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Condition survey for ventilation and air conditioning systems

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Abstract

The Finnish "Condition survey" concept is intended to give the owners and users of existing buildings, residential or non-residential, a reliable and solid basis for decision-making and planning for measures to improve the indoor environment and energy performance of the buildings.

In this concept, the main focus is usually the performance of ventilation and/or air conditioning system, assessed primarily by walk-through survey, questionnaires and detailed measurements whenever needed - from the indoor environment point of view but taking into account also the energy performance aspects. Therefore this concept is usually much more extensive than the inspection required by the EPBD.

The guidelines for condition survey were published first in 2013, after testing the approach in just a few buildings. In order to make the concept more common, altogether 18 pilot surveys were carried out and analyzed under supervision of the HVAC Association of Finland (SuLVI). The pilots included 12 non-residential and 6 residential buildings. In the pilot surveys, the guidelines were followed and

assessed, using questionnaires both to the owners/ users and persons responsible of the surveys. SuLVI checked all survey reports. The pilot surveys can be regarded as successful, because they revealed many typical hidden problems in ventilation and air conditioning systems. The pilot studies revealed also that the main concept is applicable, but needs adjustments in details. There is also a need for training for both the condition surveyors and clients.

Keywords – Ventilation systems, Air conditioning systems, Indoor air quality, Energy performance, System inspections, Condition surveys

1. Introduction

The Finnish "Condition survey" concept is intended to give the owners and users of existing buildings, residential or non-residential, a reliable and solid basis for decision-making and planning for measures to improve the indoor environment or energy performance of the buildings, or both.

In this concept, the main focus is usually the performance of ventilation and/or air conditioning system, assessed primarily from the indoor environment point of view but taking into account also the energy performance aspects. So, the main principle is indeed to take into account both health and energy aspects. So, it is usually more extensive than the inspection required by the EPBD.

The guidelines for condition survey were published first in 2013, after testing the approach in just a few buildings. In order to make the concept more common, altogether 18 pilot surveys were carried out and analyzed under supervision of the HVAC Association of Finland (SuLVI). The pilots included 12 non-residential and 6 residential buildings. The condition surveyors (persons responsible for the condition surveys) in the pilots have typically a B.Sc. or M.Sc. degree in HVAC engineering, but seldom special expertise in building automation or cooling systems. Only a few of the clients have sufficient technical knowledge in HVAC systems – some client organizations don't have any technical persons in their personnel.

2. Contents of the Survey

In non-residential buildings the survey is carried out in two phases:

1. Basic survey: study of documentation, walk-through, personnel interviews, general assessment of systems and maintenance, intermediate reporting including recommendations.
2. Detailed survey: detailed study of existing systems and equipment, including measurements, and final survey reporting including recommendations to owners and users.

In non-residential buildings, the work of the condition surveyor actually consists of three parts, two of them in phase 1. The preparatory part includes collecting and study of the existing documentation. This gives the basic

information for the second, or “on-site” part of phase 1, including general assessment of the condition of the systems and the quality of maintenance. The assessment is still based on the documentation, but includes a visit in the building and owner/user interview.

Phase 1 may end up in a statement that everything in the building is OK, or recommend a full renovation including demolition of the existing ventilation and air conditioning systems. Almost all cases fall somewhere in between, and the final statement and recommendations cannot generally be predicted in the beginning of the survey. Therefore a systematic approach is necessary.

Phase 2 contains a more detailed survey, including general and detailed measurements to assess the current condition of the systems and equipment, and also the indoor environment.

In residential buildings, the two phases are combined into one survey, so the basic and detailed surveys are done more or less in parallel.

The condition survey as a whole concept can be very different in different buildings. Each survey has to be planned separately taking into account the type and age of the building as well as the technical building systems, and also the objectives given by the client.

3. Outcomes of the Pilot Surveys - summary

In the 18 pilot surveys, the guidelines were followed and assessed, using questionnaires prepared by the project team. The questionnaires were separate for the owners/ users and persons responsible of the surveys (condition surveyors). The project team checked all survey reports, a few of which were also presented to representatives of all pilot surveys in a feedback seminar.

