Airtightness Of The Building Envelope

David Unwin
General Manager
BSRIA Commercial Airtightness
Corporate status

- The Building Services Research and Information Association
  - a company limited by guarantee
  - non profit distributing
  - non tax paying
  - 650 Members
  - Global presence

- BSRIA Limited
  - wholly owned trading subsidiary
BSRIA is ……..

- a consultancy, test and research organisation,
- working with construction and building services companies and their clients
- adding value to your business, saving you money and giving you peace of mind
BSRIA has ......

- an independent and objective approach
- an authoritative reputation
- a unique blend of technical and marketing capability
- 53 years of building services research and consulting experience, and a turnover of £10.5 million (08/09)
- 160 people, operating in 4,000 square metres of laboratory space
- UK’s leading information database for building services

We serve the whole built environment chain from client to consultant and facilities manager
Being a BSRIA member

Demonstrate that you are leading the industry through innovation and best practice

- Access to all BSRIA services, and, specially for members:
  - Personal and web access to the Information Centre
  - Publications package
  - Networks for information exchange and research
  - Expert enquiry service
Airtightness

We can help you save energy by delivering an airtight building

- Pressure testing of buildings for Part L compliance
- Nationwide services with four regional UK offices and a fifth on the way
- Armagh office covering all of Ireland for both domestic and commercial testing
- Expert input to the design process
- Support services including thermal imaging and smoke testing
- Guidance on fume cupboard and local ventilation systems
What Is Airtightness?
What Is Airtightness?

- Or to put it another way…
What Is Air Leakage?
What Is Air Leakage?

Air Leakage
Is The
UNCONTROLLED
Flow Of Air Through
Gaps And Cracks
In The
Fabric Of A Building
What Is Air Leakage?

- Air Leakage Is Measured As Either
  - Air Leakage Index
  - Air Permeability
- The leakage of air (m³/hour) in or out of the building, per square metre of building envelope at a pressure differential of 50 Pascals (m³/ (h.m²) @50Pa) between the inside and outside of the building.
What Is The Building Envelope?
Envelope Area For “Air Leakage Index” = Combined Area Of Walls + Ceiling
= 2 x (30 x 12) + 2 x (20 x 12) + 30 x 20 = 1800 m²

Envelope Area For “Air Permeability” = Combined Areas of Walls + Ceiling + Floor
= 2 x (30 x 12) + 2 x (20 x 12) + 2 x (30 x 20) = 2400 m²

If the Airtightness Test shows a total air flow of 4.50 m³/s (ie. 16,200 m³/h), the results of the Airtightness Test will be

Air Leakage Index = 9 m³/h.m²
Air Permeability = 6.75 m³/h.m²
History Of Airtightness Testing

- Pioneered in Scandinavia
- Tracer Gas Techniques
- Pressurisation
- “Fan Rover”
- Individual Client Airtightness Specifications
- Building Regulations – 2002
- Formation Of ATTMA
- Building Regulations - 2006
Formation Of ATTMA

- Air Tightness Testing and Measurement Association
  - Founded in 2002 at the request of the ODPM (Office Of The Deputy Prime Minister)
    - Now CLG (Communities & Local Government)
  - BSRIA Founder Member
  - Industry Self Certification Body To Demonstrate “Competence”
  - Helps Specifiers and Building Control in the selection of appropriately experienced airtightness contractors
REGULATION 20B

- Testing Of Buildings With A Usable Floor Area Greater Than 500 m² Is Now A LEGAL Requirement

“A local authority is authorised to accept, as evidence that the requirements of paragraph 2.a.ii have been satisfied, a certificate to that effect by a person who is registered by the BINDT in respect of pressure testing for the air tightness of buildings”
Building Regulations Part L - 2006

REGULATION 20B

- Testing of buildings with a usable floor area greater than 500 m² is now a legal requirement.

