plasma cutting process.

The ductwork is not generally wiped down or specially cleaned at this level unless specified.

**Delivery to site:** Unless otherwise specified, ductwork delivered from the premises of the manufacturer is not protected.

**Installation:** Before the installation of individual duct sections they should be inspected to ensure that they are free from all debris but not be wiped or specially cleaned.

**Protection of ductwork risers:** All risers should be covered to prevent the entry of debris into the duct. In respect of the safety of personnel, full regard should be given to requirements of health and safety at work. Downward facing and horizontal duct openings: These are not covered.

**Intermediate level**

The intermediate level includes the following requirements in addition to the provisions of the basic level.

**Site storage:** The area provided for storage should be permanently clean, dry and protected from site dust and this may require a boarded floor and water resistant covering.

**Installation:** The working area should be clean and dry and protected from the elements. The internal surfaces of the ductwork sections should be wiped to remove excess dust immediately prior to installation. Open ends on complete ductwork and overnight work-in-progress should be sealed. Prior to the installation of air terminal devices, any remaining protective end covers should be removed before installing the terminal device with the damper in closed position.

**Advanced level**

Advanced level includes the following requirements in addition to the provisions of the intermediate level.

Since the ductwork will be cleaned post-installation many costly and onerous procedures such as capping during transport can be dispensed for most installations.

In some cases further protection methods may be applied by means of voluntary documents.

**Production and site delivery:** All self-adhesive labels for part identification should be applied to external surfaces only.

**Site storage:** A clean, dry and dust free environment should be provided for the storage of ductwork prior to installation.

**Installation:** The working area should be clean, dry and dust free.

**Special considerations:** The oil-residues may be only mentioned as a recommendation, because at this time no practicable test method for the use in field is available.

An agreement about allowed microbiological colonisation should be separately specified, including realistic verification criteria. For most uses clean installation is normally enough to keep the level of microbiological colonisation negligible.)

## F.3 Application of cleanliness levels - airtightness

The airtightness of the ductwork is also important for cleanliness. Leakages in unclean hollow spaces or suspended ceilings can have a big influence to the indoor air quality, especially for the advanced level. The minimum recommended tightness class related to these cleanliness levels can be expressed as follows, corresponding with the technical recommendations of EN 13779:2007, A.8.2,

**Table F.3 — Recommended minimum tightness class**

| Level | Recommended minimum tightness class |
|---|:---:|
| Basic | B |
| Intermediate | C |
| Advanced | D |

# Annex G
(informative)

# Terminal devices and units – Specific guidance

Diffusers and other supply and exhaust air units, as well as fan coil units, induction units, in-line plant such as CAV and VAV boxes, chilled beams and chilled ceilings, should be easy to clean.

Visual inspection is usually sufficient in assessment of need for cleaning and for the result of cleaning, but verification can be carried out using vacuum test methods as for ductwork.

# Annex H
## (informative)

# Measurement methods for dust accumulation

## H.1 Evaluation methods of dust accumulation

### H.1.1 General

Different methods to evaluate cleanliness of ventilation systems are available. The simplest methods are based on more or less subjective visual observation of the cleanliness of ventilation system combined with use of some special instrumentation. More advanced techniques are able to give relatively accurate results that are comparable to given limit values. In Figure H.1 the methods are presented in sequence of the reliability level of their results.
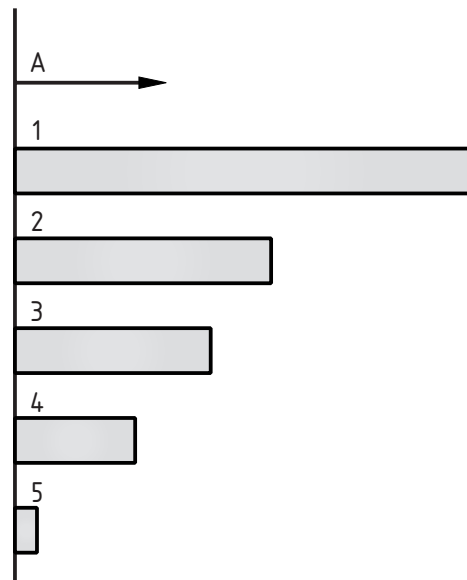


