

# AIRTIGHTNESS QUALITY MANAGEMENT SCHEME IN FRANCE: ASSESSMENT AFTER 5 YEARS OPERATION

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## ABSTRACT

From 2006 till 2012, the 2005 energy performance (EP) regulation (RT 2005) did not entail any obligation to justify the envelope airtightness level. As a consequence, asking for the certification of airtightness quality management approaches was a voluntary request from constructors. Thus, they might be allowed to take into account a better-than-default value into the thermal calculation. Since 2012, French 2012 EP regulation (RT 2012) requires building airtightness level to be justified, with two ways of justification. Either the constructor performs systematic measurements on each building, or the constructor proves that a certified quality management approach is implemented. Thus, since 2012, the number of requests for airtightness quality management certification has significantly increased.

In order to evaluate the airtightness quality management approaches, the French State has created a specific national committee. It aims at authorizing constructors to justify their buildings airtightness level through a quality management approach. The CETE de Lyon is in charge of this committee.

This paper will present and analyze the evolution of the committee processes and statistics, concurrently with the French EP regulation. The first part will focus on an assessment of the committee validation process. It will also present the evolution of the number of requests and certifications, since 2006. Results show that compared to each previous year (2006-2011), the number of RT 2012 requests in 2012, has been multiplied by 4. Moreover, the number of RT 2012 certifications is, by June 2013, higher than the whole RT 2005 certifications delivered over 6 years. The second part will present the control process implemented by the committee on certified constructors. First, it will present the self-declared airtightness values that are presented by constructors in their yearly renewal files. Then, it will focus on results of the control campaign set up by the committee. Results show that the majority of measured dwellings meet the required airtightness level. Nevertheless, results of that control campaign show that approved constructors do not entirely implement their quality management approach.

The paper concludes with the committee process improvements. These improvements must meet the increasing number of requests, without losing quality reputation of these approaches. The State will continue to inspect certified constructors in two ways. Yearly files analysis will focus more on the actual implementation of airtightness quality approach. The control campaign will be maintained because of its impact on constructors. A question is now set on the need to externalize this quality management approach committee because of the number of requests. The process could be the same as the airtightness measurement qualification made in France, a few years ago.

## KEYWORDS

## 1 INTRODUCTION

French energy performance (EP) regulation is frequently revised in order to reduce buildings energy consumption. Now, the airtightness value of building envelope must be taken into consideration in the thermic calculation to obtain low-energy-consumption buildings.

French EP regulation allows two ways to justify the airtightness value of the building envelope for residential buildings. Either the constructor performs systematic measurements on each building, or the constructor proves that a certified quality management (QM) approach is implemented. QM approach presents the advantage of enabling constructors to carry out measures on a restricted sample of their production. Since 2006, the French State has implemented a committee (named the Annex VII committee) in charge of examining these approaches and proposing the certification. The certification allows constructors to justify the airtightness value of their buildings through a QM approach. The CETE de Lyon is in charge of this committee.

In the 2005 version of the French EP regulation (RT 2005), a certified QM approach enabled approved constructors to use a better-than-default-value in their regular thermic calculation. Thus, constructors could use a  $0.8 \text{ m}^3/\text{h}/\text{m}^2$  ( $Q_{4\text{PaSurf}}$ ) envelope airtightness value, instead of the  $1.3 \text{ m}^3/\text{h}/\text{m}^2$  default value (for single dwellings). In that process, RT 2005 QM approaches were a voluntary constructors' approach. Since January 1<sup>st</sup> 2013, the 2012 version of the French EP regulation (RT 2012) has required the airtightness level of residential buildings to be justified to a lower-than-required value. Consequently, constructors must justify the airtightness value of their buildings. This new regulation has led more constructors to implement QM approaches.

This paper aims at presenting quantitative and organizational evolutions noted by the committee after more than 5 years of activity. The paper will also present control result evolutions on certified constructors.

This paper is organized as follows. Section 2 presents the committee process and its organizational and quantitative evolutions. Section 3 deals with results for different controls implemented by the committee so that the certified QM approaches are reliable. Section 4 closes the paper by looking at future evolutions of the committee organization.