- “A local authority is authorised to accept, as evidence that the requirements of paragraph 2.a.ii have been satisfied, a certificate to that effect by a person who is registered by the BINDT in respect of pressure testing for the air tightness of buildings.”
Paragraph 2.a.ii states “the testing is carried out in accordance with a procedure approved by the Secretary of State”

The 2006 Approved Document goes on to say “The approved procedure for pressure testing is given in the ATTMA publication ‘Measuring Air Permeability Of Building Envelopes’”
## Good And Best Practice Standards

<table>
<thead>
<tr>
<th>Type</th>
<th>Air Permeability</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m³/(h.m²) at 50 Pascals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Best Practice</td>
<td>Normal</td>
</tr>
<tr>
<td>Offices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Naturally Ventilated</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Mixed Mode</td>
<td>2.5</td>
<td>5</td>
</tr>
<tr>
<td>Air Conditioned/Low Energy</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Factories/Warehouses</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Superstores</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Schools</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Hospitals</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Museums &amp; Archival Stores</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Cold Stores</td>
<td>0.2</td>
<td>0.35</td>
</tr>
<tr>
<td>Dwellings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Naturally Ventilated</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Mechanically Ventilated</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

m³/(h.m²) at 50 Pascals
Airtightness In Ireland

- The ROI document “Limiting Thermal Bridging and Air Infiltration” is an adaptation of the UK DCLG document of the same name, the details having been modified and extended to reflect construction practice in Ireland
Background

- The energy consumed by dwellings accounts for a large proportion of Ireland’s total energy consumption, and of the carbon dioxide emissions which contribute to climate change.
- Side effects of thermal bridging & air leakage include:
  - Surface condensation, damaging decorations and enabling mould growth
  - Deterioration of the building fabric caused by interstitial condensation
  - Occupant discomfort caused by draughts and cold rooms
- Continuity of Insulation and Airtightness need to be thoroughly considered at all stages of design and construction.
ROI - Building Regulations Part L - 2007

- Air pressure testing should be carried out on a proportion of dwellings on all development sites
- Including attached garages/conservatories/commercial work spaces
- A performance level of 10m³/(h.m²) represents a reasonable upper limit for air permeability
DEAP Calculations

- For some dwellings where the carbon emission rate is difficult to achieve for architectural reasons, the Airtightness target under the DEAP (Dwelling Energy Assessment Procedure) calculations MAY need to be reduced to 7, 5 or even 3 m$^3/(h/m^2)$ @ 50 Pa to meet the overall carbon emission rate required by the regulations.
### Number Of Pressure Tests Per Dwelling

<table>
<thead>
<tr>
<th>Number of units</th>
<th>Number of tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 or less</td>
<td>One test</td>
</tr>
<tr>
<td>Greater than 4, but equal or less than 40</td>
<td>Two tests</td>
</tr>
<tr>
<td>Greater than 40, but equal or less than 100</td>
<td>At least 5% of the dwelling type</td>
</tr>
<tr>
<td>More than 100:</td>
<td>At least 2% (for dwellings in excess of first 100 units) At least 5% of units, until 5 successful</td>
</tr>
<tr>
<td>a)Where the first five tests achieve the design air permeability</td>
<td></td>
</tr>
<tr>
<td>b)Where one or more of first five tests do not achieve the design air permeability</td>
<td></td>
</tr>
</tbody>
</table>
Dwelling Types

- Various generic forms of dwelling are considered as separate discreet types, these are detailed in SEI's website, [www.sei.ie](http://www.sei.ie), including:
  - Change in method of construction e.g. timber frame and brick/block
  - Ground floor, mid floor and top floor flats
  - End of terrace and mid terrace
  - Semi-detached and detached
  - Significant changes in the building floor level
Dwelling Types

What Is A “Dwelling Type”

Apartments

The above shows 3 types of apartment, testing requirements would be as follows:

1 of 1 or 2
1 of 3 or 4
5
“Air pressure testing should be carried out on a number of new dwellings on all development sites. A performance level of 10 m³/(h.m²) @ 50 Pa represents a reasonable upper limit”
Paragraph 1.5.4.1

“Tests should be carried out by a competent person and in accordance with IS EN 13829:2000 ‘Thermal performance of buildings: determination of air permeability of buildings: fan pressurisation method’
Paragraph 1.5.4.5

“Where remedial work and a new test is required on any dwelling, following an initial test, the size of sample for testing should be increased by one, for that dwelling type”
Competent Testers

- The Irish National Accreditation Board (INAB) and the United Kingdom Accreditation Service (UKAS) both run schemes to accredit companies to carry out Airtightness Tests on buildings.
- Both organisations base their schemes on the IS EN 13829:2000 and ATTMA Technical Standard 1.
- TS1 can be downloaded from www.attma.org.
Airtightness of Commercial Buildings

- Not mandatory in ROI (yet) BUT regularly specified
  - Individual Client Requirement
    - Some as tight as 2 or 3 m³/(h.m²)

