

Airtightness Quality Management Approaches in France: end and birth of a scheme. Previous and new schemes overview and analysis.

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ABSTRACT

Since 2006, the French Energy Performance regulation, named RT, has been allowing two ways to justify building airtightness: either with a measurement or with the application of a quality management approach. The quality management approach certification is managed by the French Ministry in charge of construction, for which it set up a specific expert committee to assess quality management approaches. Since 2012, the justification has been compulsory for residential buildings. This obligation led to a more systematic use of certified quality management approaches.

This paper aims at presenting the analysis of the current process, its results and the improvements to be scheduled in the next certification process which will be managed by accredited certification bodies.

The first part of this paper explains the certification process and tools. It presents the yearly follow-up requirements and the control process content. The second part presents and analyses the certified bodies characteristics and the evolution of measured values along the years. This part gives information about the type of bodies implied in French quality management approaches and the way they imply themselves in the yearly application of their approach. The third part deals with the analysis of the whole certification process: certification it-self, yearly follows-up and control campaign. This part shows the results of the processes and states pros and cons of the current process. A last part presents the new scheme for the certification obtainment. Indeed, to cope with the increasing number of applications, starting July 2015, French authorities decided to entrust accredited certification bodies under contract with the government to deliver these quality management approach certifications. An overall analysis of the current process is made, leading to the implementation of the new certification scheme. Both are presented in the paper. Moreover, the first decisions taken by the accredited certification bodies to implement their quality management approaches certification are also given.

The paper concludes on the overall analysis of the quality management scheme that has been implemented since 2006 in France, its pros and cons, and the evolutions decided for the new certification scheme. The current scheme has been improved year after year and is now robust enough to be transferred to private bodies. Moreover, some new developments were needed which could not be implemented by the French authorities, and which will be set up thanks to the new scheme.

KEYWORDS

Airtightness, Quality Management, Certification, Control, Energy Performance Regulation

1 INTRODUCTION

In 2006, the French energy performance (EP) regulation (RT 2005) introduced a significant reward on the overall building energy performance assessment when justifying a better-than-default value for the air permeability of the envelope. Then, in 2012, the RT 2012 compelled residential buildings airtightness to be better than limit values and to be justified.

The French indicator for the building envelope airtightness is Q4PaSurf, which is the airflow rate at 4 Pa divided by the cold surface area (excluding the lowest floor). In the RT 2012, the airtightness level of residential building envelope must not exceed $0.6 \text{ m}^3 \cdot \text{h}^{-1} \cdot \text{m}^{-2}$ at 4 Pa for single-family buildings. A better-than-default value can be used, provided it is justified. The French EP regulation gives two options to justify the building airtightness level:

- Either with a systematic measurement, performed by a certified tester;
- Or by the application of a certified quality management approach (QMA) on the building airtightness, that allows to test only a sample of buildings.

The RT 2012 obligation of justifying residential building airtightness level led to a more systematic use of certified QMA.

QMA contents are described by Charrier (Charrier, 2014). The underlying basis of an airtightness QMA is to implement a scheme that lasts from the genesis of the building project to its commissioning and that ensures that the building airtightness will not exceed a limit value. This limit value must be better or equal than regulatory requirements. The QM approach is based on a precise description of “who-does-what-when-and-how”. In addition, each step must be traceable and traced.

French authorities are in charge of delivering airtightness QMA certifications. To reach this goal, the French government has implemented a committee (named the “Annexe VII” committee) in charge of analysing the approaches and proposing the certification. This committee has existed since 2007. In 2014, French authorities decided that the QMA certification had to be transferred to private certification bodies, because of the success of the process and the limited State resources to go on managing the certification process. The transfer is planned on July, 2015.

This paper aims at presenting the analysis of the State process, its results, pros and cons after 8 years application, and the next certification process which will be managed by accredited certification bodies.

