IMPLEMENTATION OF MEASUREMENT AND QUALITY FRAMEWORKS IN THE FRENCH REGULATION FOR ACHIEVING AIRTIGHT ENVELOPES

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ABSTRACT

It is foreseen that the 2012 version of the French regulation will include a minimum requirement for the envelope airtightness of residential buildings, with two options to justify its treatment: a) measurement at commissioning or b) adoption of an approved quality management approach. This paper describes the qualification process for authorizing technicians to conduct airtightness measurement when the result is to be used in the EP-calculation method. It also discusses the requirements set for approved quality management approaches. These processes have started in 2008 which allows us to analyze the impacts of the measures taken on the supporting staff and on the market. Our analyses underline the importance of the qualification process to ensure homogenous measurement practice between technicians. They also show the limits of the controls that can be implemented if the process is not appropriately sized to absorb a large number of applications. Regarding the approved quality management approaches, their impact is increasing rapidly with builders engaged in that process who produce hundreds to several thousands of homes a year. Other market players also explore this option, namely industries and contractors.

KEYWORDS

air infiltration, envelope, ductwork, leakage, energy use, low-energy buildings

INTRODUCTION

The objective of the revision of the French energy performance regulation is to generalize low-energy buildings. The threshold is set to 50 kWh of primary energy per m^2 per year for residences, with some modulation depending on climate zone and altitude; this number includes the primary energy use for heating, cooling, domestic hot water, auxiliary equipment, and lighting. Given the severe impact of envelope leakage in such low energy buildings, a minimum requirement will very likely be set for the envelope airtightness of residential buildings in the 2012 energy performance regulation. Two options are foreseen to comply with this minimum requirement : a) measurement at commissioning or b) adoption of an approved quality management approach. The first option raises the question of the quality of the measurements to ensure homogenous measurement practice between technicians, and thereby avoid perverse effects that could put discredit to the whole framework and distort competition. The second implies the definition of a legal framework that describes the requirements for approved quality management approaches. This paper discusses successively the approach envisaged to answer those two problems based on the lessons learnt from experience with the previous framework.

QUALITY FRAMEWORK FOR MEASURERS

Although there exists a European and an International Standard (EN 13829 and ISO 9972) on the measurement of envelope airtightness, there remains unanswered questions when the result is to be used as an input in an energy performance calculation method. One key problem lies in the building preparation, i.e., the openings that have to be sealed or closed during the measurement. One example often cited is the case of a biomass boiler with a combustion air intake in the living space, for which it could be interpreted that method A requires that the intake remains in its normal condition of use, although it may make sense to seal it if the calculation method appropriately takes into account the energy impact of the additional air drawn into the house.

This is the reason why the BBC-Effinergie label defines in more detail the openings that can and cannot be sealed or closed during the test (Table 1). The basic rule is that the building envelope must represent its condition during the season in which the heating or cooling systems are used; however, openings whose contributions are taken into account in the energy calculation method are sealed. This rule is now integrated in an application guide for EN 13829 which has been released in February 2010 (GA P 50-784).

Another major issue lies in the competence of the measurer. Evidence shows that there can be serious misinterpretations of the measurement protocol and analysis that can of course be intentional but that can also be done in good faith, simply because of a lack of basic knowledge on the energy performance regulation, HVAC systems, or airflow and pressure measurement techniques. This can lead to serious errors in the estimations of the derived quantities that are used in the calculation method. For this, the ministry has decided to require that the measurers be authorized to perform such measurement. The authorization is delivered according to a 3-step approach :

The candidate must attend a training which is approved by the ministry based on a referential. Three trainings bodies are now offering these kinds of trainings.
The candidate must succeed to a theoretical and a practical examination. The theoretical examination is based on a multiple-choice questionnaire. The practical part consists in the examination of a test report by the training body. The training body is given a grid to help this evaluation process.
The candidate must submit 5 reports to a commission in charge of advising the ministry to deliver authorizations. The commission is made of about 20 anonymous experts in the field who evaluate the reports. The experts can ask for complements if the mistakes are not fundamental or if clarification is needed. In this case, the authorization is discussed at the following meeting based on the new materials provided by the candidate. An application cannot be evaluated more than 3 times; over 3 trials, the candidate must submit a new application.

As of April 2010, 153 persons have applied for an authorization; 53 have been authorized. Applicants usually have to go through 2 meetings of the commission to obtain their authorization. The mean elapsed time between the application and the authorization is about 5.5 months.

