At a Glance

Airtightness

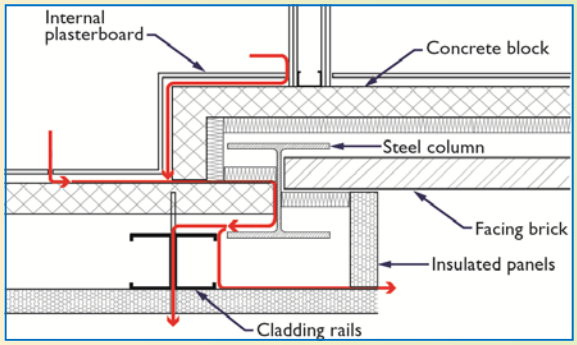
Quick Facts

Who is this topic guide for?

- Architects
- Building service designers
- Energy assessors
- Builders
- Services installers
- Fire sealers
- Airtightness testers
- Building control officers
- Building owners
- Building occupiers

What is airtightness?

ATTMA defines 'air leakage' as the "**uncontrolled flow** of air through gaps and cracks in the fabric of a building. It is sometimes known as infiltration or draughts. Air leakage is not to be confused with ventilation, which is controlled airflow in and out of a building".



Where does air leakage occur?

Air leakage generally occurs at interfaces between construction elements such as:

- joins between walls
- edges of roofs
- edges of walls
- around doors and windows.

What are the causes of air leakage?

The causes are wind blowing against or across the building and warm air rising within a building (the stack effect).

Introduction

The leakage of heated or cooled air into and out of buildings, also known as infiltration or draughts, plays a major part in the energy efficiency of buildings. Air leakage should not be confused with ventilation. Whereas air leakage is uncontrolled and occurs at gaps and cracks in the building envelope, ventilation is controllable by means of natural ventilation openings and mechanical ventilation systems. Project teams should design and construct the building fabric to be reasonably airtight, and also provide natural or mechanical ventilation systems that maintain good indoor air quality while minimising energy use. In other words:

Build tight, ventilate right

The amount of air leakage within a building is a function of the prevailing environmental condition, wind speed, wind direction and external temperature coupled with the air leakage of the building.

Air leakage testing is necessary as a means of demonstrating that the airtightness targets used in energy calculations have been achieved in reality. In England and Wales, airtightness testing has been mandatory for virtually all new buildings since the 2006 Building Regulations.

What is the impact of air leakage?

A significant amount of air leakage resulting in heat loss occurs in all buildings but much less in air tight buildings. According to REHVA's research, the energy impact is "in the order of 10 kWh per m^2 of floor area per year for the heating needs in a moderately cold region"[1]. REHVA also suggests there is a growing number of studies indicating that there is considerable impact on buildings in mild and hot climates, as well.

Why test for building airtightness?

- Energy efficiency - heating buildings involves burning fossil fuels, which contribute to CO_2 emissions and global warming. The goal is to reduce air leakage and therefore heating use and heating bills.
- Energy management - calculating heat losses can also be used as a tool for predicting building energy use. (With the current trends for energy efficiency, this is increasingly relevant.) It is also an important element for manufacturers and building planners to accurately estimate potential performance of building materials.
- Health issues - excessive moisture and mould growth can occur in poorly ventilated buildings with poor air quality. This can adversely impact occupant health.

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How much air leakage is acceptable?

All buildings leak air, but generally older buildings are more likely to leak. Current trends for energy efficiency and reducing energy costs has meant newer buildings are now much more airtight. Airtightness Testing and Measurement Association (ATTMA) standards TSL1 and TSL2 specify the following benchmarks for normal levels of building air permeability:

Airtightness benchmarks

Type	Air Permeability ($m^3/(h.m^2)$@50Pa)	
	Best practice	Normal
Naturally ventilated dwellings	5.0	7.0
Mechanically ventilated dwellings	1.0	5.0
Naturally ventilated offices	3.0	7.0
Mixed mode offices	2.5	5.0
Air conditioned / low energy offices	2.0	5.0
Factories / warehouses	2.0	6.0
Superstores	1.0	5.0
Schools	3.0	9.0
Hospitals	5.0	9.0
Museums and archival stores	1.0	1.5
Cold stores	0.2	0.35

$m^3/(h.m^2)$@50Pa is the flow of air (m^3/hour) in or out of the building, per square metre of the building internal envelope at a reference pressure of 50 Pascals between the inside and outside of the building.

When to specify building airtightness?

Airtightness should be specified as early as possible during the building design phases and in conjunction with energy calculations. Most importantly, it should also be specified prior to choosing the building materials that will be used to make the building airtight.

BSRIA Expert says...

England's Building Regulations require airtightness testing to be carried out on all new buildings. However, the guidance provided in Approved Documents L1A and L2A includes some exceptions to this. First of all, certain buildings such as agricultural buildings are exempt from Building Regulations altogether. Second, some buildings such as those with a planned time of use of two years or less are exempt from energy efficiency requirements.

