Implementation by the EU Member States of the EPBD : opportunities and challenges in relation to building airtightness

P. Wouters – C. Delmotte – N. Heijmans – P. Van den Bossche – F. Dobbels
Belgian Building Research Institute (BBRI – WTCB – CSTC)

1. Introduction

Building airtightness is not a new topic of interest. Already in the seventies of the last century, intense work was done regarding building airtightness in the Nordic countries. In the Air Information Review of August 1980 (ref. 1) (figure 1), an article entitled ‘Build tight – ventilate right’ already very well described the challenges.

Also in 1980, the Air Infiltration and Ventilation Centre (AIVC) published a guide entitled ‘Air Infiltration Control in Housing – A Guide to International Practice’. This guide, primarily based on Swedish experience, described very well the various aspects of building airtightness.

2. Requirements in the EPBD

The Energy Performance of Buildings Directive (EPBD) (ref. 1) imposes to the Member States requirements as regards:

(a) the general framework for a methodology of calculation of the integrated energy performance of buildings;

(b) the application of minimum requirements on the energy performance of new buildings;

(c) the application of minimum requirements on the energy performance of large existing buildings that are subject to major renovation;

(d) energy certification of buildings; and

(e) regular inspection of boilers and of air-conditioning systems in buildings and in addition an assessment of the heating installation in which the boilers are more than 15 years old.

According to article 3, the methodology of calculation of energy performances of buildings shall include at least the following aspects:

- thermal characteristics of the building (shell and internal partitions, etc.). These characteristics may also include **airtightness**;
- heating installation and hot water supply, including their insulation characteristics;
- air-conditioning installation;
- ventilation;
- built-in lighting installation (mainly the non-residential sector);
- position and orientation of buildings, including outdoor climate;
- passive solar systems and solar protection;
- natural ventilation;
- indoor climatic conditions, including the designed indoor climate.

As such, the EPBD does not explicitly impose to take building airtightness into account but clearly gives a strong signal to pay attention to building airtightness.

The deadline for implementation of the above listed requirements was January 4 2006. Only if Member States can prove lack of qualified and/or accredited experts, a delay until January 4 2009 can be admitted.

Information about the practical status of implementation of the EPBD by the Member states can be found in the Information Papers on Country Status reports as published by the EPBD Buildings Platform (www.buildingsplatform.eu).

3. The role of European standards

CEN, the European Committee for Standardization (www.cen.eu), has published different documents which promote a harmonised consideration of building airtightness in the framework of the EPBD.

A first important standard (EN 13829:2000) describes the measurement method of air permeability of buildings through fan pressurization.

Other (draft) standards describe the method to calculate the ventilation air flow rates in buildings (including infiltration) to be used for applications such as energy calculations, heat and cooling load calculation, summer comfort and indoor air quality evaluation. The documents cover dwellings (EN 13465:2004), buildings in general (prEN 15242) and commercial buildings (prEN 15241).

Finally, other documents like EN 13779:2004 or TR 14788:2006 give guidance on the maximum n_{50} value for buildings.

An overview of ventilation related standards can be found on www.aivc.org

4. Approaches for integrating building airtightness in energy performance regulations

Building airtightness is at present included in several EPBD related regulations, e.g. in Belgium, France, Slovenia, Netherlands, … In practice, there are sometimes major differences in the way building airtightness is taken into account :

- In several countries, proof of compliance must be done at the moment of the building permit (e.g. in the Netherlands), whereas in other countries evidence must be given after the finalisation of the works;
- In some countries, a better airtightness than the default value can only be taken into account if proven by measurements, whereas other countries also allow the use of standard details (e.g. the Netherlands);
- There are countries with a minimum requirement (e.g. Slovenia);
- The default value for building airtightness differs from country to country;
- The precise calculation procedure regarding building airtightness differs from country to country.

5. Market uptake of EPBD

Several countries have already since many years requirements or at least strong recommendations regarding airtightness. Interesting developments from the last few years are the mandatory requirements for large buildings in the UK and the airtightness requirements for passive houses.

5.1 UK requirements on large buildings

Since 1 April 2002, when Part L2 of the Building Regulations (ref. 11) came into force in the UK, new buildings with excessive air leakage are no longer acceptable. All new commercial and public buildings over 1000 m² must be tested by an accepted testing body for airtightness.
The regulation requires that air permeability should not exceed 10 m³/hm² at an induced pressure difference of 50 Pa across the extended envelope.

5.2 Passive houses (Passivhaüser)

Passive houses are characterised by extremely low transmission and infiltration losses in combination with high efficiency heat recovery ventilation systems. The airtightness requirements (i.e. $n_{50} \leq 0.6\ h^{-1}$) are very severe. It is clear that such a severe airtightness requirements is a major driver for a rational approach regarding airtight building concepts, whereby good building design in combination with appropriate execution techniques is essential.

