

ASIEPI WP5 web event 1  
12th December 2008

**Ways to stimulate a market transformation of envelope airtightness**

*Analysis of on-going developments and success stories in 4 European countries*

Answers to questions asked during the meeting [Rémi Carrié and Gaëlle Guyot, CETE de Lyon]

**HOW DO YOU MEASURE THE AIRTIGHTNESS OF MULTI-FAMILY BUILDINGS?**

Measuring or evaluating the airtightness of multi-family buildings is challenging as there may be technical and practical difficulties that prevent from pressurizing the whole building. These difficulties include for instance building configuration (e.g., exterior hall ways that do not allow pressurisation from a single point), pressurisation fan size, stack effect, or cost.

Therefore, the measurement of the whole envelope of multi-family buildings is rarely performed in practice. However, several countries use alternate schemes to overcome these problems, for instance:

- in France, in the framework of the BBC-Effinergie label, the measurement can be performed by apartment. The basic idea is to test a sample (e.g., of 3 units for a building of 30 apartments or less) and to make a weighted average of the results to estimate the global airtightness.
- in Norway, tests on single apartments can be used. It is seen as a simple practical measure that also encourages airtightness between apartments, which is good to avoid noise and cross-contamination.

**HOW IS A PRESSURISATION TEST PERFORMED ON SINGLE APARTMENTS?**

The airtightness measurement of single apartments is usually performed the same way as in individual houses. Therefore, there is no specific protocol to balance the pressure between the apartment under test and other apartments. Different protocols may lead to very different results.

**WHAT ARE THE SURFACES TAKEN INTO ACCOUNT FOR EVALUATING THE Q50 (LEAKAGE FLOW AT 50 PA DIVIDED BY ENVELOPE AREA) WHEN MEASURING APARTMENTS SEPARATELY?**

This is defined in EN 13829, § 6.1.2. All exterior surfaces, plus floors, ceiling and walls to neighbouring apartments are taken into account.

However, other assumptions are used in some countries to extract indicators that better fit the national requirements of the EP-regulations (see question regarding the measurement of multi-family buildings).

**IS DUCTWORK AIRTIGHTNESS GOOD IN THE MEMBER STATES?**

The SAVE-DUCT project has shown that there are large discrepancies between countries on this subject (the project report is available through AIVC at [www.aivc.org](http://www.aivc.org)). Analyses performed on measurements results have shown that Belgian and French ductwork systems were typically 3 times leakier than Class A whereas Swedish systems commonly complied with Class B (i.e., 3 times tighter than Class A). The main reason is that the Swedish quality system (Boverket) imposes a rather pragmatic testing scheme which has encouraged the systematic use of ductwork with pre-fitted seals that guarantee good airtightness. This type of ductwork is very much used in Nordic countries where similar conclusions can be drawn.

This topic will be discussed in more detail during the next ASIEPI WP 5 Web Event in October 2009.

### **WHAT IS THE ENERGY IMPACT OF ENVELOPE LEAKAGE?**

Energy wastage due to envelope leakage has been estimated in various countries through numerical simulations:

- in Belgium and in Germany, the energy impact has been calculated to be about 10% of the energy performance level for individual houses;
- estimates based on simulations on 9 real buildings in France lie between 0.5 and 15 kWh-pe/m<sup>2</sup> per year (depending on climate, ventilation system type, and building configuration), with an average of 6.6 kWh-pe/m<sup>2</sup>, between “default” and excellent airtightness

For comparison purposes, in Belgium, France, and Germany, the impact of good envelope airtightness is similar to that of solar collectors for domestic hot water.

### **HOW DO YOU DEAL WITH ENVELOPE AIRTIGHTNESS VALUE IN ENERGY LOSSES CALCULATION?**

There are three major ways to estimate this impact:

- the simplest is to evaluate the infiltration losses based on a rule of thumb established by Drubul in 1988 (\*) and suggested by Kronvall (\*\*) in 1978. The rule says that the infiltration airflow rate in air changes per hour may be determined by dividing the n50 value by an empirical coefficient that lies between 10 and 30. In practice, the empirical coefficient is often set to 20 (i.e., the infiltration airflow rate is equal to the airtightness at 50 Pa divided by 20);
- an intermediate approach is to estimate the infiltration airflow rate based on the empirical model proposed in ISO 13790, annex G;
- a more detailed approach is to perform an hourly simulation of the airflow rates, based on a pressure network code such as that described in EN 13465.

Once the infiltration airflow rate is known, the calculation of the energy losses is straightforward.

In national regulations, one of those three methods is commonly used in the EP-calculation.