This paper is organized as follows. Section 2 presents the State certification process since 2007: its organization and gradual improvements. Section 3 presents the way the market answered to the State requirements. Section 4 presents the analysis of the State process: the results and the process pros and cons. Finally, section 5 presents the new certification process, embodied by accredited certification organisms under contract with the government and the limits.

2 STATE CERTIFICATION PROCESS FOR AIRTIGHTNESS QMA: IMPLEMENTED PROCESS AND TOOLS

As presented by Charrier (Charrier, 2014), the Annexe VII committee is composed of a dozen of national experts in charge of analysing the consistency with the authorities requirements, expressed in a ministerial ruling, the Annexe VII of the RT 2012 (JO, 2010). To this end, the committee is in charge of three main deadlines: the certification obtainment, the certification yearly follow-ups, and the certified QMA controls. This part aims at presenting the whole process, organization and tools that the Annexe VII committee implemented.

2.1 Organization and tools for the airtightness QMA analysis

The analysis of airtightness QMA is based on the evaluation of all the files describing the QMA. These files are analysed regarding the authorities requirements. For subjects that are not dealt in the ministerial ruling, the Annexe VII committee proposes precision points, previously discussed and validated. Those precisions are officially diffused via a French authorities web site.

In order to analyse the airtightness quality management approaches, the committee is organized as follows: a couple of experts analyse the same approach, thanks to an evaluation grid. Then, all the committee experts meet to make a final and collective decision. The collective meeting is an important part of the process because the analysis is based on a subjective files analysis. The collective final decision guarantees the treatment homogeneity.

The analysis is based on an evaluation grid described by Charrier (Charrier, 2014). This evaluation grid is also available on the public web site used by French authorities to communicate about their airtightness QMA requirements. This communication enables candidates to be aware of the way the applications will be examined. Gradually, this evaluation grid has been completed by a precise description of what is expected for each criterion. Indeed, each expert could have its own understanding of each criterion, which led to heterogeneous evaluations. Then, as presented in part 3, the committee experts analyse 4 main QMA templates, coming from 4 main studies centers, barely adapted to each builder organisation. To get homogeneous evaluations between similar applications, the evaluation grid has been completed by the repeating comments for every similar application. This grid is often sent to studies centers so that they could improve their QMA templates, for all their clients. Since 2012, so as to meet the increasing number of certifications requests, the Annexe VII committee has had to improve its organisation. Those improvements are described by Charrier (Charrier, 2014). Finally, the Annexe VII committee rule is to propose a certification or a certification denial for each candidate to French authorities, who take the final and official decision.

2.2 Organization and tools for the yearly follow-ups

The certification is valid one year and is renewable yearly if the builder provides a yearly follow-up. Requirements for this follow-up are defined in the ministry rule JO (JO, 2010) and based on the fulfilment of the documents that trace the QMA application.

The yearly follow-up analysis is based on a files analysis, as for the certification. In 2014 and 2015, to strengthen the yearly follow-up, the Annexe VII committee required to submit all the QMA tracing files for two non-compliant buildings. Indeed, the goal is to check whether the certified QMA is actually applied. Moreover, in 2015, the Annexe VII committee restricted the yearly follow-up evaluation period to 6 months, from January to June. Likewise, the committee Annexe VII restricted the number of evaluations to 2, whereas before there could be up to 4 evaluations. Indeed, in 2014, some renewal had been pronounced in November or December, when builders had to submit their new follow-up file one month after. This shortened delay for follow-ups validation compelled studies centers to submit complete files.