The pilot surveys tried to follow the methodology prepared earlier in the project, but taking into account the main objective given by the client. In many cases, the main objective was to find out the general condition of the ventilation systems and the need for immediate improvements in these systems, see Fig. 1

In a few pilot surveys, this primary objective was related to the general need for building renovating, typically related to the age of the building and its systems.

The third primary objective, although not so common, was related to the observed or suspected problems in the indoor environment, for example draught problems, high or low indoor temperatures, equipment noise, etc.

In several pilot buildings, recommendations aiming at energy performance improvements were made. However, in none of the pilots energy issues were the primary objective to the condition survey.

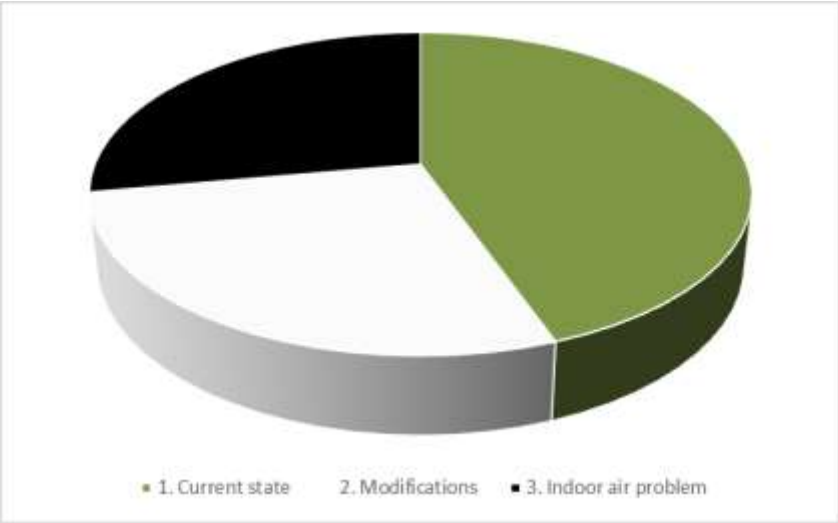

Fig. 1 The main reason to the condition survey in the 18 pilots. 1) need to find out the current condition of the systems, 2) need for renovation or modifications, or changes in the usage or technical systems, 3) observed or suspected problems in indoor climate

In several pilot buildings, detailed measurements to find out the system performance and indoor climate conditions were made. This is the major challenge to the condition surveyors. There is still a common view that a less extensive condition assessment or basic audit without measurements will be sufficient to assess the system performance and to give the client correct recommendations. This, however, is not enough – technical measurements will be needed, and also a good knowledge of measurement methods and instruments is necessary.

The revised standard EN 12599 [1] is useful for the functional measurements in ventilation and air conditioning systems but for individual measurements and monitoring, more detailed guidance for measurements is necessary. To do the right measurements, and right conclusions thereof, requires good skills. Especially the building automation system survey is very challenging. In order to choose the right measuring strategy (e.g. whether instantaneous measurements could be sufficient, or is long-term monitoring necessary) and measuring equipment, the consultant has to understand how the system performs in different load conditions. Several simultaneous measurements are necessary to find out the possible problems and their reasons.

4. Example – block of flats

One of the residential pilots was a small block of flats, a two-storey building with four dwellings in both floors, built at the end of 1990's. The dwellings were rather small, either one or two rooms plus bathroom, cloakroom and kitchenette.

The ventilation system was mechanical exhaust, for supply air intake adjustable slot intakes equipped with coarse air filters had been installed above the windows in living rooms and bedrooms. The system was cleaned and balanced in 2012, otherwise in its original shape. The system run at 1/1 speed throughout the day and night, which is not typical in Finnish residential ventilation. The residents could only adjust the air flow through the cooker hood using a manual damper.

The system documentation was available and up-to-date.

There were no major problems in ventilation, indoor climate, or energy usage of the building. There were, however, some complaints about ventilation noise, and high pressure difference outdoor – stairwell and/or stairwell – dwelling, causing difficulties in opening the doors, especially to elderly people.