5.3 Blowerdoor conference

The existence of an international conference with as specific focus the issue of building airtightness is a good indication of the growing interest for this issue. It seems realistic to expect a further increase in the interest for the various aspects of airtightness in buildings.

6. Challenges and opportunities

The interest for energy efficiency issues in buildings has grown the last 2 years spectacularly and this by all kind of decision makers. Within this context, it is logical to expect that building airtightness will gain in importance. How this will happen in practice will be influenced by a number of decisions and trends. Some of these aspects are briefly described here.

6.1 Effective way for dealing with airtightness in regulations

Energy performance regulations

A key idea of energy performance regulations is the fact that the performance assessment (and related requirements) is focusing on the total energy performance of a building and not on the individual component performances. As such, the designers and executors have a large liberty in the approach for achieving a given target. Especially in very price-competitive markets, those measures with a high energy saving per invested € will be the most attractive. Therefore, it is essential that the calculation methods used by the Member States foresee the possibility to include the building airtightness results. If not, there isn’t any motivation to invest in an improved building airtightness.

Individual component requirements

Whereas a requirement based on an overall energy performance calculation procedure does not give any guarantee that attention will be paid to building airtightness, an explicit attention for building airtightness can be obtained by imposing minimum airtightness requirements. Such approach can be interesting if there is sufficient evidence that investing in building airtightness is among the most relevant measures and/or if there is a sufficient evidence that a better building airtightness is needed (e.g. for thermal comfort reasons, because it is not evident to improve it once a building is constructed, …). The risk of such requirement is that the cost-benefit relation may be too high in certain cases.

Control of regulations

Various studies have shown that the requirements are not always realised in practice despite the fact that the declarations indicate compliance with the regulations. The risk of a deviation between the reality and the declared value is probably quite high for airtightness results if there is not an effective system of compliance control in place. An effective system of compliance control can be obtained by a strict governmental control scheme, by the fact that there is a rigorous control scheme by architects and/or consulting engineers or by other means.

6.2 Subsidies and fiscal deduction

At present, many countries have a range of financial stimuli to accelerate the implementation of energy efficient investments in buildings, e.g. subsidies, fiscal deduction, attractive loans, …

Typically, a number of conditions have to be met in order to receive the benefits. Quite often, the requirements are expressed in a descriptive way, e.g. installation of high efficiency glazing, installation of condensing boiler, installation of a ventilation

system with heat recovery, … In case of such approach, one has to convince the decision makers to include building airtightness in the list of acceptable measures.

An alternative, more attractive approach, is to relate the benefit to the achieved energy performance improvement whereby the energy performance calculation method can be used as the quantitative basis.

6.3 Availability of appropriate materials and systems

Achieving a good building airtightness is much more feasible when appropriate materials and systems are available. Examples are airtightness layers, tapes, connecting elements for e.g. ducts, …. During the last decade, a whole range of such products have become available in several countries. A widening of the available products to all EU countries is important.

6.4 Training – making building airtightness predictable

The achievement of a certain airtightness level through ‘trial and error’ is not the appropriate approach for a wide scale market uptake of building airtightness since it will be too costly and not evident to integrate in the building process.