2.3 Control process

In 2011, in order to strengthen the certified QMA reliability, the Annexe VII committee implemented control campaigns which are described by Leprince (Leprince, 2011) and Charrier (Charrier, 2013). Those control campaigns are performed by public, independent and neutral controllers. They are divided into two parts: a qualitative control, aiming at verifying the actual application of the certified QMA on some building; and the quantitative control, consisting in measuring the airtightness value on a sample of buildings. Control campaigns target only a

sample of certified QMA. In the first control campaign (2011-2012), the qualitative control only verified if tracing documents were fulfilled or not. In the second control campaign (2014) the file analysis has been strengthened either by analysing each file contents or by being audited *in situ*. Indeed, one major limit to the Annexe VII committee is that evaluations are only based on a files analysis. Sometimes direct oral exchanges could improve the application understanding. 2014 control campaign implemented an *in situ* quality audit, for 4 builders. The current (2015) control campaign strengthened the requirements on the ending of works. Indeed, measurements for previous control campaign were quite often performed on unfinished buildings, at least with impacting airtightness works not completed. Once the control campaign ended, an individual results and decisions report is provided to each controlled builder.

3 MARKET ANSWER TO AIRTIGHTNESS QMA CERTIFICATION

Since 2006, airtightness QMA has been implemented by one main stakeholder: single family houses builder. Indeed, among 101 certified airtightness QMA, only one is applied by an envelope industrialist on single and multi-family dwellings. To be more precise, Figure 1 presents the distribution of the number of certified builders depending on the number of dwellings built per year. The distribution suggests that it remains interesting for builders producing over 50 houses per year, the trade-off being somewhere in the range of 20-50 houses per year.

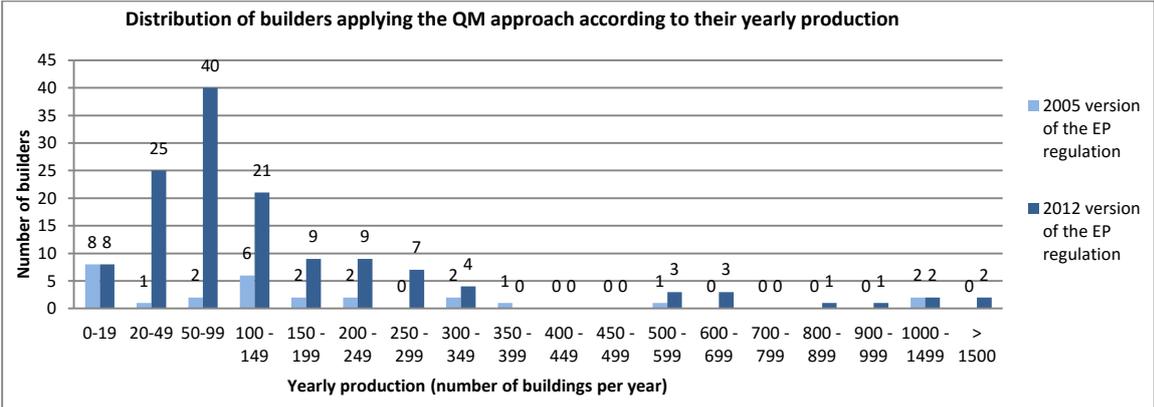


Figure 1: distribution of builders applying airtightness QMA according to their yearly production (number of buildings per year)

Then, Figure 2 shows that 60% of certified builders ask for a limit value equal to the authorities limit value ($0,6\text{m}^3 / (\text{h.m}^2)$), and 40% ask for a better-than-regulatory limit value, between $0,3$ and $0,5 \text{ m}^3 / (\text{h.m}^2)$. Figure 2 shows more precisely how the QMA airtightness limit value is distributed with the certified builders yearly production. We can notice that builders with $0,6$ or $0,5\text{m}^3 / (\text{h.m}^2)$ airtightness limit value are more likely builders with a yearly production between 100 and 250 buildings. Builders with $0,4 \text{ m}^3 / (\text{h.m}^2)$ airtightness limit value are more likely builders with a yearly production between 50 and 100 buildings. It must be noticed that such limit value builders are well represented by builders with a yearly production higher than 1000 buildings.