In addition, due to the high air change rates (typical in small flats, and exceptionally high due to use of design fan speed throughout the time), the residents were interested to find out the feasibility of an exhaust air heat pump heat recovery system.

All extract air flows from individual rooms were measured (instantaneous measurements using a hood anemometer), as well as the negative pressure indoors, instantaneously using an electronic manometer. The air flows were well close to the design air flows, except from a few kitchenettes. Also the air flows from garages were measured; these were significantly lower than the design air flows. The survey ended up in recommending cleaning of all extract air devices yearly, but the new balancing of the whole system can well wait a few more years.

The negative pressure was exceptionally high indoors, the outdoor – indoor pressure difference varied between 55 and 90 pascals. (recommended negative pressure is between 5 and 20 Pa). There were two obvious reasons to this: continuously high ventilation, and exceptionally airtight building envelope. And airtight envelope is OK as such, so the only possibility to reduce the negative pressure will be adding new outdoor air intake slots, e.g. two above each window.

Even though the ventilation rate would remain very high, heat recovery from exhaust air (heat pump system) will not be economically feasible, the calculated pay-back time was much higher than the expected lifetime of the system.

5. Example – non-residential building

One of the non-residential pilots was a 5-storey building, including offices, plus shops in the ground floor. The building was originally an apartment house built in 1899 and gradually converted into office use between 1959 and 1971.The building and technical systems were partly renovated in 2007. The building was then connected to the district cooling network of Helsinki.

The main findings and recommendations are summarized below.

- The building and system documents were mainly up-to-date
- The ventilation air flows were properly designed, but in reality deviations in supply and/or extract air flows in rooms occurred, up to +/- 50% of the design air flows.
- The maintenance of the systems is regular, but a bit superficial, for example air filters should be changed more frequently. The reason to the less frequent maintenance actions was, at least partly, the fact that access to plant rooms and air handling units therein was somewhat difficult. Improvements are recommended especially to ensure easy access to air filters and other components which require frequent service or maintenance.
- The building automation system performance was far from optimal. Especially if recommended changes in the ventilation (towards demand-controlled ventilation) and air conditioning systems were made, this will require changes but not necessarily total renewal on building automation. The condition surveyor recommended a more detailed survey by a building automation specialist.

6. Technical conclusions

The pilot surveys can be regarded as successful, because they revealed many typical hidden problems in ventilation and air conditioning systems. These problems are seldom so serious that either the end users or maintenance personnel would have paid enough attention to the problems..

For example, air flows into or from individual rooms can deviate 50% or even more from the planned air flows, pressure conditions indoors can stay inappropriate. These deviations and many minor faults in building automation and HVAC equipment can result in discomfort or unnecessarily high energy costs but can remain hidden without a systematic survey.

The most challenging, from the total performance point of view, were the building automation and cooling systems, and how the system parts

influence each other's performance. The condition surveyor needs not to be a specialist in all subsystems, but he/she has to understand the systems on general level, to identify possible problems correctly, and to call the right specialist on the right moment.

Aiming at energy savings has increased building automation during the recent decades. This was shown also in many of the 18 pilots. The pilots revealed a general need to increase the knowledge among the consultants, in order to correctly locate and identify the problems in the systems, and to find specialists. In the pilots, the condition surveyors had no major difficulties to identify the systems, but they typically could make just general observations and record the age or some system components without the involvement of system specialists.

7. Condition survey vs. Inspections Required by the EPBD

The recast EPBD in fact encourages alternative approaches to the original mandatory inspection which, according to experiences throughout the EU, has not been a real success story anywhere. In Finland, the national law which required inspections of the generation part of the refrigeration system only, was withdrawn, and the condition survey pilot exercises were supported by the government as one potential alternative approach.

The basic flowchart for both the Finnish condition survey concept, see Fig.2, and the EPBD-related inspections are very similar. However, the condition survey does not make any distinction between "ventilation only" and "air conditioning" systems. This is mainly due to the fact that in Finland air conditioning systems generally include also ventilation.

In the light of this, the new structure of the inspection standards [2], [3] will be, at least in Finland more useful than the existing standards, separate for air conditioning systems (EN 15240 [4]) and ventilation systems (EN 15239, [5]).