## 2 COMMITTEE PROCESS AND ITS EVOLUTION

This section presents firstly the evolution of the QM approach philosophy between RT 2005 and RT 2012. Then, the evolutions of the request and certification numbers are presented. At the same time, the committee organization had to evolve to meet the demand. This evolution is presented in the final section.

### 2.1 A successful approach in RT 2005

Since 2006, RT 2005 has enabled constructors to justify the airtightness value of a building envelope with a certified QM approach. The regulation text (JO, 2006) describes what is expected in the QM approach. The following points describe what is mainly expected in a RT 2005 QM approach in order to be approved:

- Construction type of buildings concerned
- Organizational elements
- Description of “who does what”
- Craftsmen’s contractual involvement and training
- Documents that allow the tracing of each step of the QM approach
- Site supervision documents
- Documents that trace actions in case of non-compliance
- Bar chart of airtightness measured values on a sample of buildings concerned.

The Annex VII committee is composed of national airtightness experts. When a QM approach is submitted, experts base their analysis on an evaluation grid detailed for each point required. The RT 2005 grid includes 11 evaluation criteria. The evaluation grid mentions the criterion type, the expert detailed observations, the consulted files and the final expert opinion (compliance, non-compliance, some additional justifications to be given or advice).

From 2006 to 2012, 28 requests have been submitted to the committee, and 24 RT 2005 QM approach certifications were delivered. As a consequence, this first implementation of QM approach in EP regulation has been successful and constructors gave an enthusiastic and positive welcome to these approaches. Indeed, in RT 2005, as it remained a constructors’ voluntary approach, submitting an airtightness QM approach was the proof of an actual motivation to implement a good quality in construction. At the same time, approved constructors were rewarded with being allowed to use a better-than-default-value in their thermic calculation. This enabled them to justify lower-energy-consumption buildings than traditional ones. This success enabled the French State to keep that possibility in the 2012 EP version (RT 2012).

Considering QM approach, RT 2012 regulation is more precise and more demanding. Indeed, thanks to RT 2005 experience, the French State reinforced expectations on key steps in order to guarantee the QM approach reliability. All RT 2005 required point remain in the 2012 version, but they must be more detailed, from the point of view of the organisation, of the traceability, and of the actual implementation. For instance, dealing with craftsmen’s training, RT 2012 QM approach must a) provide the training support, b) detail how the constructor plans their craftsmen’s training, so as to guarantee everyone’s training, c) describe and provide the document that enables the constructor to be sure that anybody concerned by the QM approach is trained d) provide this document filled out. The same method applies to the traceability of non-compliant points and of the actions taken in that case. Furthermore, an independent ISO 9001 audit must be carried out in the approach, sites supervisions and measures documents must be provided for some constructions. JO (JO, 2010) describes all the points that must be taken into consideration in RT 2012 QM approach. The RT 2012 evaluation grid is composed of 27 evaluation criteria. Thus, having a certified RT 2005 airtightness QM approach is useful to implement a RT 2012 one, but is not enough to acquire the RT 2012 certification. Finally, the positive experience of RT 2005 certified approaches contributed to a positive welcome of RT 2012 processes, and to a similar mobilisation for their implementation.

## **2.2 An important increase in the number of requests with the RT 2012**

As introduced in the previous section, the number of RT 2012 QM certification has been motivated by the RT 2005 positive experience. Figure 1 presents the evolution in the number of requests from 2006 to 2013.