Because of the large number of applications received in the past months (over 60 between January and June 2010), and because the foreseen large number of applications as the 2012 regulation will require this authorization for all measurements if it is used as proof of compliance to the EP-regulation, we are working on a new organisation to be able to deal with over 1000 applications a year. The basic idea is to delegate the process to a private body who will organize the examination of the reports by pool of experts approved by the ministry.

We have also defined a framework to monitor the activity of the authorized measurers. For this, the measurers must file a database for each measurement they perform. This record is a simple table in a spreadsheet, with pre-defined fields. Each measurer must send this record along with his first application; he must also send it every

year to have his authorization prolonged. An interesting project called Web@set is underway to explore the possibility to build a national database with information provided on-line by the measurers as they prepare their reports and who would have access through to other services through the Website, e.g., statistical analyses.

This overall framework is still under construction, but our feeling is that it has greatly helped the measurers' community keep a positive image. The potential discredit that could fall on a new job and a subject which remains controversial among building professionals has been avoided so far.

	Energy Performance Method (French regulation)	**Method A**	**Method B**
Windows, doors, trapdoors	Close	Close	Close
Closets and toilets doors	Close (others doors are left opened)	Close (others doors are left opened)	Close (others doors are left opened)
Mechanical ventilation or air conditioning installations	Seal	Seal	Seal
Openings of natural ventilation without closing device	Seal	Open (1)	Seal
Openings of natural ventilation with closing device	Not allowed by hygienic regulation	Close	Seal
Combustion appliances without closing device	Open or Seal (2)	Open	Seal
Combustion appliances with closing device	Close or Seal (2)	Close	Seal
Water traps	Fill or Seal	Fill or Seal	Fill or Seal
Other voluntary openings without closing device	Open	Open	Seal
Other voluntary openings with closing device	Close	Close	Close

Table 1 : Building preparation. State of openings depending on the purpose of the measurement : method A, method B, or method for the French energy performance calculation. Table inspired from GA P 50-784. (1) If automatically-regulating openings are present, it is likely that the regression will not be satisfactory. (2) Seal if airflow rate impact is taken into account in the energy calculation method.

APPROVED QUALITY MANAGEMENT APPROACHES

The 2005 version of the regulation has introduced the possibility to claim for a better value than the default airtightness value in the EP-calculation, without performing a test, provided that an approved quality management approach be applied.

The basic requirements for the quality management approach to be approved are :
- to identify "who-does-what" and when;
- to trace each step of the approach;
- to prove that the approach is effective based on measurements on a sample;
- to propose a scheme to ensure that the approach will remain effective with time, based on measurements on a sample.

We were originally sceptical about the viability of this option. However, our confidence is growing although this framework needs a careful independent evaluation. This is due to the convincing results obtained by several bodies, especially builders of single-family houses advised by a few consultant firms well-experienced with quality management approaches. Their results consistently show values well-below the relevant limits, although such levels are usually attained in 20 to 30% of houses (Figure 1). These results are based on measurements usually performed by "authorized measurers" in ISO 9001 bodies. Note however that the measurers are not necessarily independent of the contractor.

As of June 2010, 20 quality management approaches have been submitted for approval to the ministry, 11 have been approved, 5 have been approved pending checks (Table 2). Figure 2 shows one overall scheme inspired from an approved approach by a manufacturer of autoclave aerated concrete (AAC, Xella Thermopierre). In sum, this synthesis shows the wide scope of potential applicants for such approach, with a production ranging from about 50 dwellings a year to over 5000 between the applicants, and its compatibility with the status of builder or industry.

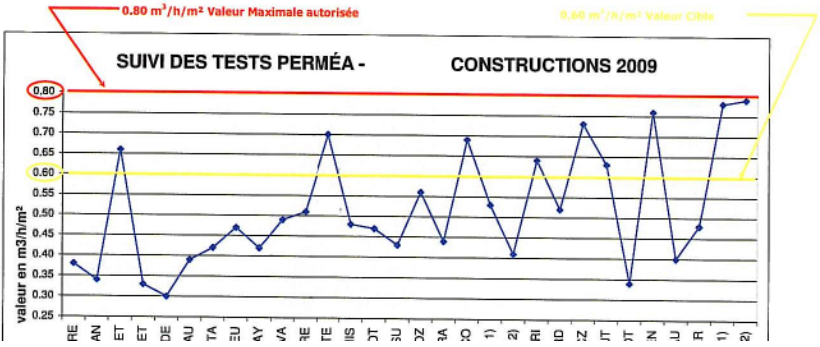

Figure 1 : Excerpt from a monitoring report of a single-family house builder showing air tightness values consistently below the limit of 0.8 $m^3/h/m^2$ (red line). This builder aims to attain 0.6 $m^3/h/m^2$ on a regular basis (yellow line).

