“DIAGVENT” GUIDEBOOK - CHECKING THE PERFORMANCE OF VENTILATION SYSTEMS

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ABSTRACT

Ventilation in buildings is necessary first for hygienic reasons and also to preserve the building structure. This is more essential, today, because the buildings are more and more airtight, mainly due to energy regulations. It is also evident that air renewal energy losses and fan consumption become more and more important in relation with the total energy consumption of buildings.

Nevertheless, many defaults are encountered on installed ventilation systems. It seems necessary to check the installations, at the starting up and regularly in time, and not only when the problems occur.

In France, today, there is no obligation for regular inspections of ventilation systems, whereas it is a legal requirement in other countries like Sweden.

DIAGVENT method has been established on the basis of many inspections on different residential and commercial buildings, and on the Swedish experience which where applied in France.

This method is described in a small practical guidebook (around 30 pages). It includes three levels of inspections or diagnosis:

- DIAGVENT 1: no measurements, only visual checking, for commissioning new installations. The main objective is to verify that the installed system is in accordance with the expected one. The system is started on ;
- DIGVENT 2: is the main part in the method ; it is a more detailed inspection, both for new and existing installations ; it includes not only visual checks but also performances measurements (total and local air flow rates, pressures, electrical power) ; it also includes analysis of the results and indications for feasible improvements or more detailed investigations, if necessary ;
- DIAGVENT 3: corresponds to specific measurements, when a strong problem has been revealed after DIAGVENT 1 or 2, or after a complaint from the users. It may lead to a very detailed inspection and may include sophisticated measurement techniques (for acoustics, air leakages, air pollution transfers, etc.). Specific measurements are not detailed in the guidebook, but it is shown, depending on the nature of the problem, which point should be checked and what kind of measurement or analysis should be made.

DIAGVENT guidebook should be a practical tool for the professionals: engineering consultants, inspectors, installers, maintenance companies …
It gives, for example, practical information on standard measurement devices for DIAGVENT 2: which type of device and where it can be bought. It gives some useful reference values (air flow rates, duct air leakages, fan electrical consumption…) to help the professional during the analysis of the results.

This guidebook can be free downloaded on the CETIAT website. French professional training bodies are already interested in including this ventilation diagnosis method in their training programs.

KEYWORDS

Ventilation, Checking, Performances, Guidebook, Inspections, Commissioning.

INTRODUCTION

It is not new to say that the performances of ventilation systems, in practice, do not always properly achieve initial objectives, which are to bring hygienic air to the occupants in buildings. Of course, a lot of installations are also in a good situation and give satisfaction to the owner and to the occupants. But some observations are not acceptable; other situations are very poor quality and often there is no appropriateness between the results and the intrinsic performances of the ventilation components.

As this situation goes on, it seems necessary to check the installations, at the starting up and regularly in time, and not only when the problems occur. In France, today, there is no legal requirement for systematic inspection on ventilation installations; only very few of the new ones are visited.

The aim of DIAGVENT guidebook is to help the professionals: engineering consultants, inspectors, installers, maintenance companies … to make inspections on ventilation installations. Complementary with the method, DIAGVENT gives practical information on standard measurement devices and also some useful reference values (air flow rates, duct air leakages, fan electrical consumption…) to help the professional during the analysis of the results.

SOME RESULTS ON PERFORMANCES OF VENTILATION SYSTEMS IN FRANCE

During the last years, many investigations were driven by the authors on the performance of ventilation systems in different buildings. Many of them were made for ADEME, others for ALDES [1], and others for private bodies. One initial objective of ADEME was to test a method, like the Swedish method Boverket [2]; for that, a Swedish inspector took part in some investigations on commercial buildings [3].