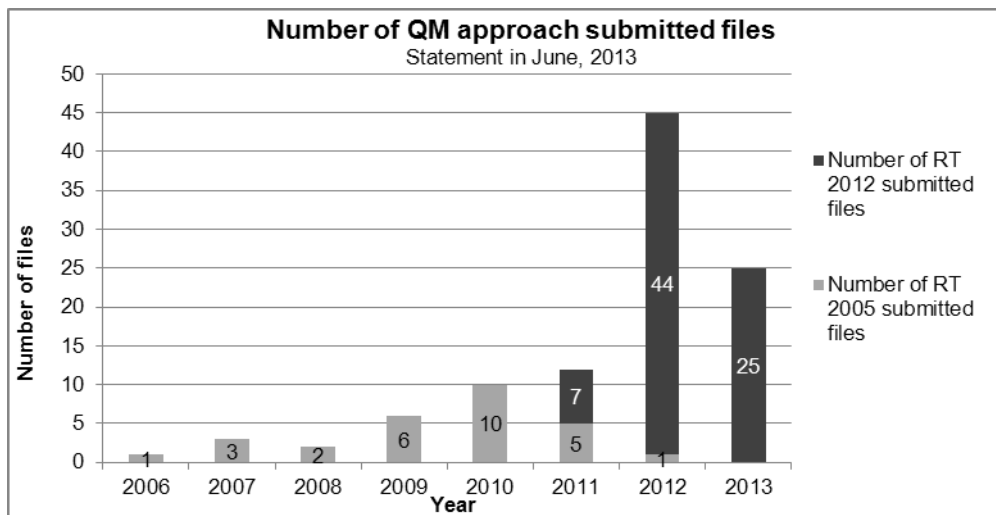


Figure 1: Number of QM approach submitted files. Statement in June 2013.

RT 2012 QM approaches can be submitted since 2012. During the period of application of RT 2005, 28 requests were submitted over 6 years, from 2006 to 2012. In 2010 and 2011, around 10 requests were received per year. The evolution between RT 2005 and RT 2012 QM approaches is indicated by a multiplication by 4 of the number of requests between 2011 and 2012 and by 5 between 2011 and 2013. Thus, as in RT 2005, around ten files were received per year. The Annex VII committee now receives around 50 files per year for the RT 2012.

This growth can be explained 1) by the RT 2012 that requires building airtightness to be justified, 2) by the RT 2005 QM positive experience.

Moreover, it must be noted that the RT 2005 QM approaches were a voluntary constructor approach that enabled them to have lower-energy-buildings than traditional ones. On the contrary, with the RT 2012, the QM approaches being one of the possibilities to be in accordance with regulation, QM approaches seem to be submitted more in order to comply with regulation than to have a real quality in construction.

### 2.3 A consecutive evolution of the committee organisation

The Annex VII committee had to evolve to meet the growing demand of QM approach certifications. The number of evaluation meetings of the Annex VII committee doubled between 2011 and 2012, going from 5 per year until 2011, to 10 per year since 2012. Moreover, the number of analysed files per meeting has increased since 2011. It multiplied by 4 between 2011 and 2013. As a consequence, the number of yearly analysed files was 18 in 2011, 68 in 2012, and is already about 70 at mid-2013. It must be noted that, at present, before obtaining the certification, a request need to be evaluated at least three times by the committee.

The Annex VII committee has needed to evolve to meet the increasing demand. The main evolutions in the committee organization are the followings:

- The number of experts doubled between 2011 and 2012, evolving from 6 to 12. The increase was regular and required, for each new expert, some time before performing a complete QM approach evaluation.
- Each file is analyzed by two experts, before the committee meeting. For their evaluation, the experts complete the assessment grid presented in.2.1.

- Before the meeting, the two experts compare their evaluation. In the case of discordant criteria, they agree on a common position that they will present to the committee.
- At present, 4 main private engineering departments are contracted with constructors to implement their QM approach. Each office proposes a similar approach to each constructor. Thus, the committee analyses very similar files, for which only the constructors' appropriation and adaptation to their practices differ. As a consequence, while the committee is examining a file, every other expert gives their observations. This enables the committee to identify repetitive observations on similar files and to send homogeneous evaluations, after each meeting.
- Moreover, after each committee, a grid is filled in with those repetitive observations. This grid is sent to each expert before their evaluation. This enables each expert, and then the committee, to be homogeneous with previous analysis.
- Finally, a personal grid of repetitive observations is sent to each private engineering department every 6 months, so that their services take into consideration repetitive observations permanently.

It may be noted that the evolution mentioned above made the meetings more efficient and enabled the committee 1) to analyze more files per meeting 2) and to guarantee homogenous analysis. But it can also be noted that some evolutions are required, mainly from private engineering departments. Among the 4 main private engineering departments, after having received the evaluation grids, 2 usually make the constructor QM approaches evolve. On the opposite, 2 do not make all of the constructor QM approaches evolve.

