Air Tightness Compliance

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Air-Tightness in Buildings

CONTENTS

- What it’s about
- Why it matters
- Best Practice
- Building Regs
- Where it can go wrong
- The consequences of failure
- Recommended approaches
- Services available
- Q&A
Air Leakage is measured in...

$m^3$ of air, per square-metre of Envelope, per hour at 50 Pascals differential pressure (between inside & outside the building).

The ‘Envelope’ is the “shell” of the building that contains the “conditioned air”. In most cases this would comprise the ground floor slab, the perimeter walls and the underside of the roof. If the roof-void is naturally ventilated then the top floor ceiling becomes the top part of the envelope.
The Envelope...
The Envelope…
## Definitions

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<th>Description</th>
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<td>Air Tightness</td>
<td>Volume of Air-Leakage through the “Envelope” Per Hour</td>
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<td>Per Hour</td>
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<td>Per M² of Envelope At 50 Pascals Differential Pressure</td>
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## Good & Best Practice Guides

<table>
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<tr>
<th>Type</th>
<th>Air Permeability  ( m^3/(h.m^2) ) at 50 Pascals</th>
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<td>Mixed mode</td>
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<td>Museums and archival stores</td>
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<td>Dwellings</td>
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<td>naturally ventilated</td>
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<td>mechanically ventilated</td>
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The Case Air-Tight Buildings

- Air-tight buildings waste less energy, and cause less CO$_{2e}$
- Enables right-sizing of HVAC Plant
- Reduced Energy Costs
- Vital to achieving ‘passive’ builds
- Reduced Interstitial Condensation
- More Comfort for Occupants
- Opportunity for Builders or Owners to give their buildings an advantage.
The Principles

- **Air leakage** accounts for a significant proportion of the overall energy losses in UK buildings.

- In leaky buildings it can occur constantly, driven by:
  - Wind
  - Internal/External pressure differences ($\Delta P$)
  - The ‘stack effect’.

- Buildings don’t need to “breathe”, only people do!

Therefore….

"Build Tight – Ventilate Right!"…
“Build Tight – Ventilate Right”

- Air-Tight Buildings need well designed ventilation
  - Ventilation is controlled
  - Infiltration is not!

- Air-tight buildings with ‘whole-house’ mech ventilation are more energy efficient

- Passivhaus, Super E, etc..
  - Very high air-tightness (less than 1 m³/m².hr @50Pa)
  - Very high thermal insulation
  - Ensures only energy loss is through whole-house ventilation system and a MHRV unit recovers up to 90%
Canadian Practices

- Use of specific air-barrier membranes within timber frame construction
- Air-tight service penetrations
- MHRV commonplace
  - Building Code requirement in most states
- Air-tightness levels of $1 \text{ m}^3/(\text{m}^2\cdot\text{hr})@50\text{Pa}$ or less
- Canadian ‘standards’:
  - R2000 & Super E
Top Performers
(<1m³/(m².hr)@50Pa)
Energy Savings

Example 1: “A comparison was made between two notional 20,000 m³ buildings; one with an air permeability of 9.3 m³.h⁻¹.m⁻² and the other with an air permeability of 23 m³/(h.m²). The infiltration heat load from the first was 861 GJ p.a and the second was 2,439 GJ p.a.” ATTMA TS1

Example 2: “Improving AT from 12 m³/(m².hr) to 3 can reduce energy wastage by +/-12%” Belgium Building Research Institute
The New Part L 2010

The Building Regulations 2000

Conservation of fuel and power

APPROVED DOCUMENT L1A
L1A Conservation of fuel and power in new dwellings
Coming into effect 1 October 2010

2010 edition

APPROVED DOCUMENT L2A
L2A Conservation of fuel and power in new buildings other than dwellings
Coming into effect 1 October 2010

2010 edition
Part L1A 2010

Air Tightness Requirements

- Part L1A relates to ‘Work in new Dwellings’
- Overall 25% reduction in CO$_2$ emissions compared to 2006 version
- SAP2009 is used to calculate the “TER” & “DER”
- Requirement for “TER/DER” to be calculated and submitted at planning stage. SAP2009 will provide BCOs with better clarity.
- “Limiting air permeability” remains at $10m^3/(m^2\cdot hr)@50Pa$. 
Part L1A 2010

Air Tightness Requirements

☐ Number of tests per dwelling type is 3 or 50% of each dwelling type (whichever is the lessor).

