

PROPOSAL FOR UPDATING FRENCH REGULATION CONCERNING AIRTIGHTNESS MEASURING EQUIPMENTS' CALIBRATION

Florent Boithias^{*1}, Sarah Juricic¹, Sylvain Berthault¹

*1 CETE de Lyon
Département Laboratoire d'Autun
Boulevard Bernard Giberstein
71404 AUTUN CEDEX*

**Corresponding author: florent.boithias@developpement-durable.gouv.fr*

ABSTRACT

French standard for airtightness measurements is NF EN 13829. It is completed by French application guide GA P50-784, to set calibration rules more precisely, among other issues. This guide was published in 2010. To answer measurers' remaining questions, a Frequently Asked Questions web site was created by CETE de Lyon. Today, some weaknesses of French GA P50-784 have been clearly identified. It was therefore planned to update it, taking into account the experience gained in the last few years in dealing with airtightness in France, measurers frequently asked questions and ISO 9972 standard requirements in revision.

This article presents the conclusions of a working group created in 2011, lead by CETE de Lyon, which was in charge of updating French philosophy about calibration rules by optimizing the compromise between calibration's precision and costs. It is also planned to improve precision requirements for low air flow rates measurements. The content of this article must not be considered as the future French regulation; it is only the final proposal of the working group.

KEYWORDS

Airtightness, building, calibration

INTRODUCTION

Airtightness measurements in France are based on three complementary references:

- European standard NF EN 13829, published in 2001 [1] ;
- French application guide GA P50-784 of European standard, published in 2010 [2] ;
- On-line Frequently Asked Questions (FAQ) on CETE de Lyon's website.

First, NF EN 13829 details the protocol to be followed to measure airtightness. It also explains calculations which must be done to get the air-leakage flow rate at the considered pressure level, as well as the conversion of air-leakage flow rates into one single airtightness indicator : n_{50} [vol/h].

Then, GA P50-784 explains how to determine French legal airtightness indicator $Q_{4Pa_{surf}}$ (also written Q_{4Pa_surf}) and associated uncertainty. It gives sampling guidelines for grouped

and collective housing. Calibration rules are also specified in this application guide. It is published under French Association for Normalization (AFNOR) copyright.

Finally, answers to measurers' Frequently Asked Questions can be found on CETE de Lyon's website. These answers are not based on any reference. They complete and precise NF EN 13829 standard and GA P50-784. Authorized measurers agreed by French Ministry in charge of Construction must follow the FAQ's specifications, in case of doubt on some issues dealt with in the standards.

Today, some weaknesses of French GA P50-784 have been clearly identified. It was therefore planned to update it, taking into account the experience gained in the last few years in dealing with airtightness in France, measurers Frequently Asked Questions and future ISO 9972 [3] standard requirements, which should replace NF EN 13829.

This article presents the first conclusions of a working group created in 2011, lead by CETE de Lyon, which is in charge of updating French philosophy about calibration rules. The content of this article just gives some elements of the final proposal of the working group and should not be considered as part of the future French regulation. It begins by reminding today's calibration rules; then, weaknesses of these rules are detailed; finally, tracks of progress are proposed.

CALIBRATION RULES APPLICABLE TODAY

Calibration rules given in GA P50-784 are shown in Table 1.

Device	Measuring range	Required precision	Calibration or verification frequency	Authorized organisms
Barometer	900 – 1100 hPa	± 2 hPa	3 years	- Manufacturer - COFRAC accredited organism
Pressure-gauge	0 – 100 Pa	± 2 Pa	1 year	- Manufacturer - COFRAC accredited organism
Flowmeter	Unspecified	± 7 %	1 year	- Manufacturer - COFRAC accredited organism
Thermometer	-30 °C / +50 °C	± 1 °C	3 years	- In-house - Manufacturer - COFRAC accredited organism
Wind gauge	0 – 25 m/s	± 0,5 m/s	3 years	- Manufacturer - COFRAC accredited organism
Distance measuring equipment	0 – 20 m	± 1 cm	3 years or replacement for electronic devices	- In-house - Manufacturer - COFRAC accredited organism
Adjustable diaphragm	Unspecified	Unspecified	1 year	- Manufacturer - COFRAC accredited organism
Fixed diaphragm	Unspecified	Unspecified	5 years or less according to manufacturer specifications or in case of damage	- Manufacturer
Fan	Unspecified	Unspecified	5 years or less according to manufacturer specifications or in case of damage	- Manufacturer
Pipes' shape	Unspecified	Unspecified	Unspecified	- Manufacturer

Table 1. Calibration rules given by French application guide GA P50-784

The certificate delivered after calibration must describe the calibration protocol and state whether the device is in conformity or not. For non-measuring devices, like diaphragms or fans, it is only asked to report a list of tested components and associated corrections.

MAIN WEAKNESSES

First problematic issue is precision and reliability of calibration: French application guide makes it possible to choose between sending measurement devices either to the manufacturer or to an external COFRAC accredited organism. COFRAC is the French Accreditation Comity, member of EA (European Accreditation) and ILAC (International Laboratory Accreditation). The manufacturer is not able to be as reliable as a COFRAC accredited organism.

Secondly, calibration is not mandatory for fans and associated diaphragms. It is only required to check shapes, rotation speeds and stability, without any precision criteria nor operation range.

Thirdly, full airtightness measurement systems cannot be calibrated at once. Components can only be calibrated separately. However, manufacturers observed in some cases that deviation measured on a full system could be greater than theoretical deviation calculated from known components' deviations.

Fourthly, systems for air-flow rate measurement have no specified measuring range. They can therefore be calibrated on a given range and then used on a wider range. This point creates difficulties to reach precision especially at low air-flow rates ranges, for which most of blowing-door technologies are usually not calibrated.