Regarding delays, with RT 2012 that expects a more precise approach, constructors need at least 3 committee evaluations before obtaining their certification. We can expect that, with the organization described above, private engineering departments will finally produce quasi perfect QM approaches. This should soon enable constructors to need only two committee evaluations, that is to say the average delay that was observed at the end of RT 2005 evaluations. At the present time, the average delay observed between the first file submission and the certification is 10 months. This delay did not evolve with the years. Indeed, while the number of required committee evaluations before obtaining the certification grew up, the number of committee meetings and their efficiency evolved at the same time. Nevertheless, since mid-2012, we observe a growing delay between the file submitting date and the first committee evaluation date. Indeed, the average delay observed before mid-2012 was 30 days. It has regularly grown up since that period, and the delay is now around 80 days.

To conclude, Figure 2 presents the evolution of the number of delivered certifications, between 2008 and 2013. The number of RT 2012 QM approach certifications is about 27 at mid-2013. This means that the number of RT 2012 certifications delivered over 1.5 years is the same as the number of RT 2005 certifications delivered over 6 years. With that tendency, about 45 certifications can be expected at the end of 2013. From that point of view, the committee organization evolution is a success.

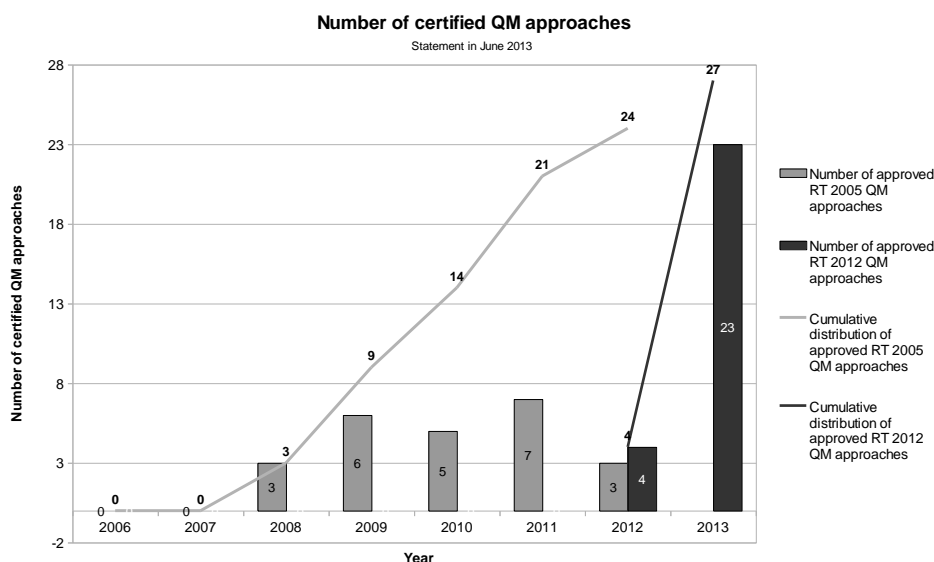


Figure 2: Number of delivered certifications. Statement in June 2013.

Regarding the number of buildings yearly produced in accordance with a QM approach, this number was approximately 6000 with RT 2005 approaches. With the present tendencies, we can expect that RT 2012 certified applicants will represent around 40000 buildings, that is to say around 20% of the national residential building production.

We can see that the RT 2012 QM approaches are a famous process. However, we must bear in mind that the control of their actual implementation is essential, in order to guarantee their reliability.

### 3 CONTROL PROCESS ON CERTIFIED QM APPROACHES

Once the QM approach is certified, it is important to check regularly whether the certified approach is implemented and fulfilled. Thus, the French regulation had foreseen the submission of a yearly renewal file to the Annexe VII committee, in order to control regularly the actual implementation. In addition of the process, the Annexe VII committee set up a control campaign in 2011, in order to reinforce the verification of the implementation of certified QM approaches. The next section will present the yearly renewal file process and results. Then, the control campaign process and results will be presented.