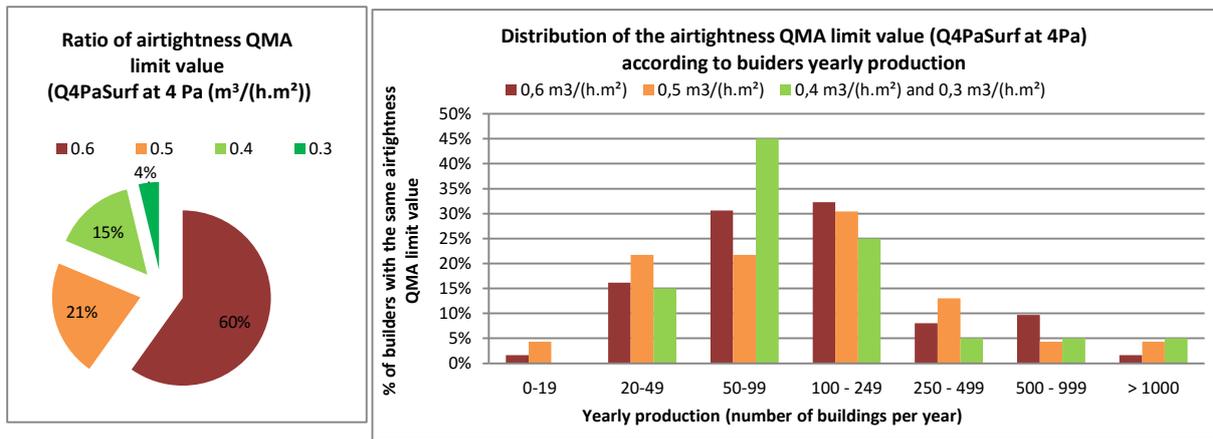


Figure 2: distribution of the airtightness QMA limit value according to builders yearly production

Another market adaptation to the airtightness QMA authorities requests has been the development of airtightness QMA templates by four main studies centers. Indeed, some studies centers decided to help builders in implementing their airtightness QMA and applying it. To this end, they implemented airtightness QMA templates, more or less adapted to each builder organization. Moreover, these studies centers sold in a whole package the yearly *in situ* ISO 19011 audit, and the yearly sample measurement that each candidate has to perform for the certification request. This market answer is controversial. Indeed, on the one hand, it enabled to help builders to implement a QMA and for French authorities to get so many builders requests. But on the other hand, this led to a lack of builders implication in their QMA. Moreover, as studies centers implement and contribute to the application of the QMA, their audit and measurements objectivity might be questionable.

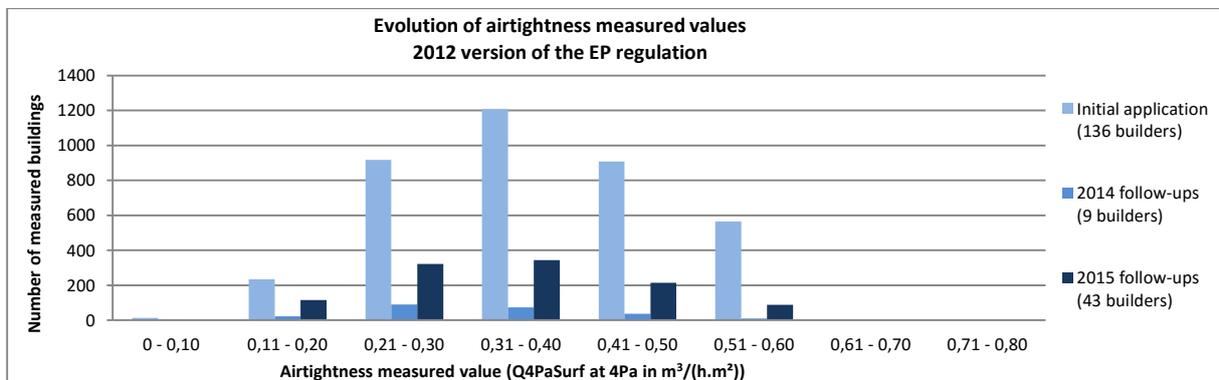


Figure 3: evolution of airtightness measured values

The last market analysis is about the evolution of the airtightness measured values with year. Indeed, the basis of quality management approaches is the ongoing approach, its contents and the results, improvement. As a consequence, measured values improvement was expected year after year, for certified builders. Figure 3 shows that such improvement is not obvious. The measured values improvement has been requested for 2016.