**Key**

A    reliability
1    vacuum sampling on filter, or wiping the dust with a cloth
2    gravimetric tape method
3    evaluation with optical gel tape
4    visual evaluation with reference scale
5    visual survey without reference scale

**Figure H.1 — The reliability level of the results by different evaluation methods for dust**

### H.1.2 Visual inspection

Visual inspection method is a basic method to evaluate the cleanliness of ventilation system. Although it is subjective, as such it gives a very good, low-cost and instant estimate of the condition on ventilation system surfaces. It is usually good enough to detect e.g. extreme microbial growth such as slime in water reservoirs, and deposits from major malfunction of filtration, and to reveal lack of maintenance. The visual inspection may be assisted with technical devices such as cameras, endoscopes, and robotic cameras with video capability. In some references, the visual inspection is

made more repeatable by using standardised forms and notebooks that make the inspection more systematic. To make visual inspection more objective, the inspectors should also have experience from many ventilation systems. In clear cases, visual inspection by a trained person is also a useful method to evaluate cleanliness after the cleaning.

For new installations the visual inspection may be aided with a scale based on reference material consisting of photographs of newly installed ductwork for comparison. The scale presents the amount of dust accumulation on the photographs so that the inspector is enabled to give a numeric value for evaluation.

### H.1.3 Methods of verifying deposited solid dust and micro-organisms

Most of the methods to verify cleanliness of ventilation systems are based on the measurement of mass of the dust and debris deposited on a known surface area. In the filter sampling method dust is vacuumed on a weighed filter either with or without a filter housing. In the latter method (typically for dirty ducts), the dust attached to the walls of the filter housing may also be included in the sample. Several methods have been developed in order to loosen dust from the surface. Some methods, such as NADCA/HVCA vacuum test rely on the ability of the method to remove dust from the surface to act as a proxy for the ability of the dust to be re-entrained into normal system airflows.

It is also possible to take a sample without vacuuming by using a wiping method with a filter or nonwoven cloth. Solvent may increase the loosening of the dust from the surface, which makes the method very effective for greasy/oily contamination; however careful consideration is necessary to ensure a proper comparison of pre- and post-sampling weight of the wipe and its solvent, and to ensure consistent wiping pressure.

Sticky tape may also used to collect deposited dust particles from the surface. The tape is weighed before and after collection of the dust and the difference of the mass is used in calculation of the dust density on the surface. The shape and dimensions of the tape restricts the sampling area constant.

On very dusty surfaces, the collection capacity of tape on surfaces with dusty surfaces can be overwhelmed and so is not applicable in those circumstances.

A gel tape method is applicable for verification of the cleanliness of indoor surfaces. The sample is collected on a transparent tape that contains gelatine gel as glue. The transparency of the tape is measured with a special analyser before and after the sampling. The analyser gives a percentage value (%) which is related to the density of dust particles on the gel surface. The optical method with gelatine tapes or with semi-transparent engineering adhesive tapes may be also used to evaluate the cleanliness of air ducts, especially after duct cleaning.

Another method is based on measuring the thickness of the dust deposit. The thickness of dust layer is measured with the aid of a special device which uses an electromagnetic induction sensor. This method is not typically sensitive enough to be used for post-clean verification.

A simple wet film thickness method using a measuring comb is typically used to measure grease/oil deposits in kitchen extract systems.

Microbial contamination is usually determined by the cultivation method which also enables the identification of the genera and species of micro-organisms. Determining the fungal spore and bacteria counts can be done from a dust sample collected using the filter sampling method.

Direct counting of spores or microbial cells with aid of microscopy is usually impossible because of the high density of dust particle with various light reflectance properties in the samples.

## H.2  Summary of methods for evaluation of cleanliness

A list of the evaluation methods is expressed in Table H.1.