#### 3.1 Yearly files analysis

Each year, every certified constructor must give a renewal file to the Annex VII committee, so that the actual implementation of their approach is proven. This file must contain 1) the actual QM approach, 2) the fulfilled application files, 3) test results on the previous year sample. The Annex VII committee evaluates the content of the files and the measure results, thanks to an evaluation grid.

This section deals with the test results that are sent by constructors. More precisely, it presents measured values carried out until the end of 2011. Results on 2012 cannot be presented. Indeed, in 2013, the yearly files analysis has been limited because of the RT 2012 certification requirements. These first results, that concern 12 certified constructors, enabled the Annex VII committee to evaluate whether constructors improved their measure results year after year.

Figure 3 shows the evolution in the measured values, for the 12 approved constructors together.

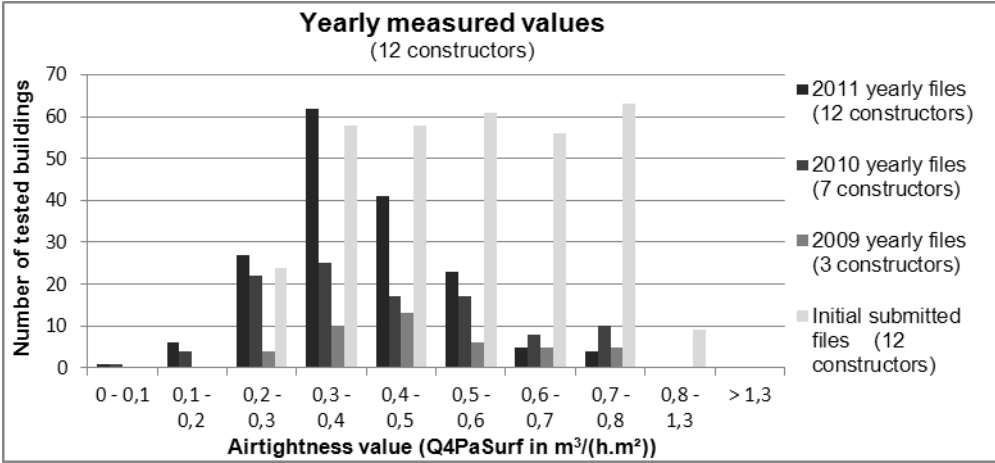


Figure 3: Yearly measured values, all constructors together. From 2008 to 2011.

Figure 3 shows that, year by year, the certified constructors improve their measure results. Indeed, if we compare the evolution of the results, from 2008 to 2011, it can be noted that the peak of the bar graphs tends to lower airtightness values. This indicates that the QM approach implementation enables constructors to improve their measure results and more generally the quality in their construction. Moreover, year by year, a lower number of measured values close to the 0.8 m³/(h.m²) limit value is observed. This global result is positive. However, for the yearly renewal file analysis, each constructor’s bar graph must be analysed.

Among the 12 certified constructors, 2 presented some warning results because of the number of measured values close to the 0.8 m³/(h.m²) limit value. As the results comply with the regulation, the committee could only address a word of warning to those 2 constructors. Figure 4 shows a type of warning bar graph.

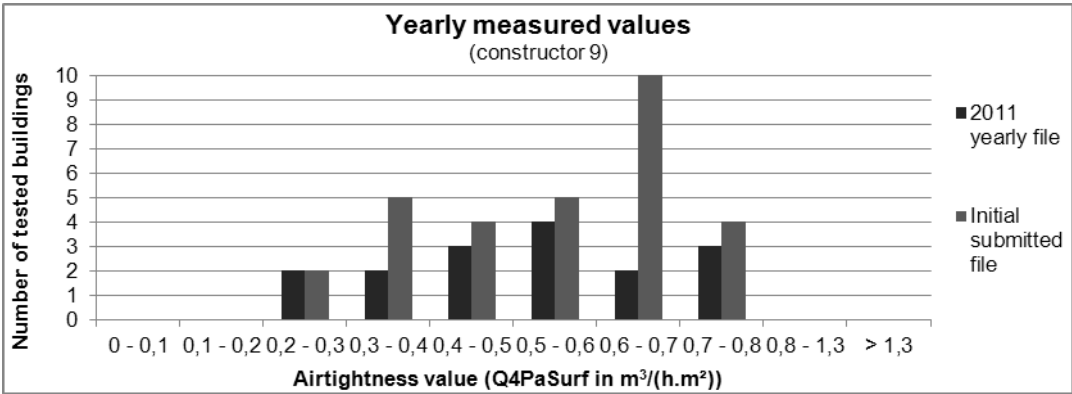


Figure 4: Yearly measured values for constructor 9, in 2010 and 2011.