Finally, it must be noticed that, although French requirements enable ducts airtightness QMA, no certification has been asked for such QMA. This can be explained by low reward in the EP calculation for a better-than-default value and no subsidies to encourage such approaches implementation.

4 STATE CERTIFICATION PROCESS: EFFICIENCY, PROS AND CONS

This part deals with the analysis of the State process efficiency, analysing the 3 main processes: the certification process, the yearly follow-up one and the control campaign one.

4.1 Certification process efficiency

Since 2006, the committee Annexe VII has always been evolving so as to improve its efficiency and to get more homogenous and objective analysis. This evolution is shown in Figure 4 that represents the evolution of the number of certification requests, in RT 2005 and RT 2012, and the number of certifications, year after year. We can notice that the committee annexe VII evolutions have been effective as the number of certifications and requests evolutions have the same slope.

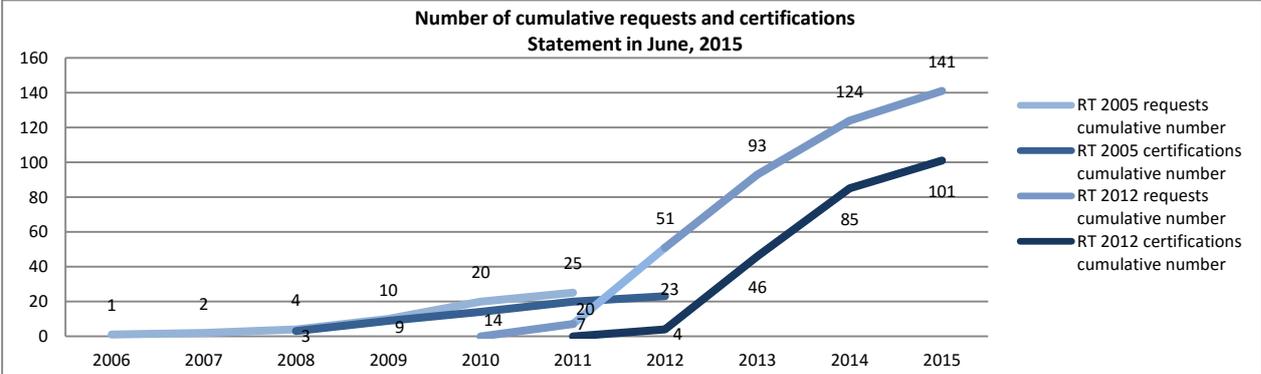


Figure 4: Requests and certifications cumulative number

Then, concerning delays between the request and the State certification, they were stable in 2012 and 2013, around 10 months, thanks to the committee evolutions. The delay is now around 8 to 9 months, for the same reasons.

Another marker of the process efficiency is that QMA encourages applicants to secure a minimum airtightness level. This statement is supported by Figure 5 which shows that both the median value of the airtightness levels and the spread of the distribution are significantly smaller for buildings subjected to a QM approach.