**Table H.1 — Summary of the methods used for evaluation of cleanliness of ventilation systems**

| Evaluation method | | |
| --- | --- | --- |
| **Visual inspection** | | |
| Non-systematic inspection | No scaling for the cleanliness, subjective | |
| Systematic | Grades for the cleanliness, semi-objective optical and electrical devices may be used to store pictures and video | |
| **Quantitative methods for dust** | | |
| Method | Units | Note |
| Filter sampling | $(g/m^2)$ | most common, repeatable |
| -HVCA vacuum test method | | |
| -Vacuum/brush method | | |
| Cloth wiping | $(g/m^2)$ | effective when used with solvent, care needed for weighing and pressure |
| Tape sampling | $(g/m^2)$ | suitable for low levels ($<\sim 4$ $g/m^2$) |
| Gel tape sampling | (%) | need special device |
| Deposit thickness test | (µm) | need special device |
| Comb method | (µm) | need a simple instrument |
| **Quantitative methods for micro-organisms** | | |
| cultivation of dust sample | (CFU/g) | identification of the cultivable species |
| cultivation of liquid sample | (CFU/ml) | |
| cultivation of swab sample | $(CFU/m^2)$ | |
| counting of spores in dust sample | (spores/g) | gives total spore count, needs a specific separation technique |
| **Quantitative analysis of oil residues** (usually not performed in the field) | | |
| Filter contact method | $mg/m^2$ | analysis by gas chromatograph of by IR-spectroscopy |

# Annex I
## (informative)

# Preferred vacuum test method

## I.1 Test equipment

1) Air pump: A high volume air sampling pump capable of drawing 15 l/min through a cassette containing 37 mm matched weight or pre-weighed filters.

2) Filter media: 37 mm mixed cellulose ester (MCE) matched weight or pre-weighed filters (0,8 μm pore size) in three piece cassette.

If pre-weighed filters are used, care has to be taken to dessicate samples at pre-weighing and post-exposure weighing to counter-act possible humidity effects

Other size sampling filters (pore size 0,8 mm) may be used, and care should be taken to ensure that smaller diameter filters (< 37 mm) are not over-loaded, i.e. they are recommended only for post-clean verification.

3) Calibration: Air volume rate calibration device that is accurate to $\pm$ 5% at 15 l/min.

4) Template: Approximately 0,4 mm thick, 0,01 $m^2$ sampling area, typically 10 cm $\times$ 10 cm. Other shapes can be used to suit different sampling locations.

## I.2 Sampling procedure

1) Inspect visually the surfaces.

2) Secure template to surface to be sampled so that it will not shift position during sample collection. The template to lay flat against the surface to be sampled. Check that the surface to be sampled is dry and that the fans are not running when the sampling is being conducted.

3) Remove protective plugs from cassette.

4) Attach outlet end of cassette to pump tubing. Attach a 5 cm length of suction tube to the inlet side of the cassette.

5) Adjust air flow using appropriate calibration device to 15,0 l/min.

6) Vacuum the open area of the template by scraping the inlet tube across the entire exposed area. Move the suction tube at a rate not greater than 5 cm/s.

7) After the surface has been vacuumed, remove the tubing and replace the plugs in the capsule.

8) Mark the cassette (unless pre-marked) with an indelible pen. A code may be used to protect client confidentiality. A log should be kept to correlate the code with other important information such as job site, location in ductwork, date, etc.

9) Send the cassette to an independent laboratory for weighing using a precision balance of at least 4-point accuracy.

## I.3 Analysis procedure

1) In the case of post-clean verification measurement, the filters alone are weighed, i.e. the difference between the two matched weight filters, or the gain in weight on the pre-weighed filter gives the raw result.

2) In the case of measurement of probable dirty surfaces, where loose dust is likely to have been captured in the sampling capsule but not impinged on the filter(s), a different analysis methodology is employed as follows:

   a) The entire cassette is weighed.

   METHOD FOR MATCHED WEIGHT FILTERS

   b) The cassette housing is weighed after the filters and loose dust have been removed and put to one side.

   c) The bottom (clean) of the matched weight filters is weighed and the value multiplied by 2.

   The total dust collected in the cassette is calculated as: (a-b-c).

   METHOD FOR PRE-WEIGHED FILTER

   d) The cassette housing is weighed after the filter and loose dust have been removed and put to one side.

   e) The weight gain on the pre-weighed filter is measured.

The total dust collected in the cassette is calculated as: (a-d+e)

3) The laboratory will report results in milligrams (mg). The raw results should be converted into $g/m^2$ by multiplying by 100 and an assessment offered in general terms to comprise the report to the client.

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