Finally, mandatory information given by the calibration certificate is not complete for the measurer to calculate uncertainty. For example, standard reference and calibration uncertainty, as well as devices' resolution, are not specified in the certificate.

TRACKS OF PROGRESS

The aims of the working group created in 2011 are :

- To ensure greatest precision of airtightness measurements;
- To consider any existing or future technology for airtightness measurement;
- To minimize practical and financial constraints for measurers.

Precision is particularly crucial for future controls of airtightness for dwellings built after January 2013. According to French Thermal Regulation (RT 2012), those buildings will be measured at the end of their construction and their airtightness will have to be below:

- $0.6 \text{ m}^3/\text{h}/\text{m}^2_{\text{cold surface}}$ at 4 Pa differential pressure between indoor and outdoor for individual dwellings;
- $1 \text{ m}^3/\text{h}/\text{m}^2_{\text{cold surface}}$ at 4 Pa differential pressure between indoor and outdoor for collective dwellings.

COFRAC was identified by the working group as the only way to get fully transparent and reliable calibration, with all information needed to calculate uncertainty given on the certificate. It was therefore decided that COFRAC calibration would become mandatory for all components of measurement systems, to ensure excellent precision, except for barometers (for atmospheric pressure measurements), thermometers and distance measuring equipments.

Those equipments were considered as having lower impact on the final result than flowmeters, for example.

To enable calibration of all existing and future measuring systems, not necessarily using pressure-gauges as flowmeters, and also to ensure the consistency of the full acquisition chain, the group recommended that the systems should be calibrated without separating components. However, to limit practical constraints for measurers, who sometimes need to use flowmeters in association with many different fans, it was decided that the possibility of calibrating components separately would be preserved.

A two-possibility solution was therefore proposed:

- First, the full system has to be calibrated when sold to the customer, with a maximal tolerated error of $2 \text{ m}^3/\text{h} \pm 7 \%$;
- Then, two choices are proposed :
 - Either the system is kept full every time it is used and can therefore be calibrated at once every year, with a maximal tolerated error of $2 \text{ m}^3/\text{h} \pm 7 \%$;
 - Or system's components are not always kept together and must be calibrated separately, with frequencies and maximal tolerated errors reported in Table 2.

Device	Measuring range	Required precision	Calibration or verification frequency	Authorized organisms
Barometer	700 – 1100 hPa	$\pm 2 \text{ hPa}$	4 years	- Category 1 ¹
Pressure-gauge	{-100, -50, -10, 0, 10, 50, 100} Pa	$1 \text{ Pa} \pm 1\%$ ²	1 year	- COFRAC accredited organism
Thermometer	-20 °C / +40 °C (3 steps on full range)	$\pm 1 \text{ °C}$	4 years	- Category 1
Distance measuring equipment	0 – 20 m (0 – 100 m for telemeters)	$\pm 1 \text{ cm}$		- Category 2 ³
Complete measuring system (full acquisition chain)	6 steps on desired range (3 steps per configuration ⁴ if many)	$2 \text{ m}^3/\text{h} \pm 7\%$	1 year	- COFRAC accredited organism
Pressure-gauge (flowmeter)	Desired measuring range	$1 \text{ Pa} \pm 1\%$	1 year	- COFRAC accredited organism
Wind gauge	5 steps on desired range	$0,5\text{m/s} \pm 3\%$	3 years	- Manufacturer - COFRAC accredited organism
Fan and associated aperture or cone	6 steps on desired range (3 steps per configuration if many)	$2 \text{ m}^3/\text{h} \pm 4\%$	1 year or 2 years (still to be discussed)	- COFRAC accredited organism

Table 2. Calibration rules proposed by the working group

¹ Category 1: calibration or verification must be done in conformity to FD X 07-012 or FD X 07-011 (in-house, manufacturer or external organism).

² Percentage of measured value

³ Category 2 : self-control with specific protocol and verification file.

⁴ Configurations can be rings with different diameters, for example.

Each component and the entire system must not be used out of the measuring range used for calibration. This ensures precision at low air-flow rates, for example, because systems which are not calibrated on low ranges can no more be used. For very airtight buildings measurements, specific systems should therefore be bought by measurers and calibrated on low air-flow rates ranges.

It was observed that new rules proposed by the working group were quite complex, compared to previous ones. However, they were considered as the only way to meet the three objectives the group had defined. It is still unknown whether one of the two possible solutions for calibrating systems (full system or component-by-component) will be more expensive than the other. This could make measurers prefer one solution than the other on the long term.

POINTS STILL TO BE DISCUSSED

First, frequency of calibration for fans must be precised: chosen period will be either 1 year or 2 years, depending on observed deviations on Building Services Research and Information Association (BSRIA, UK) database. It was decided that the period would not exceed 2 years in order to keep maximum competitiveness between the two possible calibration solutions.

As airtight door is never verified together with full measuring system, the group also imagined a service control procedure, which could become mandatory to check full system's consistency between two calibrations. A decision must still be made on this point.

Then, after having found the air-flow rate range usually used for dwelling measurement, specific calibration rules should be defined for higher and lower air-flow rates, in order to guide calibration organisms' investments.

Afterwards, fans with uncommon diameter should not be forgotten in calibration rules. Specific rules should therefore also be defined for them.

Finally, as there is no French organism able to do COFRAC calibration for fans at the moment, it was planned to set a deadline for the regulation changes to be applicable, so that organisms have time to adapt. Suitable deadline should also let enough time to measurers to calibrate their equipments and get aligned with new rules. This deadline is still to be defined.

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