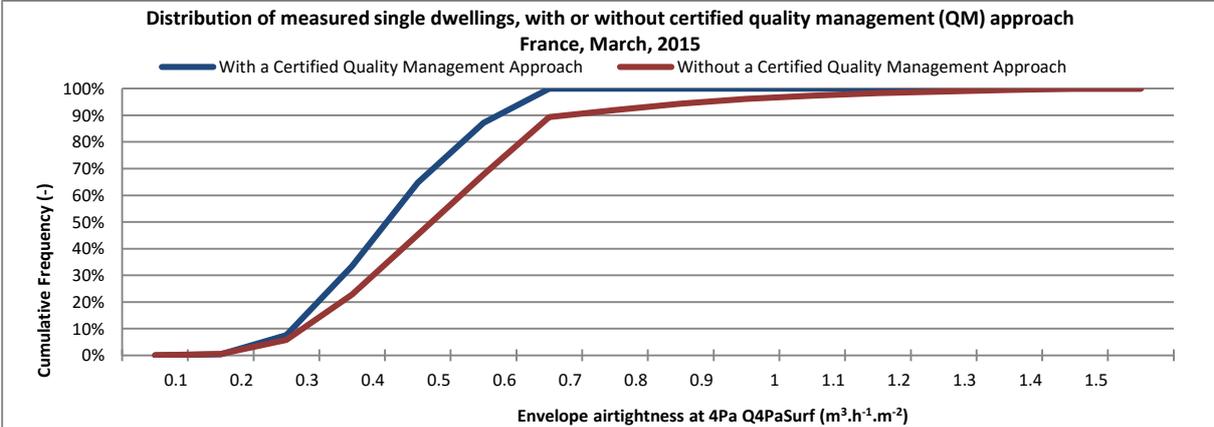


Figure 5: distribution of measured airtightness of houses with and without implementations of a certified QM approach

The feedback of the State certification process can be summed up by the pros and cons of the State process in Table 1.

Table 1: Pros and cons of the State certification process

| Pros | Cons |
|------------------------|---|
| ✓ Homogeneous analysis | ✓ Limited capacities of French authorities to meet the demand |

| | |
|---|---|
| <ul style="list-style-type: none"> ✓ Analysis objectivity and neutrality, thanks to a double analysis and to a common final decision. ✓ Improving and efficient process | <ul style="list-style-type: none"> ✓ Files analysis limits. No direct exchange with the candidate. Sometimes, misunderstanding between the committee requests and the builder answers. ✓ State certification is cost free, which implies that some builders ask for a certification whereas their QMA is not complete or well applied. ✓ The audit ISO 9001 is carried out by the studies center that proposed its QMA template. The yearly ISO 9001 audit objectivity is questionable. The same applies for measurements. |
|---|---|

4.2 Yearly follow-up process feedback

As described in part 2.2, the yearly follow-up process evolved in 2014 and 2015. In 2014, 11 upon 11 approaches have been renewed. In 2015, 40 upon 49 have been renewed. The number of ended certifications has increased in 2015. Reasons are various:

- 1 did not sent its yearly follow-up files, despite various requests;
- 4 builders asked for the end of the certification, after the control campaign results or because, as small production builder, the cost of the QMA was higher than a systematic measurement;
- 4 builders did not succeed after the two committee analysis.

A feedback of the 2015 follow-up analysis is the limit of files analysis, as described in part 4.1. Another feedback is about the committee limitations to 2 committee analysis per follow-up. This decision compelled studies centers to implement complete follow-up files. Moreover, delay feedback is positive. Indeed, it was adapted to the number of answers expected and no builder has been rejected because of the out of time answer.

4.3 Control campaign process feedback

Results of control campaign process are positive. One of the first feedbacks comes from controlled builders. Indeed, since 2011, a majority of certified builders positively welcome the control campaign. Reasons are double: first, it enables direct exchange with French authorities. Then, it puts forward well applied QMA. This is once more true that results of the control campaign led to a double-label summing-up certificate. This report is once more used as a reward by builders that they do not have other certificate to put forward the certification obtainment.

Then, another feedback is that, very often, state controllers had to perform a measurement on a building with airtightness affecting works unfinished. For instance, those works could be dedicated to the client, but the certified QMA did not precise anything about such work. This really questions the reliability of the sample measurements performed by the studies centers.