Observations and measurements, on more than thirty buildings (residential, offices, schools, hotel, etc.) and fifty ventilation systems (majority of simple exhaust systems, some balanced systems) show the main following results:

- Total air flow rate at the fan case :
    - Half the number of fan units do not give the total scheduled air flow in the range of ± 20 % ;
    - When the total flow rate is not obtained, 75 % of the fans give less than 80 % of the air flow rate, and 25 % give more than 120 % ;
- Global air leakage of the ductwork :
    - In residential applications (multifamily buildings), new or existing, the global air leakage of ventilation system is between 15 % and 45 % !
    - In commercial applications, existing, the global air leakage of ventilation system is between 10% and 35 %
    - This is in accordance with previous studies [5] ;
- Air flow rate in the rooms :
    - Due to the previous results, air flow rates in rooms are not always in accordance with the hygienic values or with the scheduled values ;
    - The situation is more difficult in some buildings like the schools where we found air flow rates in the range of 30 % to 100 %.
- Electrical consumption of fan motors :

- On about thirty installations (simple exhaust or balanced systems), it was found that 2/3 were below 0,25 W/m3/h, which is the reference in the French thermal regulation (it is quite a good result) ; and 1/5 were above the double of this reference value.

Also, other observations can be made on:

- available documentation : it is very difficult to get a complete documentation, even any documentation in many cases,
- air inlets and outlets : the main problem seems to be the connection defaults between exhaust air terminal devices and ducts ;
- controls : the users are not aware about the possibilities in the management of the systems ; many installations are running all the time instead of being switched off when the building (commercial) are not occupied ;
- dirtiness of components and ducts : air inlets and exhaust air terminal devices are very often dirty, sometimes completely blocked ; there is no general concern about cleaning ducts, which are often very dirty ; new European standards on accessibility could help in the future.

Picture 1: Air inlet, very dirty

Picture 2: Open duct (!)

Picture 3: Leakages, ductwork

DIAGVENT METHOD AND GUIDELINE

The DIAGVENT method is described in a thirty eight pages small book (A5 format)which is divided in three main parts :

- Typology of the more common installations ;
- Methods: description of the three diagnostic levels DIAGVENT 1 2 and 3 ;
- Annexes and useful information.

First Part: Typology

DIAGVENT presents a typology of the more common ventilation installations, in France:

- in residential applications :
  - simple exhaust system, self regulated
  - simple exhaust system, humidity controlled
- in commercial applications :
  - same that residential
  - air conditioning systems

It gives some simple drawings, to show the above principles.

Then, a description of the main components which will be found in the different installations is given, just to show what the inspector could find on site.

Second Part: Methods

●*DIAGVENT 1: Completeness checking and starting on.*

It seems useful to describe very simple investigations to verify that the installed system is in accordance with the expected one. No measurements are made, only visual checking. It is mainly applicable for commissioning new installations. At the end of the inspection, the system is started on.
DIAGVENT 1 follows the main steps for inspection:

- Electrical box: supply characteristics, emergency command …
- Ductwork: nature, accessibility, connexions quality, supports…
- Fan case: type, accessibility, doors, belt, supports…
- Fan is started on: rotation direction, vibrations…
- Rooms: inlets, outlets, presence of drafts, noise (the fan is running)…

At the end of DIAGVENT 1, a summary sheet is performed, listing the 5 main points of the inspection and indicating the defaults which were encountered.
A model of this sheet is given in the guidebook.
The inspector should also directly explain the results to the owner, with the support of photos.

●*DIAGVENT 2: Checking the performance of the ventilation system.*
This is the main part in the DIAGVENT method. It is a more detailed inspection, both for new and existing installations. It includes not only visual checks but also performances measurements (total and local air flow rates, pressures, and electrical power). It also includes analysis of the results and indications for feasible improvements or more detailed investigations, if necessary.
The preparation of the inspection is important: explanations to the owner; trying to get the documentation, in advance, to understand the system, to identify or select the main parts which will be inspected; questions about the feeling of the occupants; checking the maintenance reports…
Then, on site, DIAGVENT 2 will follow both the experience of the inspector (for example to adapt the inspection to the real system configuration) and the main following steps:

- Documentation : drawings, schedule of conditions, maintenance… if possible, documentation is examined in advance (see above, preparation);
- Fan(s) : visual checking (DIAGVENT 1) and measurements (air flow rate, pressures/under pressures, electrical power);
- Ductwork: visual checking mainly, partial air flow rates, pressures/under pressures, air leakage visualisation with smoke…;
- Air diffusion in rooms: visual checking (great attention to the connections between ducts and air terminal devices), local air flows, pressures/under pressures (for example between rooms)…;
- Command and controls: information, electrical supply, connections, time switch…

After inspection, analysis of the results is made: for example comparison between the scheduled air flow rates and the existing ones, calculation of a specific power ratio (W/m3/h), global air leakage evaluation…
A summary sheet is performed; a model is given, which include the main parts:

DIAGVENT 2 – Diagnostic sheet - Performance of the ventilation system				
Important default to correct ☐			Nothing or minor default ☐	
General data: address, building, occupation, owner, ventilation system, inspector name and qualification…				
Point	Default	Note *	Other observation	OK**
…				

…				

*: note=1 if the default is important or critical (for example half the scheduled air flow rate); note=2 if the default is minor (for example dust in the exhaust fan box) (as in the Swedish inspection method [2] & [3])
**: it seems to be interesting to mention, not only the defaults (see above) but also the different points which are observed and which lead to no specific remark (just to show that this point has been observed and that it is OK)

Practical information and description of the useful measurement devices is given and, at the end of the manual, Internet addresses are listed (not an exhaustive list) to help the user to find this kind of devices.

In the DIAGVENT guidebook, an indication is given on the duration of DIAGVENT 2 inspection for different sizes and types of buildings; a table is established. It is only an informative data, just to give an idea to the inspectors and to the owners.

Of course, after DIAGVENT 2, it is necessary to meet the owner and to explain the results (photos are useful) ; general observations are listed and some improvement ways are shown to the owner. Sometimes, depending on the heaviness of some defaults, it could be necessary to go to the DIAGVENT 3 diagnostic level.

●*DIGVENT 3: Specific measurements on ventilation system.*
When a strong problem has been revealed after DIAGVENT 1 or 2, or after a complaint from the users it may be necessary to go to a very detailed inspection which may include sophisticated measurement techniques (for acoustics, air leakages, air pollution transfers, etc.). Specific measurements are not detailed in the guidebook, but it is shown, depending on the nature of the problem, which point should be checked and what kind of measurement or analysis should be made, with the reference to measurement techniques and standards.

The problems addressed are:

- Air flow rate deficiency (global or local)
- Acoustic disturbance
- Exaggerated electrical consumption
- Transfer of odours
- Presence of moisture
- Drafts

For example, in case of presence of moisture once the absence of any water infiltration has been verified, the inspections listed are:

- Measurements in the rooms concerned for temperature and humidity levels over representative periods in order to evaluate the humidity generation.
- Analysis of the design conditions of the ventilation system and of the effective conditions of use of the buildings to check if there is a real adequation or not.

Third Part: Annexes and useful information
DIAGVENT guidebook also includes:
- Bibliography (standards, guidebooks, measurement methods…)
- Websites (measurement devices manufacturers, technical centres for DIAGVENT 3)
- Annex 1: DIAGVENT 1 and 2 inspection sheet models
- Annex 2: Reference values (air flow rates, fan consumption, ductwork leakage)
- Annex 3: Detailed inspection method for typical residential ventilation system
- Annex 4: Method for measuring the air flow in duct

- Annex 5: Method for measuring the electrical fan power
- Annex 6: Examples of photos

		
Picture 4: In duct air flow measuring with hot wire anemometer	Picture 5: Measuring the electrical power at the fan unit	Picture 6: Local air flow measuring at an exhaust ATD in a bar

PERSPECTIVES

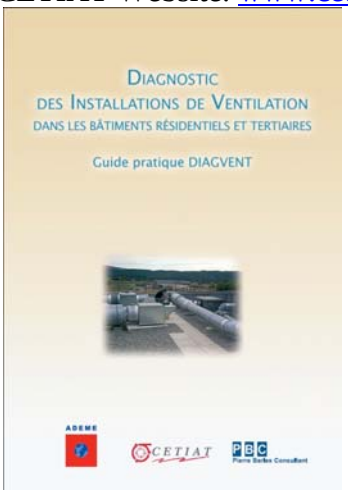
DIAGVENT guidebook tries to be the translation of a practical experience, from many investigations on residential or commercial buildings ventilation installations. Swedish experience in checking the performances of ventilation systems was an example for starting this work.

One aim is to help inspectors with a practical tool, and useful information.

DIAGVENT does not describe an exhaustive method, but a flexible one which will be adapted to the situation and the experience of the practitioners.

DIAGVENT is in French, but it could easily be translated in English.

It can be free downloaded on the CETIAT Website: www.cetiat.fr.



Picture 1: DIAGVENT Guidebook cover

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