☐ Use of ACDs is no longer a factor in the testing sample size.

☐ If one “fails”, do remedial work on it (and all similar types) then retest it, plus one other.

☐ Recommended that half of tests for each type is conducted among the first 25% that get built (to enable lessons to be learnt)
New Part L1A

Other Notable Items within the Document

- Separate blocks of flats needs to be treated as separate developments
- If test ‘fails’, the that plot needs to be retested, plus another.
- On developments of 2 or less Plots: either test or..
  - Use the compliant test for a similar plot from last 12 months
  - Use a theoretical “result” of 15 in the SAP calc.
- Tests to be conducted by a competent person
- Trickle vents can be taped.
New Part L2A

Similar to Part L1A – EXCEPT…

□ Instead of SAP2009, **SBEM** is used to calculate the CO$_2$ emissions rates “TER” & “BER” (target & actual).

□ All buildings over 500m$^2$ GIFA must be tested.
  □ Below 500m$^2$, there is the option to use a ‘result’ of 15.

□ Lower levels of “Design Air Permeability” may be set as a means to make the SBEM calc work. If so, the test needs to achieve this result.

□ If a building ‘fails’, it must be retested.

□ Particular guidance given for:-
  □ Modular buildings
  □ Extensions
  □ Very large/complex buildings.
Compliance with 2010 Part L

Conclusions to be drawn...

☐ Stipulations for air-tightness is little changed from 2006 version

☐ The maximum permitted result is still “10”

☐ However, the need for 25% reduction in overall CO2 emissions will make lower “design” air permeability inevitable.
The Consequences of Failure

Air-Tests are relatively cheap... Failing them is not!

- Particularly on more complex Projects, early input from a reputable air-tightness expert can be crucial.
- Test failures could mean:
  - No PC, no Handover
  - Possible penalties, liquidated damages, ‘bad-will’
  - Remedial works are far more costly at a late stage
    - Diminished labour on site
    - Carpets down, ceiling grids in, décor finished
    - Access restricted
  - Some air leakage is extremely difficult (& expensive) to remedy
Compliance with EPBD

- EPCs (and DECs) are raising awareness
- EPC software packages use default values for air-permeability
  - Pre 2002 Buildings: 25 m³/(m².hr)@50Pa
- If buildings are tested, actual (lower) figures could be used – and leakage sites located into the bargain
- Air-sealing works are a viable means to effect fabric (and rating) improvements in existing buildings.
A Leaky Building

STROMA

Full Building Example Smoke Test
Air Leakage Modes

Through...

- Eaves details
- Voids/cavities left open to interior
- Voids above solid ceilings
- Gaps between steel frame and inner-leaf masonry
- Service penetrations
- Unsealed dry-lining
- Windows, doors, weather seals
- Unsealed layers in built-up roof systems
- Risers & plant rooms
- Hollow floor planks
- Leaky HVAC systems
- Permeable materials
Air Leakage Modes (Resi)
Designing for Air-Tightness

Fundamental Approaches

- Under Part L, establish what the air-tightness target has to be (“10” or less?) within the SAP/SBEM compliance strategy.

- Identify the surfaces within the building that together will form the ‘air barrier’
  - Produce marked drawings, showing air barrier line and joint details between air-barrier elements.
  - Ensure ‘air barrier’ line is continuous, unbroken and encapsulates the entire ‘conditioned space’

- The more convoluted the envelope design, the more leaky it might be!
Designing for Air-Tightness

Fundamental Approaches

- Ensure that the ‘air barrier layer’ separates the conditioned space and any naturally ventilated spaces
  - Plant rooms, lift shafts, roof voids, undercrofts, ext. stores etc

- Check that the materials and components that are to constitute the “air barrier” are intrinsically air-tight, as are the joints between them
  - Suspended ceiling tiles, fibre-board fire protection, perforated roof liners, mineral wool, course blockwork, etc, are not air-tight.

- Challenge the suppliers of ‘envelope components’, such as doors, windows, curtain walling. Request test data.
Designing for Air-Tightness

Choosing the AIR-BARRIER LAYERS.....