On the other hand, among the 12 constructors, 10 presented yearly bar graphs that illustrated an actual improvement in the measure results. Figure 5 gives an example of a constructor good measured result. Indeed, the graph shows a regular movement of the peak of measures toward lower values. Moreover, it can be noted that each year, there are fewer measured values close to the limit one.

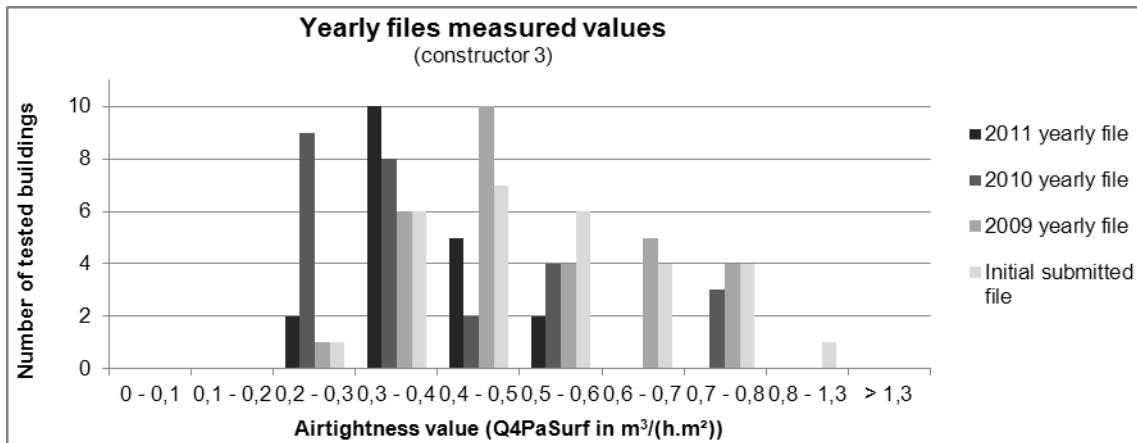


Figure 5: Yearly measured values for constructor 3. From 2008 to 2011.

The yearly renewal file analysis enables the Annex VII committee to check whether the certified QM approach is implemented and fulfilled. However, with the RT 2012 approach submission files, the RT 2005 approved constructors did not really collaborate for their 2012 yearly renewal file. Indeed, in 2012, some constructors did not answer to the committee's requests on their yearly files. Moreover, in 2013, considering the RT 2012 important demand, the committee decided, not to require renewal files from constructors who were setting out RT 2012 QM approach.

As a consequence, since 2012, the committee has not been able to analyse all the yearly renewal files. Nevertheless, considering the number of QM certifications, it appears essential to keep the yearly renewal files analysis. Indeed, it enables the committee 1) to have a look on the evolution of measured values, 2) to check whether the QM approach is really implemented by constructor. Moreover, as each certified constructor will submit every year a renewal file, the management of the QM approach certification must evolve so as to meet this future demand.

### 3.2 Control campaign results: good results for a majority of the controlled constructors, two failing constructors

In addition of the yearly file analysis, the Annex VII committee wished to set up in-situ controls, carried out by state employees. The first control campaign occurred in 2011 and 2012 and is described by Charrier (Charrier, 2013). The control campaign was divided in two types of control:

- a quantitative control that consisted in measuring a part of the approved constructors' production,
- a qualitative control that consisted in requiring all the documents produced in the frame of the certified QM approach, for randomly selected buildings.

Results of that control campaign are presented in Charrier (Charrier, 2013) and summed up in a double label, presented in Figure 6.