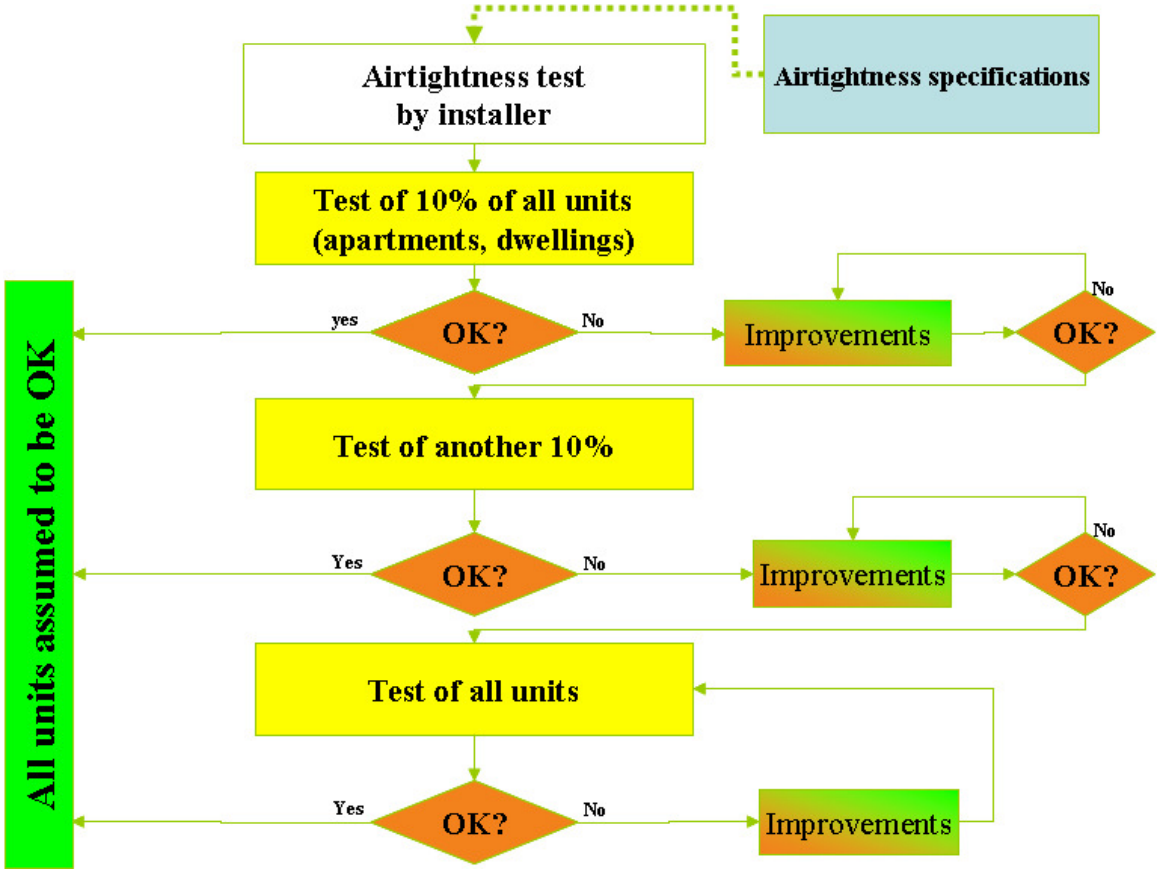
Therefore, appropriate training tools and courses are very important. The availability of guidance on building details and appropriate execution technique is very important. International collaboration is probably very useful.

6.5 Efficient framework for quality control and certification

As indicated before, it is not obvious to guarantee building airtightness without a framework for control. Such framework can be based on systematic control measures, on random control measures and/or on quality control of those who are in charge of the works.

With respect to the control measures on building airtightness, it is important that this is possible at economic attractive conditions. Therefore, it is important to evaluate possibilities for improving the cost-benefit relation whereby the following considerations can be useful:

- Development of cheap and small systems for testing the airtightness of apartments;
- Intelligent procedures for a random check of the building airtightness in multi-family buildings (e.g. as done for ductwork airtightness in Sweden – see scheme);
- Framework whereby the building contractor can carry out control tests;



6.6 Optimal building airtightness

It is well known that the cost for reducing the U-value of a building component from 0.4 to 0.2 W/m²K is much higher than from 1.0 to 0.8 W/m²K. In general, the same is true for improvements in building airtightness. Therefore, it is important to identify airtightness levels with a good cost-benefit relation, as well in the case of governmental requirements as when specifying internal targets for a building project. The appropriate level has to be seen in the specific context of a given project, whereby the construction type (wooden structure, masonry, …), the available experience, the overall energy requirement level, … may be important boundary condition.

Imposing airtightness levels which in a given context require too high investment costs will be counter productive and may reduce the interest in building airtightness. In case of legal requirements, it may be important to consider an increase of the requirement as function of time (in order to give the market the opportunity to learn how to achieve in a cost effective way a given airtightness level).

6.7 Airtightness and existing buildings

It is obvious that a very substantial improvement of the energy efficiency of the existing building stock is a major objective in the medium (e.g. 2020) and long term (e.g. 2050) strategies of many member states and the EC. The Action Plan on

Energy efficiency envisages a 20% saving in 2020. The potential contribution through a reduction of infiltration losses in the achievement of this target is quite large. Appropriate techniques and execution methods for existing buildings are needed. Moreover, many existing buildings have no or inappropriate ventilation systems and therefore the installation of appropriate ventilation systems is important.

7. Information on EPBD and building airtightness

7.1 EPBD Buildings Platform

In order to provide information on EPBD related issues, the European Commission has launched the EPBD Buildings Platform.

The EPBD Buildings Platform has officially started in January 2006 for a period of 2 ½ years (till June 2008).

The website www.buildingsplatform.eu.

The website is the central element in the whole dissemination strategy of the EPBD Buildings Platform. In principle, all information which is generated in the context of the Platform can be found here.