(\*) Drubul C, *Inhabitant's behaviour with respect to ventilation*, Technical note 23, Air Infiltration and Ventilation Center, 1988

(\*\*) Kronvall J, *Testing of houses for air-leakage using a pressure method*, ASHRAE trans. Vol 84 no 1 1978

### **IS IT POSSIBLE TO COMPARE AIRTIGHTNESS MEASUREMENTS BETWEEN THE MEMBER STATES?**

To some extent yes. A collection and analysis of some data collected through the ASIEPI partners has been presented at the 2008 BlowerDoor conference (Pappaglastra et al., 2008). However, caution should be exercised when comparing airtightness values :

- the measurement methods are not necessarily the same. EN 13829 mentions two methods (A and B) that can lead to very different results e.g., depending on how combustion appliances are sealed; (\*)
- the calculation of the volume or the envelope area that is used to normalize the leakage flow may be different for the same building, depending on assumption adopted nationally or even by the operator.

It would be useful to harmonize these methods to be able to reliably compare and monitor results.

(\*) In Belgium, additional specifications for the measurement of envelope airtightness have been published (<http://www.epbd.be/go/airtightness-measurement>)

### **WHY ARE THERE DIFFERENT INDICATORS (n50, Q50, W50, ETC.)?**

Now in Europe, many countries have adopted the n50 value (i.e., the leakage flow divided by the volume) for their EP regulation while others (e.g., Belgium, France, UK) use the envelope area normalization. The rationale behind this latter choice lies in the fact that the volume is not needed for an energy performance calculation. Using the n50-value should require a precise definition of the way the volume is calculated, which to our knowledge, is not the case

in any European country. On the other hand, the envelope area is usually well-defined in regulations.

More generally, the indicator used may be different depending on the application. The volume normalization seems well-appropriate to pollutant transfer applications as the volume is a necessary input. Similarly, the exterior envelope area indicator seems well-appropriate to energy use applications. The floor-area normalization may be interesting for comparison purposes as it is often more difficult to have access to the volume or envelope area data than the floor-area.

#### **WHAT ARE THE MINIMUM REQUIREMENTS FOR LOW-ENERGY BUILDINGS?**

To our knowledge, only two low-energy labels include a minimum requirement for low-energy buildings:

- the PassivHaus standard ([www.passivhaus.de](http://www.passivhaus.de)) that requires an airtightness better than 0.6 air changes per hour at 50 Pa ( $n_{50} \leq 0.6$  ach);
- the BBC-Effinergie standard ([www.effinergie.org](http://www.effinergie.org)) that requires for an individual house an airtightness better than 0.6 m<sup>3</sup>/h per m<sup>2</sup> of cold surface area at 4 Pa (this translates for an individual house to a  $n_{50}$  of about 2.5 ach).

Although a minimum requirement is not imposed, the global energy use requirements of low-energy labels encourage to achieve good envelope airtightness. Problems may arise when an appropriately set default value can be used, allowing buildings to be labelled although their airtightness is much worse than the default value.

#### **IS THERE A DATABASE TO SEE WHICH LEVELS OF AIR TIGHTNESS ARE COMPULSORY IN EU MS, OR GUIDELINES?**

There is no up-to-date document at this time.

#### **IS THERE A CERTIFICATION PROCESS FOR THE PRESSURISATION TEST TECHNICIANS?**

There exists a certification scheme in Germany which is not compulsory to perform tests.

There exists a compulsory authorization process in France for technicians who perform test on BBC-Effinergie buildings.

To our knowledge, there is no other certification or authorization scheme in European countries.

#### **WHAT IS THE EFFECT (EXTENT) OF THE AGING PROCESS IN THE AIRTIGHTNESS PERFORMANCE?**

There is little information on the subject at the moment. A study referenced in a paper written by Erhorn et al. and presented at the 2008 AIVC conference shows airtightness values of 31 "PassivHaus" houses at commissioning and 2 year later. The average  $n_{50}$  at commissioning and 2 year later were 0.37 and 0.46 ach at 50 Pa, respectively.

#### **ARE THERE COUNTRIES WHERE AIRTIGHTNESS TESTING IS COMPULSORY?**

To our knowledge, the UK is the only country that has made testing mandatory. This has been in force since 2002 for large buildings and extended to most buildings in 2006.

#### **DOES THE AIRTIGHTNESS DEPEND ON CONSTRUCTION TYPE?**

Measurements usually show that light (e.g., timber-frame or steel) constructions are leakier than massive construction, but this is not bound to be. In fact, PassivHaus houses are often light constructions and are very airtight.

The general statement that can be drawn is that light construction are more sensitive as the airtight layer can be more affected by poor design and workmanship than in massive constructions.