The condition survey is generally much more extensive than the inspection required by the EPBD. As the latter is typically restricted to assess the energy performance of the system with less attention to the indoor environment, the former has equal focus on both the indoor environment and the energy performance.

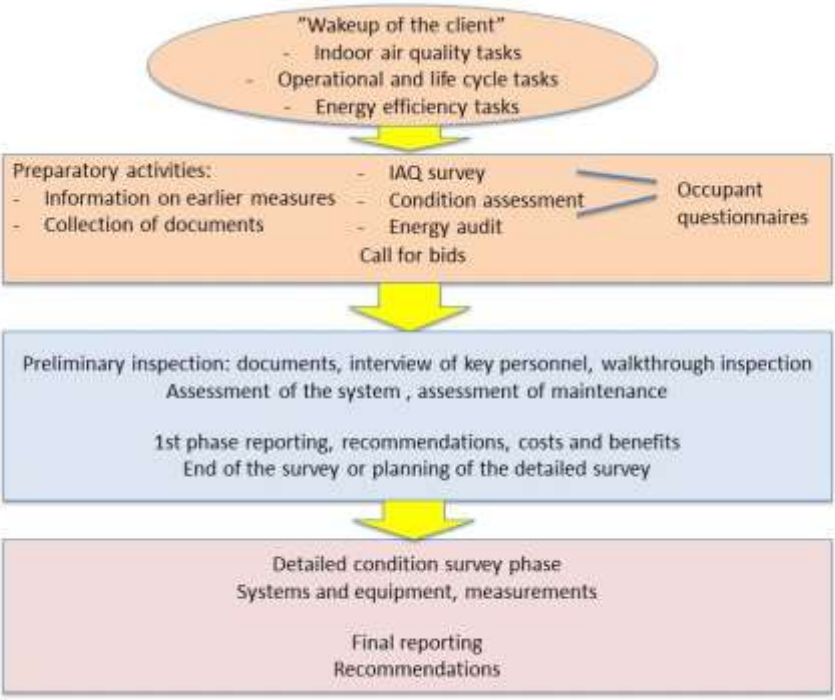

Fig. 2 The main flowchart of the Finnish condition survey methodology for non-residential buildings. In residential buildings the preliminary inspection and detailed survey phase are carried out in parallel

The principal purpose of the EPBD inspections is to provide advice to building operators and owners on ways of reducing their energy consumption while maintaining acceptable indoor environmental conditions, in other words, similar to the condition survey, but in details much focused on energy performance.

Each inspection, as well as the condition survey, shall result in an inspection report that is easily understood by the recipient and explains the advantages to be gained from implementing the recommendations.

As the extent of the two concepts is different, there is typically more need for measurements in the condition survey than in the EPBD inspections.

8. Needs for Education and Training

There is a need for training for persons who perform the surveys (typically HVAC engineers).

Also a qualification scheme needs to be developed for the condition surveyors. It is essential that the condition surveyors have sufficient knowledge and understanding of the technical systems of buildings, including cooling and building automation.

Even more training, and also practical tools, should be targeted to the clients - owners and users, among which very few decision-makers have any kind of technical education. As stated above, the end users do not pay attention to problems if they are not serious. Proper information and training will help also non-professionals to identify problems, or need for condition survey or other action early enough.

9. Final Remarks

- The "condition survey" concept has been tested systematically in a number of buildings, both residential and non-residential. Guidelines have been revised according to the findings from the pilots, and the concept has generally been successful and in the long run can result in permanent improvements in both the indoor environment and energy performance of the buildings.

- There is a huge need for training both for clients and persons responsible for the surveys. Also a qualification scheme needs to be developed. It is essential that these experts have sufficient knowledge and understanding of the technical systems of buildings, including cooling and building automation. Even more training, and also practical tools, should be targeted to the clients in order to identify at the right moment the need for actions like condition survey

- The condition survey concept points out the importance of face-to-face handing over the survey report to the client.

- Both EN 12599 [1] and the Finnish guidelines [6] give guidance for measurements still in a rather general level, so more detailed guidance and training to carry out the measurements in real buildings is needed.

Acknowledgment

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