Next, the synthesis of the control campaign is summed-up in a double label presented in Figure 6. In both control campaigns, decisions have been hard to take. For instance, which decision to take when the builder succeeded to only one of the two controls, like for instance builder 2 or builder 9? For builders who failed the qualitative control, it has been decided to warn them and either control them once again in 2015, or strengthen the 2015 follow-up analysis. For builders who failed the quantitative control, decision has been taken to strengthen the required sample to test in 2015 (not 5 + 10% of the yearly production but 10 + 10%). For information, studies centers and builders expected a more demanding sample, which could have been half of the production, in order to compel the builder to well apply its QMA and to encourage him to a reduction of the sample the year after, in case of good results. Finally, after the second control

campaign, some difficulties appear to take a sanction decision. This might be due to the limited controlled sample (5 to 7 buildings).

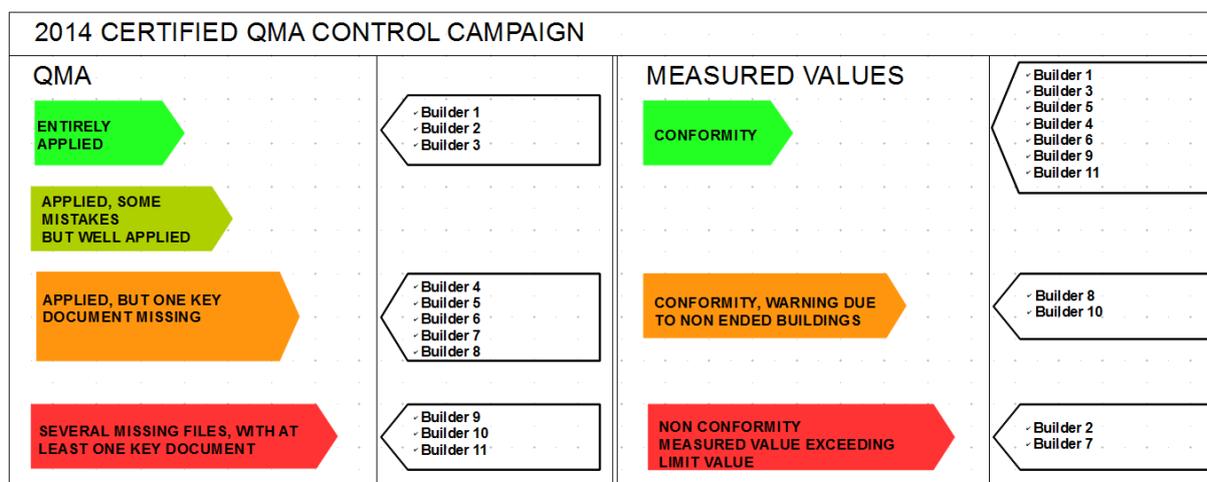


Figure 6: 2014 control campaign results

Finally, some inconsistencies appear between the control campaign and follow-up results. Indeed, the Annexe VII committee pronounced the cancellation of some certification which had succeeded completely during the last control campaign, and vice versa. This strengthened the limits of the files analysis and of the decisions to be taken with the control campaign results, which are unclear today.

As explained in part 1, the French authorities decided to transfer the Annexe VII committee. The next part explains the requirements for certification organisms and the way the annexe VII committee helped to define new rules and requirements.

5 CERTIFICATION ORGANISMS PROCESS: PROCESS AND LIMITS

The certification organisms are dimensioned to manage the number of requests. Moreover, they are used to treat certification requests.

5.1 Scheduled process

JO (JO, 2014) specifies airtightness QMA technical requirements, for any candidate. These technical requirements are exactly the same as previous process ones. JO (JO, 2014) also specifies the requirements for certification organisms. Any certification organism has to propose a certification program, which has to be validated by French authorities and by the accreditation organism. A certification organism can deliver airtightness QMA provided 1/ he is engaged with French authorities, by a contract, 2/ he is allowed, by the accreditation organism COFRAC, to deliver airtightness QMA certifications. The certification organism has to implement three processes: a certification process, a follow-up process, every two years, and a control campaign (every certified builder has to be controlled every 2 years).