- Air-tight buildings have an air-tight “air-barrier”, positioned inside the insulation.
- Internal, accessible surfaces are safest bet
  - Ideally “wet” finishes: wet-plaster, screed, paint on fair-faced block-work
- Dry-lining, ply, dense boards: OK if sealed at edges.
- Adoption of ‘hidden layers’ is risky. No way to repair when buried in wall/roof construction.
Building for Air-Tightness

Fundamental Approaches

- Check the Design
  - Is there a clear air-tightness strategy?
  - If not, challenge the designers

- Use an air-tightness expert to ‘review’ the design on your behalf, and to provide...
  - Regular site inspections & reports
  - Sample testing
  - A ready source of advice
Building for Air-Tightness

Site Management

- Programme and complete the perimeter air-barrier work first (before internal structures restrict access).
- Have a system in place for sealing service penetrations.
- Make someone responsible for constant surveillance
  - Most problems are found above ceiling-grid level and in the eaves.
- Pay close attention to the installation of hidden “air-barrier” layers.
Building for Air-Tightness

Fundamental Approaches

□ Subcontractors are Key
  □ Make them responsible for the air-tightness of their package....contractually
  □ Address the interfaces between packages
  □ Programme their works appropriately (to prevent loss of access)

□ Beware of Cost Savings at the expense of the “Air Barrier”

□ Invest in good advice – its cheaper than remedial work!
Key Issues in Large Buildings

Some typical causes of leakage
‘Conditioned’ Roof Voids

Complex Roof Are More Likely to be Leaky…
‘Conditioned’ Roof Voids

Open Eaves (Warm Roof Void)
Reliance on ‘Hidden Layers’

Sometimes its appropriate....

A perforated acoustic roof liner

Perimeter Wall build-up (under missing window cill)

Safer

Risky!
Reliance on ‘Hidden Layers’

Perimeter Wall-to-Partition Wall Junctions
Making the Perimeter Linings work

Programming the Dry Lining & Partitions Works
Making the Perimeter Linings work

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Making the Perimeter Linings work

Programming the Dry Lining & Partitions Works
Partition/Perimeter Wall Junctions

- Flexi insulation
- Jroc Soundbloc
- Metal stud partition
- 150mm SFS stud
- Gyproc aslant
- 2 layers of 12.5mm
- 70mm Rockwool

- Continuous fixing dab
- Metal stud wall
- Continuous fixing dab
Beware of ‘stopping short’…

Plaster / Dry-lining on Perimeter Walls can be the Key Air Barrier Detail

Good!

Bad!

Good!

Bad!
Beware.. Solid Ceiling Voids...

Voids above Solid Ceilings: Either Air-Seal Them or Isolate Them
Deflection Head Details

Wall/Roof Junction 1:10

- Expanded foam insulation to fill voids within profile.
- Profiled roof deck.
- 9mm thick x 200mm WBP ply fixed to underside of roof deck.
- Structural steel.
- Block outer leaf.
- 1200 gauge min. Visqueen fixed between ½ board & lapped under ply, with lapped & taped joints, fixed to allow lateral movement.
- Suspended ceiling.
- 2 layer 12.5mm plasterboard.
- Metal stud inner leaf.
- Isowool insulation quilt.
Exposed Wall Cavities

- Exposed cavities may allow air to track from the building's external wall cavity into the building.

- This can be the case where blockwork is supported on twin steel beams, or where cavity walls extend into the building to provide support for construction above.
Service Penetrations

Unsealed Service Penetrations
Stairwells

More difficult to seal the dry-lining....
Passive Fire Protection…

Passive Fire Protection of Steel Frame can “Make or Break…”
Hollow Floor Planks

Horizontal ‘chimneys’
Reliance on Blockwork..

Blockwork Walls are Permeable
Proprietary Envelope Elements

Doors, Windows, Etc
‘External’ Spaces...