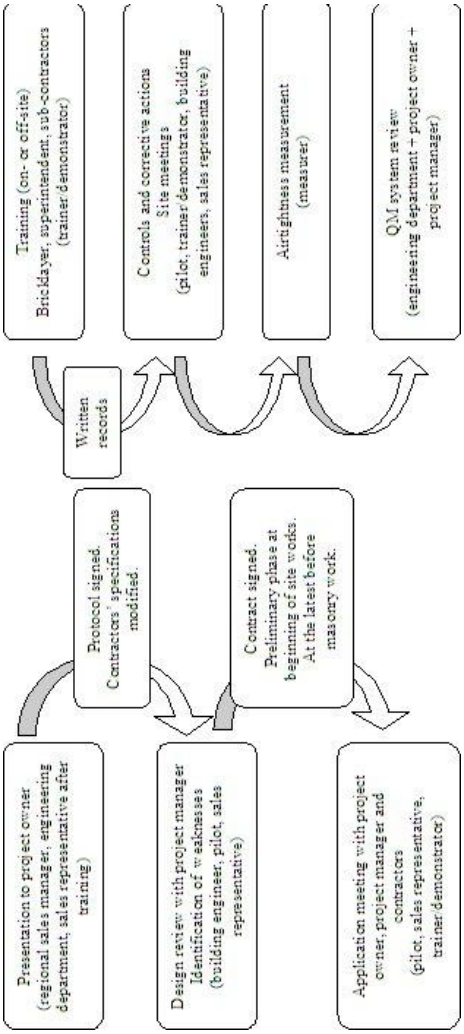

Figure 2 : Overall scheme for approved quality management approach by a manufacturer of AAC. Pilot is site coordinator of QM approach. Translated with permission from Xella Thermopierre.

Application date	Type of applicant	Type of buildings	Production (per year)	Status	Approval date
18/06/06	Federation of manufacturers	Single-family		Rejected	
19/10/07	Builder	Single-family	100	Approved	20/10/08
06/11/07	Builder	Single-family	200	Approved	25/11/08
06/11/07	Builder	Single-family	200	Approved	25/11/08
01/11/08	Manufacturer of AAC	Single-family Multi-family	40 projects (2010) representing 800 dwellings	Approved	26/10/09
24/11/08	Builder	Single-family		Approved	24/04/09
24/02/09	Builder	Single-family	250	Approved pending checks	
20/05/09	Builder	Single-family		Approved	05/08/09
25/05/09	Builder	Single-family	300	Approved	05/08/09
25/05/09	Builder	Single-family		Approved	05/08/09
29/06/09	Builder	Single-family		Approved pending checks	
09/09/09	Builder	Single-family		Approved	19/04/10
09/09/09	Builder	Single-family	50	Approved pending checks	
09/09/09	Builder	Single-family	200	Approved	19/04/10
05/11/09	Builder	Single-family	5000	Approved	19/04/10
09/11/09	Builder	Single-family		In process	
08/03/10	Builder	Single-family	250	Rejected	

Application date	Type of applicant	Type of buildings	Production (per year)	Status	Approval date
08/03/10	Builder	Single-family	900	Approved pending checks	
08/03/10	Builder	Single-family		Rejected	
08/03/10	Builder	Single-family	1500	Approved pending checks	

Table 2 : Overview of quality management approach applications as of June 2010.

CONCLUSION AND PERSPECTIVES

Generalizing airtight constructions is challenging, however, it is absolutely necessary to address this issue given the objective to generalize near-zero energy buildings in 2020. The problem has been tackled in France through several channels, among which the definition of quality frameworks for the measurement and achievement of airtight envelopes. The lessons learnt from these frameworks, operational since the beginning of 2008, are quite interesting. First, the examination of the measurers' reports within the authorization process as well as the feed-back from training shows that there remains an important need for training to ensure homogeneous practice. Insufficient training for measurers could severely distort competition. Second, major market players pay a great deal of attention to quality management approaches. The wide scope of applicants, from small builders to big ones or manufacturers, is quite encouraging, so are the results presented in the yearly reports.

Based on this positive experience, and because the treatment of envelope airtightness will be mandatory in 2012 revision of the energy performance regulation, the ministry has decided to enforce these frameworks within this revision. Therefore, measurements will have to be performed by authorized technicians to be valid to check

compliance with the minimum requirement or with the value used in the energy performance calculation. The use of approved quality management approaches will remain a possible option to prove compliance with the airtightness minimum requirement without a systematic test. With minor changes, the frameworks described in this paper will be re-conducted.

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