The test standard for dwellings, referenced in the Building Regulations, is ATTMA TSL1. Only a sample of dwellings on a development need to be tested, and Approved Document L1A provides a set of rules for carrying out this sampling. For dwellings that are not part of the sample, an air permeability is assigned which is the average result from those of the same type that were tested, plus 2 $m^3/(h.m^2)$@50Pa. This is a penalty, making it harder for developments to achieve compliance with CO_2 and fabric energy efficiency targets when sampling is carried out. For this reason, many developers opt for a 100% testing regime.

For developments of one or two dwellings only, there are two situations in which it may not be necessary to carry out any airtightness testing. The first is if a dwelling of the same type was built by the same builder in the last 12 months, and tested. The second is if an air permeability of 15 $m^3/(h.m^2)$@50Pa is assigned. This represents a very leaky building, making compliance with CO_2 and fabric energy efficiency targets more difficult.

All types of non-dwellings are required to be tested following ATTMA TSL2, including certain large extensions as described in Approved Document L2A. Exceptions to this are:

- Buildings under 500 m^2 – An air permeability of 15 $m^3/(h.m^2)$@50Pa would need to be assigned, making compliance with CO_2 targets more difficult.
- Factory-made modular buildings where a regime of type-testing has been carried out.
- Large extensions where sealing the extension off from the existing building would be difficult.
- Complex buildings where airtightness testing would be impractical, for example airport terminals – An enhanced system of design development, component testing and site inspection would be required.
- Compartmentalised buildings that cannot be tested as a single entity – A representative area of the building would need to be tested.

The Approved Documents state that airtightness testing on both dwellings and non-dwellings must be carried out using equipment calibrated within the previous 12 months by a UKAS-accredited facility. Building Control Bodies are authorised to accept test certificates from testers who are registered with ATTMA or IATS, or accredited by UKAS, for the specific class of building tested. In the absence of such a certificate, the Building Control Body would need to check that the tester has received appropriate training, is testing in accordance with ATTMA TSL1 or TSL2, is using the equipment and software correctly, and has carried out all necessary building preparation. Envelope area calculations would also need to be checked.

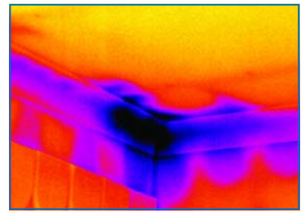
Training courses for airtightness testers are based around a set of National Occupational Specifications (NOSs). The purpose of these is to ensure that testers going forward to registration or accreditation have all achieved a level of knowledge including the theory of air leakage, practical aspects of preparing a building, and carrying out envelope area calculations. Registration and accreditation schemes ensure that testers, in additional to being trained, are subject to quality assurance procedures and periodic review, and receive top-up training.

How to plan / build for airtightness?

- Prepare a strategy that is simple, robust and achievable
- Define the building air line in the design phase (the entire building perimeter where air is likely to leak)
- Assign an individual team or manager to be responsible for the project
- Ensure that lines of communications are well established
- Ensure that all windows and doors are specified as airtight.
- This should be a team effort involving architect, main contractor and sub contractor.

Which tests are used?

- Smoke testing and thermography testing can show where the leakages occur.
- Air pressurisation using blower doors or customised fans will measure how much leakage is occurring.



How is air leakage measured?

Testing engineers will depressurise or pressurise the building and see how much air flows in and out at a selected pressure. This process will be repeated using a range of different pressures.

Regulations

Airtightness regulations: what is the industry trying to achieve?

According to the UK Government's energy policy paper (2010-2015)[9], buildings accounted for nearly 50% of all UK's carbon emissions in 2009. Whilst The National Planning Policy Framework's[10] specific target to make all new homes 'zero carbon' by 2016 was withdrawn in July 2015, the overall aim of significantly reducing carbon emissions remains.

The building industry is tasked with the challenge of making this happen. Among the solutions proposed is to reduce air loss from buildings (airtightness) and increase insulation through improved building materials, building techniques and codes regulating levels of ventilation.

So what are the current issues with airtightness and its regulations?

The building industry is now facing the complex problem of balancing airtightness regulatory requirements with thermal comfort needs of building occupants[2]. There is an ongoing challenge for the industry to provide the right balance of controlled building ventilation in a secure and draught-free way.

The fundamental issue with implementing **Part L of the Building Regulations** is that while building homes to a certain level of airtightness minimises heat loss, reducing air infiltration also removes a source of 'background' ventilation that a building needs.[7] Lack of adequate ventilation brings associated health risks for occupants, damp buildings and poor air quality.

The UK government has therefore developed **Part F of the Building Regulations** (Regulation 42) to ensure that the essential need for good building ventilation, indoor air quality and thermal comfort is not compromised.

So what do the latest regulations contain?

Part L of the Building Regulations stipulate a number of minimum fabric energy efficiency targets loosely based on standards developed by the Zero Carbon Hub. Specifically, buildings must comply with:

- A reduced target emission rate (TER), which mean that homes must emit 6% less CO_2 than was required in the 2010 regulations. The reductions should be met via improving building fabric and increasing energy efficiency of building services.
- Fabric energy efficiency standards (FEES), which helps limit the amount of energy consumption of buildings.