The Buildings Platform newsletter

In order to allow a regular and efficient information exchange with interested people, there is a monthly newsletter. This newsletter is only distributed in electronic format. A free subscription to the newsletter can be done through the website.

The databases

An easy and centralised access to information is a key objective of the Platform. Therefore, databases play a key role in the dissemination strategy of the Platform.

The following databases are available :

- Publications database
- Database of CEN standards
- Database of relevant EPBD related events
- Database of website links
- Database of EPBD related webstreaming video presentations

Information papers

Information papers (IP) are relatively short papers (typical length of 2 to 8 pages). Its main purpose is to inform a wide range of persons of the status of work in a specific area. At present, some 25 information papers are available.

The helpdesk

An electronic helpdesk is part of the Platform. Answers on a wide range of EPBD related questions are given. In addition, the possibility exist to raise specific questions. These questions and answers will in a later stage become available for all interested persons.

7.2 Air Infiltration and Ventilation Centre

The AIVC (Air Infiltration and Ventilation Centre) (www.aivc.org) was created in 1980 and is operated under Annex V of the Energy Conservation in Buildings and Community Systems (ECBCS) implementing agreement of the International Energy Agency (IEA). The primary objective of the AIVC is to provide a high quality international technical and information forum covering the areas of ventilation and air infiltration in the built environment with respect to efficient energy use, good indoor air quality and thermal comfort.

The Annex is a partly task shared and partly jointly funded activity. The participating countries (present members are Belgium, Czech Republic, France, Greece, Japan, Netherlands, Norway, South-Korea and USA) are represented on the Steering Group, which serves as the AIVC’s Board of Directors. The management is done by INIVE EEIG (International Network for Information on Ventilation and Energy performance – www.inive.org).

The deliverables include:

- AIVC Website as a reference portal for ventilation and air infiltration related issues
- Databases on publications (AIRBASE), software tools and standards;
- Newsletter AIR (Air Information Review) four times/year with information on the most relevant developments regarding ventilation, air infiltration, indoor climate and energy in buildings;
- Publication of Ventilation Information Papers (VIPs), Contributed Reports and Technical Notes, e.g. :
  - TN 13 : Wind pressure data requirements for air infiltration calculations
  - TN 32 : Reporting guidelines for the measurement of airflows and related factors in buildings
  - TN 34 : Air flow patterns within buildings: measurement techniques (IEA annex 20)
  - VIP 08 : Airtightness of buildings
- AIVC Annual Conference (2004 Prague – 2005 Brussels – 2006 Lyon – 2007 Crete – 2008 Japan)

On the AIVC website, there are a large number of documents in pdf-format of which many are related to building airtightness. For most of these documents, a passwords is required. Citizens of the following countries can receive a password free of charge: Belgium, France, Germany, Greece, Netherlands, Norway and USA. For more information : www.aivc.org.

8. Conclusions

The growing concerns about climate change have become a very strong driver for increasing the energy efficiency of the building stock. Moreover, the EPBD obliges all EU member states to impose minimum energy efficiency targets for new buildings. Within this context, there clearly will be a increased interest for an improved building airtightness. The practical impact will strongly depend on the way how various challenges will be handled.

International collaboration can probably accelerate this process and lead to better cost-efficiency results.

9. References

1. Air Information Review – Built tight – ventilate right, AIVC, AIR Vol. 1 N°4, August 1980
2. DIRECTIVE 2002/91/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 December 2002 on the energy performance of buildings, Official Journal of the European Communities, January 4 2003
3. Action Plan for Energy Efficiency: Realising the Potential – Commission of the European communities - COM(2006)545 final
4. EN 13829:2000 Thermal performance of buildings - Determination of air permeability of buildings - Fan pressurization method (ISO 9972:1996, modified)
5. EN 13465:2004 Ventilation for buildings - Calculation methods for the determination of air flow rates in dwellings
6. prEN 15242 Ventilation for buildings - Calculation methods for the determination of air flow rates in buildings including infiltration
7. prEN 15241 Ventilation for buildings - Calculation methods for energy losses due to ventilation and infiltration in commercial buildings
8. EN 13779:2004 Ventilation for non-residential buildings - Performance requirements for ventilation and room-conditioning systems
9. CEN/TR 14788:2006 Ventilation for buildings - Design and dimensioning of residential ventilation systems

10. V. Dorer, C. Tanner, A. Weber. 2004. Airtightness of buildings. AIVC VIP 08,
11. L2B Conservation of fuel and power in existing buildings other than dwellings. Building Regulations. UK, 2006

10. Acknowledgments

This paper was written in the context of the Belgian contribution to the AIVC. The authors wish to thank the Walloon Region for its support to the Belgian participation in the AIVC.