- Why?
  - Energy efficiency & design low energy
  - Occupant comfort
  - Seen to be green
    - Marketing considerations
    - “politically” expedient
  - Compliance with potential future legislation
Airtightness of Commercial Buildings

- Offices
  - Air conditioned and mixed mode offices should have a maximum specified air permeability of $5 \text{ m}^3/(\text{h}.\text{m}^2)$ and preferably $3 \text{ m}^3/(\text{h}.\text{m}^2)$ @ 50 Pascals in order to achieve good control for occupant satisfaction and minimise energy consumption
  - Individual design
  - Diverse architectural variations
Airtightness of Commercial Buildings

- Factories, Warehouses and Superstores
  - Major retail superstore and department store owners and operators in the ROI have been specifying (and achieving) air permeability standards of 2 or 3 m$^3$/(h.m$^2$) for many years.
  - Regular roof and wall panels or brickwork
  - Good detailing at material interfaces, particularly roof to wall
  - Better quality loading bay doors
Airtightness of Commercial Buildings

- Schools and Hospitals
  - Generally more individual and complex designs which have struggled to meet the same levels of air permeability targets as other types of buildings
  - Maximum air permeability target of 7 m$^3$/h.m$^2$ is a realistic target
Airtightness of Commercial Buildings

- Museum & Archival Storage Facilities
  - Generally require very tight control over temperature and humidity, therefore require very tight Airtightness standards
  - Maximum Air Permeability of 1.5 m$^3$/(h.m$^2$) is recommended
Airtightness of Commercial Buildings

- **Cold Stores**
  - Very high internal to external temperature differentials and therefore require special attention to control product temperature and minimise significant energy running costs.
  - Current maximum recommended Air Permeability specification is $0.3 \text{ m}^3/(\text{h.m}^2)$
  - This has been achieved and exceeded regularly for several years
2010

- Reduction Of Target Figures
  - “Best Practise” shows scope for 8 as a maximum
Schools

Offices

Factories

Dwellings

Part L 2006

Normal

Best Practice

2010 ??
European Airtightness Standards

- $2.5 \text{ m}^3/(\text{h.m}^2)$
- $4.0 \text{ m}^3/(\text{h.m}^2)$
- $2.5 \text{ m}^3/(\text{h.m}^2)$
- $2.2 \text{ m}^3/(\text{h.m}^2)$
2010

- Reduction Of Target Figures
  - “Best Practise” shows scope for 8 as a maximum

- Consistency Of Quality Of Testing
  - How many people and/or companies are offering Part L tests without the desired “competence” and “training”
2010

- **Reduction Of Target Figures**
  - “Best Practise” shows scope for 8 as a maximum

- **Consistency Of Quality Of Testing**
  - How many people and/or companies are offering Part L tests without the desired “competence” and “training”

- **Register Of Approved Testers**
  - ATTMA membership for Part L2A
    - The “Company” with UKAS accreditation
  - BINDT registration for Part L1A
    - The individual NOT the company
Design Stage

- Specify the Airtightness Target at an early design stage
- The Air Barrier Line
  - Closely follow the line of the inside face of the insulation in the exposed elements of the fabric of the building
  - The airtight surface should be brought inside rooms which will be ventilated to the outside, such as boiler rooms, plant rooms, electrical switch rooms and lift shafts
- Pen-on-Section Drawings
  - Mark up the air barrier line on the architectural main section drawings as a bold distinguishable line
- Larger Scale Drawings
  - Sensitive points and complex interfaces
Design Considerations

- **Keep it Simple**
  - More likely to be built right

- **Identify Air Barrier Line**
  - Pen on section test

- **Materials**
  - Always specify materials which are appropriate to the Air Barrier Line

- **Minimise Construction Types**
  - Junctions cause potential problems

- **Material Interfaces Detail**
  - Continuity of the Air Barrier Line
  - Specific attention to roof/wall interfaces
  - Allocate responsibility for sealing the interface

- **Minimise Penetrations**
  - Where unavoidable, develop appropriate details for their proper execution
Construction Stage

- Management
  - On-going review of design

- Communication & Education
  - Site Briefings & Tool Box Talks
  - Involve an Airtightness Specialist (such as BSRIA) as a Consultant