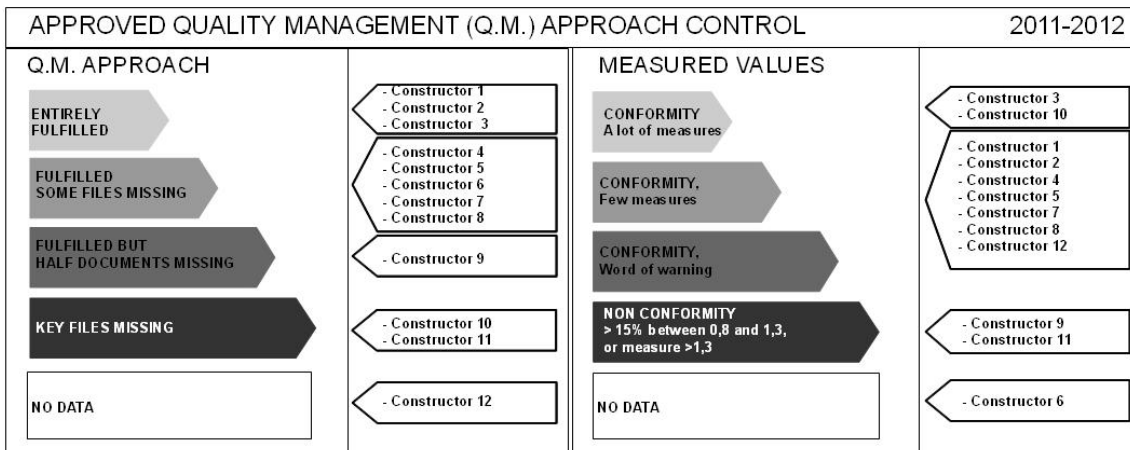


Figure 6: Double label summing up the first control campaign results

The double label illustrates the results of both controls: qualitative and quantitative one. Some results of the control campaign are:

- Two constructors have difficulty in implementing their certified QM approach (constructors 9 and 11).
- For 75% of the controlled constructors, the certified QM approach is not entirely implemented. For some of them (25%), lots of important files are missing. This means that the quality management approach does not seem to be applied and fulfilled. This reveals that constructors seem to consider that a good quality in construction is not helpful in obtaining values that comply with regulation. The quality in construction mentioned by Debrabander (Debrabander, 2011) is essential in QM approach and seems to be forgotten by constructors.

The control campaign was welcomed positively by approved constructors. However, the actual implementation of the certified approach has not been proved for 75% of controlled constructors. As a consequence, some evolutions are planned for the next control campaign that will occur in 2013 and 2014. For instance, an actual in situ audit, based on ISO 9001 processes and realised in constructors' headquarters, could be one of the possibilities to reinforce the in situ control.

### 3.3 Comparison between yearly files and control campaign results

During the control campaign, it could be noted that two constructors had difficulty in fulfilling their certified QM approach. So as to see whether this non-compliance could have been foreseen with the yearly files, a comparison between both results was made. This also enabled us to compare both types of control.

The analysis shows that the two types of control are complementary. Indeed, for constructor 11, the peak of measured values moved toward the quality direction. As a consequence we could not have noted any lack of conformity with the certified approach. On the contrary, for constructor 9, we might have felt a type of laxity in the actual implementation of the approach. However, as all yearly file results complied with regulation, the Annex VII committee could not expect more and could only have a word of warning. Figure 7 shows that constructor 9 presented in their 2011 yearly file some warning results. Indeed, 3 measures (20%) were above the limit value.