Part F of the Building Regulations (2010) mandates testing of fixed ventilation systems and specifies ventilation performance targets.

So where to download the regulations?

Approved Documents can be downloaded from www.planningportal.gov.uk.

ATTMA testing standards can be downloaded from www.attma.org.

Regulations

BSRIA Library—Journal articles

BSRIA members may order full text copies of the journal articles below at www.bsria.co.uk; all copyright conditions apply.

1. Consideration for envelope airtightness in modelling commercial building energy consumption
   Ng L, Persily A, et al, *International Journal of Ventilation, March 2014, Vol.12(4), 369-377, 4 figs, 4 tabs, refs*
   A comparative study of energy simulation software and ability to measure building airtightness and air leakage.

2. Proper building preparation for envelope airtightness testing
   Delmotte C, *REHVA Journal, January 2013, Vol.50(1), 17-19, 4 figs, 1 tab, 3 refs*
   The article suggests that provision for airtightness testing should be made at the design stage in order to make the preparation easier.

3. Research onto the effect of improving airtightness in a typical UK dwelling
   Coxon R, *REHVA Journal, January 2013, Vol.50(1), 24-27, 2 figs, 2 tabs*
   An investigation on the impact of building airtightness on space heating loads in a typical UK dwelling.

4. Change in the air
   Cope B, *RICS Building Control Journal, February/March 2015, 18*
   An article reviewing the new certification scheme for airtightness testers, led by ATTMA (Air Tightness Testing and Measurement Association) and BINDT (British Institute of Non Destructive Testing).

5. The history of non-domestic air tightness testing
   Jones T, *BSRIA Delta t, December 2014, 8-10*
   BSRIA's Tom Jones traces BSRIA's involvement in developing tools and standards for measuring airtightness testing and air leakage testing for commercial buildings.

6. Building tight - ventilating right? How are new air tightness standards affecting indoor air quality in dwellings?
   Howieson S, Sharpe T, et al, *BSERT Building Services Engineering Research & Technology, September 2014, Vol.35(5), 475-487, figs, 1 tab, 27 refs*
   Research about the importance of planned ventilation strategy and ways to avoid under ventilation by over reliance on standards and guidance, which may not always be representative of real life operation.

Many more journal articles are available at www.bsria.co.uk

References:

BSRIA members may order full text copies of the journal articles and loan report titles below at www.bsria.co.uk; all copyright conditions apply.

1. Remi Carrié F and Wouters P, Building and ductwork airtightness: a critical factor for nearly zero-energy buildings, *REHVA Journal, January 2013, Vol.50(1), 5*
2. Howieson S, Sharpe T, et al, Building tight – ventilating right? How are the new air tightness standards affecting indoor air quality in dwellings? *BSERT Building Services Engineering Research & Technology, September 2014, Vol.35(5), 475-487, figs, 1 tab, 27 refs*
3. Air movement. How to breathe new life into building services, *H & V News, 22 May 2013, 18, 21, 25-26, 29, 2 figs*
4. Knights C, Build tight, ventilate right, *RICS Building Control Journal, June/July 2014, 16-17, 3 tabs*
5. Ijeh I, Fabric toughener, *Building, 13 December 2013, No.49, 50-51*
6. Fennell H C, Haehnel J, Setting airtightness standards, *ASHRAE Journal, September 2005, Vol.47 (9), 26-28,30-31, 2 tabs, 10 refs*
7. Richards Partington Architects, Part F 2010 - Where to start: An introduction for house builders and designers, *NHBC Foundation, NF 37, November 2011, 38pp, figs*
8. NHBC Foundation, Approved Document Part L 2013: Special Edition, *Technical Extra, March 2014 (13), 12pp, figs, tabs*

Other sources used may be downloaded online:

9. Department for Communities and Local Government, 2010 to 2015 Government Policy, *Energy Efficiency in Buildings, 8 May 2015.* www.gov.uk
10. Department for Communities and Local Government, National Planning Policy Framework, 27 March 2012 www.gov.uk
11. The Air Tightness Testing and Measurement Association (ATTMA), Technical Standards attma.org
12. British Research Establishment (BRE), Airtightness and leakage testing Services. www.bre.co.uk
13. TightVent Europe. tightvent.eu/publications

BSRIA bookshop:

Designing and constructing for airtightness
Cheeseman B,
BSRIA, BG 47/2013, May 2013, 54pp
This guide provides architects, main contractors and subcontractors with a broad base knowledge of how to design and build buildings to achieve their airtightness targets.
BSRIA publications are available from www.bsria.co.uk.

BSRIA Services and contacts:

BSRIA Level 1 airtightness testing training course:
TELEPHONE 01344 465 589. www.bsria.co.uk/goto/dat09.

Airtightness testing - UKAS accredited and registered with the ATTMA Competent Persons Scheme.
TELEPHONE 0800 5871000. Email compliance@bsria.co.uk.
Get quote forms for testing non-dwellings.
https://www.bsria.co.uk/airtightness-proposal/
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