- Quality Control
  - Regular inspection of workmanship by site management
  - Independent assessment of QA for complex detailing
  - Consider specifying an Airtightness Consultant (such as BSRIA) to inspect the building during the construction process
Other Considerations

- Cladding and Curtain Walling
  - Construction process on site may introduce fixing and sealing problems to an otherwise robust system
  - Incompatibility of adjoining systems
- Fire Seals
- Loading Bay Doors
- Lift Doors
The Airtightness Test

- Specify that the Airtightness testing shall be undertaken by an independent organisation (such as BSRIA) which is a member of ATTMA or one that is accredited by INAB
Preparation For The Test

✓ All External Doors Closed
✓ All External Windows Closed
✓ All Internal Doors Wedged Open
✓ Drainage Traps Filled With Water
✓ Trickle Vents Closed
✓ Mechanical Ventilation Extracts Sealed
✓ Air Handling Plant Sealed
✓ “As Near To Operating Conditions As Possible”
✓ Wind Speed < 8m/s (Force 3)

✗ Temporary Seals To External Doors
✗ Temporary Seals To Windows Or Sills
✗ Temporary Seals To Drains Or Overflows
✗ Temporary Seals To Trickle Vents
How Do We Test?

- **Before The Test**
  - Set Up The Equipment In A Suitable Opening In The Building
    - Seal The Test Equipment Into The Building
  - Measure The Wind Speed
  - Measure The Temperature
    - Inside The Building
    - Outside The Building
  - Measure The Barometric Pressure
  - Take The “Fan Off” Pressure Readings
Single Fan “Blower Door”
Twin Fan “Blower Door”
Triple Fan “Blower Door”
“Minifan”
Four “Fan Rovers” Working Together
Figure 2. Air Leakage Measurement Data
When Things go Wrong

Smoke tests

Thermographic survey
Air leakage locations
Common Site Problems
Airtightness Specification Clauses

- “The building air tightness pressure test shall be carried out in accordance with the requirements detailed in the ATTMA Technical Standard 1, ‘Measuring Air Permeability of Building Envelopes’”
Airtightness Specification Clauses

- “The building air tightness pressure test shall be carried out in accordance with the requirements detailed in the ATTMA Technical Standard 1, ‘Measuring Air Permeability of Building Envelopes’”
  - “(For Dwellings) The building air tightness test shall be carried out by a suitably qualified person”
Airtightness Specification Clauses

“The building air tightness pressure test shall be carried out in accordance with the requirements detailed in the ATTMA Technical Standard 1, ‘Measuring Air Permeability of Building Envelopes’”

- “(For Dwellings) The building air tightness test shall be carried out by a suitably qualified person”
- “(For buildings other than dwellings) The building air tightness test shall be carried out by a member company of ATTMA (the Air Tightness Testing and Measurement Association). The company shall also be UKAS Certified”
Airtightness Specification Clauses

- “The building has been designed to achieve an air permeability of $XX \text{ m}^3/(h.\text{m}^2)$ at an applied pressure difference of 50 Pa.”
Airtightness Specification Clauses

- “The building has been designed to achieve an air permeability of XX m$^3$/h.m$^2$ at an applied pressure difference of 50 Pa.”

- XX = 10 or lower
Airtightness Specification Clauses

- “The building has been designed to achieve an air permeability of XX m\(^3\)/(h.m\(^2\)) at an applied pressure difference of 50 Pa.”

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- The specified value for air tightness should be determined when the SBEM or SAP calculations are completed.
Airtightness Specification Clauses

- “The building has been designed to achieve an air permeability of XX m$^3$/h.m$^2$ at an applied pressure difference of 50 Pa.”

- XX = 10 or lower

- The specified value for air tightness should be determined when the SBEM or DEAP calculations are completed.

- The instrumentation used to carry out the building test shall be UKAS or INAB certified and have a valid calibration certificate.
Airtightness Specification Clauses

- For your own peace of mind, you really should specify the following,

- “The building air tightness test shall be carried out by:-

- A Member of ATTMA – the “Air Tightness Testing and Measurement Association”. The company shall also be UKAS or INAB Certified
Airtightness Specification Clauses

- You may if you wish specify the following, however,

  “The Building Airtightness Test shall be carried out by:-
  - Anderson Mechanical Services (in partnership with BSRIA),
    - 77B Main St,
    - Loughgall,
    - Armagh
    - BT61 8HZ
“Thank You”

David Unwin
General Manager
BSRIA Commercial Airtightness