This new scheme aims at improving the State process. As a consequence certification organisms will perform ISO 19011 *in situ* audits on their own. It will substitute to the files analysis. The same applies for follow-ups and certification renewal. Moreover, the certification is not free anymore, and we can expect that candidates files will be of better quality. Finally, the control campaign will be applied every 2 years, on all the certified builders. In the previous process, around 10% to 15% were controlled every year.

5.2 New process limits

Because of the certification organisms organisation and in the negotiations with French authorities, exactly the same process could not be transferred to certification organisms and some less demanding point have been accorded.

For instance, the sample has been divided by 2. Indeed, the sample is calculated according to the production of the last 12 months and is asked every 2 years. In the previous scheme, the sample had to be calculated on the last period since when the QMA had been analysed. This presents a huge reduction of the tested sample, which was yet a small part of the production (5 + 10% of the production, if yearly production < 500 buildings).

Then, the neutrality and homogeneity of each analysis is questioned. Indeed, each candidate will be audited by one expert only. The expert will make a report, which will be analysed by a technical director. No committee is organised, which could have guaranteed treatments homogeneity between candidates. No evaluation grid has been submitted to French authorities. French authorities are only involved in a yearly meeting with every contracted certified organism, so as to deal with repetitive or blocking problems. The committee annexe VII had insisted to make jurisprudence but nothing has been retained.

Finally, the control process requires only a measurement control, and not a control on the application of the certified QMA. The success and strength of a QMA rely on the fact that it is a whole process that is applied on the whole life of a project. The process enables an actual quality and improvement. Measurement of the efficiency at the end of the construction is only one step among others. Moreover, the control campaign will be applied on all the certified QMA, every 2 years, which strengthens the control. However, the number of measurements is very low (3 for production > 500 buildings, against 7 in the current control campaign). Finally, the decision taken by certification organisms in case of non-complying measured value is not clear and French authorities did not fix any minimum decision to take (cancellation, sample strengthen).

6 CONCLUSIONS

The paper presents the end and the birth of processes for the airtightness QMA certification. The old process, the State one, has gradually evolved so as to meet the growing demand and to improve the certification reliability. This process has been very efficient, but suffered some deficiencies that French authorities could note solve: limited capacities to meet the demand, limits of files analysis, limits of decisions taken after control campaigns. To solve these deficiencies, the airtightness QMA certification has been transferred to private and accredited certification organisms. Table 2 presents the two processes pros.

Table 2: French authorities and certification organism processes pros

| Process | French authorities | Certification organisms |
|-----------------------|--|--|
| Certification process | ✓ Homogeneity | ✓ Audit in situ: better understanding of the approach |
| | ✓ Neutrality | ✓ Organised to meet the demand |
| | ✓ Jurisprudence | ✓ Delays between request and certification (around 4 months) |
| Follow-up process | ✓ Yearly follow-up | ✓ Audit in situ |
| | ✓ Verification of the actual application of the QMA on buildings | ✓ Complete analysis |
| | ✓ Possible consequences: certification cancellation | |

| | | |
|------------------|--|--|
| Control Campaign | ✓ Control of the application of the QMA and measurements | ✓ Every builder is tested within 2 years |
|------------------|--|--|

If a country wants to implement such airtightness QMA, the two times process seems efficient: first a State authorities certification process, which is improved with experience, and then a private certification organism process.

Next steps for French airtightness QMA are 1/ trying to guarantee continuity between the two processes, 2/ trying to guarantee compliance with regulatory requirements, 3/ trying to get homogeneity between evaluations and between certification organisms and 4/ trying to encourage ducts or ventilation QMA, that are scheduled by EP regulation.

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