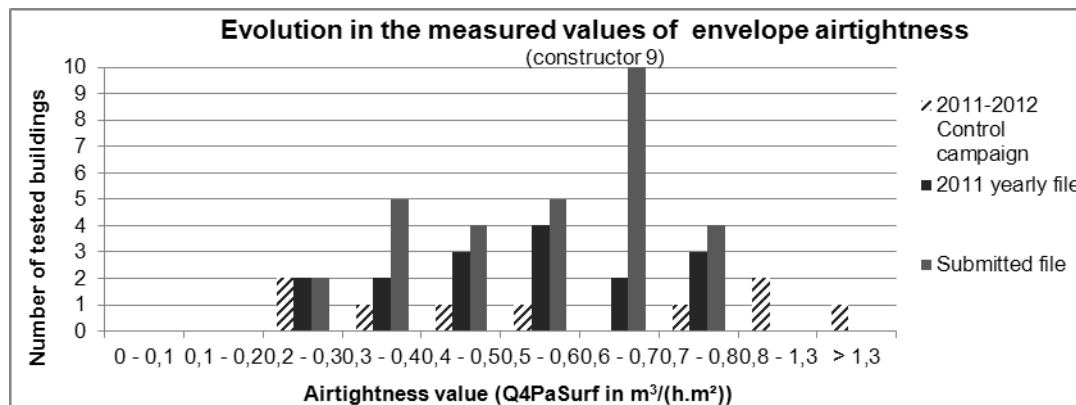


Figure 7: Measured results of both controls for constructor 9

The conclusion of that comparison is that both controls are essential so that the certified QM approaches are reliable:

- The yearly renewal file enables the committee to carry out a file analysis of the QM approach actual implementation,
- The control campaign enables the committee to set up in situ controls and measures on a sample of constructors' production, to see how the QM approach is applied in the "actual life".

Finally, the next control campaign should not concern all of the approved constructors. As a consequence, it seems even more important to continue on carrying out yearly files control.

#### 4 CONCLUSIONS

The number of QM approach submitted files has been multiplied by 5 since 2011. This illustrates the success of RT 2005 QM approaches, and the constructors wish to comply with regulation. To meet that growing demand, the Annex VII committee has evolved to be more efficient in its file evaluations and in the delays between the date of subscription and the date of certification. This led to 27 RT 2012 certifications, obtained over 1.5 years, compared to the 24 RT005 certifications, obtained over 5 years.

In order to guarantee the certified QM approach reliability, the French State implemented two types of control: 1) yearly renewal file analysis, 2) and a control campaign. These two types of control are complementary and must be continued and reinforced.

As Leprince (Leprince, 2011) described the necessity of the evolution of the airtightness measurers' qualification in 2010, it seems that the Annex VII committee should evolve in the same direction. Indeed, the State set out the quality management approach certification. Then, considering the number of requests, the RT 2005 and RT 2012 QM approaches have been successful. In order to 1) guarantee the QM approach reliability, 2) be able to meet the growing demand, 3) implement a reliable yearly renewal file analysis, the Annex VII committee should be dedicated to a private entity that would be able to meet the important demand. The private body is not yet defined, but the necessity of such a transfer is obvious. Moreover, in that possibility, control campaigns could be let to state employees so as to guarantee neutral control. In the future control campaigns there could be more in situ controls, with for instance an in situ audit based on ISO 9001 processes and realized at the constructors' headquarters.

To conclude, quality management approach are now available for the airtightness of ventilation ducts. We can expect that the committee in charge of certifying QM approaches, and constructors, will benefit from the 5 years of envelope airtightness experience. This is another important step in the QM approach and EP regulation that the State must accompany.

## 5 ACKNOWLEDGEMENTS

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## 6 REFERENCES

Leprince, V., Carrié, R., Olivier, M. (2011). The quality framework for air-tightness measurers in France : assessment after 3 years operation, 32nd AIVC Conference and 1<sup>st</sup> TightVent Conference, 12-13 October 2011, Brussels, Belgium.

Charrier, S., Huet, A., Biaunier, J.(2013). *Control of airtightness quality management scheme in France: results, lessons and future developments*. 34<sup>th</sup> AIVC Conference and 3<sup>rd</sup> TightVent Conference, 25-26 September 2013, Athens, Greece

Debrabander, C., Neutens, K. (2011). *The power of quality*, 32nd AIVC Conference and 1<sup>st</sup> TightVent Conference, 12-13 October 2011, Brussels, Belgium.

*Arrêté du 26 octobre 2010 relatif aux caractéristiques thermiques et aux exigences de performance énergétique des bâtiments nouveaux et des parties nouvelles de bâtiments*, JO 27 octobre 2010

*Arrêté du 24 mai 2006 relatif aux caractéristiques thermiques des bâtiments nouveaux et des parties nouvelles de bâtiments*, JO 25 mai 2006