The need to isolate “cold spaces” from the conditioned interior

- The ‘air barrier’ line must be positioned and sealed so as to prevent ANY transfer of air between the conditioned interior of the building and any cold, naturally ventilated spaces.
- These typically include
  - Plant rooms
  - Cold Ventilated roof spaces
  - Undercrofts, basements
  - Lift shafts, risers, escape stairwells
  - Wall cavities, overhanging eaves, service trenches
  - External store rooms
‘External’ Spaces…
‘External’ Spaces…
‘External’ Spaces...
‘External’ Spaces…
‘External’ Spaces…
‘External’ Spaces…
‘External’ Spaces

Plant Rooms & Risers.........
‘External’ Spaces

Lift Shafts

- Lift shafts are usually vented to atmosphere... therefore ‘external’
  - Vent cannot be sealed for test.
- Treat shaft walls as external walls (and air-seal them)
- Specify ‘smoke-tight’ doors if available
‘External’ Spaces

External Stores

- Rooms with Louvred Doors
  - Doors cannot be sealed for test
- Seal internal walls
- Take them to the soffit and seal... or
- Install solid ceiling
- Seal service penetrations
Incorrect Materials

Fibrous Materials, Foams, Water-based Sealants....
## Air-Leakage in DWELLINGS

### Typical Leakage Sites....

- Leakage into voids & cavities via service penetrations
- Behind ‘dot & dab’ dry-lining
- Interconnecting cavity leakage – stud partitions
- Window gaskets & trickle vents, window cills
- Recessed lighting
- Plug sockets, etc
- Air extract vents/ducts
- Loft hatches
- External door weather seals & thresholds
- Radiator pipe penetrations
Air-Leakage in DWELLINGS

Traditional Masonry versus Timber Frame?
Air-Leakage in DWELLINGS

Behind Sink Units
Air-Leakage in DWELLINGS

Extract Hoods
Air-Leakage in DWELLINGS

Behind Radiators
Air-Leakage in DWELLINGS

Downlighters?
Air-Leakage in DWELLINGS

Loft Hatches
Air-Leakage in DWELLINGS

Behind Sanitaryware
Air-Leakage in DWELLINGS

Behind Sanitaryware
Air-Leakage in DWELLINGS

Behind Sanitaryware
Air-Leakage in DWELLINGS

Door & Window Gaskets
Air-Leakage in DWELLINGS

Behind Skirtings
Air-Leakage in DWELLINGS

Via Vents
Available Services

Consultancy

Testing

Diagnostics

Remedials
Pre-Testing Assistance

- CPD Training Seminars on Air-Tightness
- Guidance on Building Regs compliance (w.r.t. air-tightness)
  - Liaison with BCO
- Drawing reviews
- Design workshops
- Site Inspections
- Sample Area Air-Tests
- Mock-up testing

Inspections and trial testing to check progress
The Air Tightness Test Itself

What’s involved?

- **Equipment**
  - Depending on the size, complexity and height of the building, either large trailer-mounted fans or smaller electric ‘blower-door-fans’.

- **Duration**
  - Most tests and any post-test leakage diagnosis are completed in a day, or less.

- **Conditions**
  - Buildings must be virtually complete
  - Calm weather conditions
The Air Tightness Test Itself

The Basic Principle of ‘Fan Pressurisation Testing’

Volume under test

Assorted leakage sites where air re-enters the volume

Air blown out of volume under test

Door fan mounted in open doorway
The Air Tightness Test Itself

Log-Log Graph of Differential Building Pressure vs Air Flow
The Air Tightness Test Itself

Preparing the Building for the Test

- HVAC systems shut down and sealed
- Water traps filled or sealed
- All internal doors propped open
- Riser doors & lift doors closed
- All external doors, windows & trickle vents closed.
- Unfinished or damaged details sealed.
Post-Test Auditing

Leakage diagnosis methods

☐ Internal Smoke Testing
  ☐ The best, most effective method (if access is available)
  ☐ Pin-points where the repair is required

☐ Full-building Smoke Testing
  ☐ A ‘blunt instrument’
  ☐ Useful for testing inaccessible areas
  ☐ Helps to ‘prove a point’
Air Tester Certification

Dwellings

The BINDT Residential Air Tester Scheme

All Other Buildings

The BINDT Residential Air Tester Scheme
ATTMA Members
Why Stroma?

- Market Leader
- Full accreditation (UKAS, ATTMA, BINDT)
- Consulting Experience.
- Contracting capability
- Cross-discounts for Testing/Consulting if Stroma Contracting used on same project.
- One-stop-shop for SAP, SBEM, EPC, Noise, etc
- National coverage (inc Ireland & Scotland)
- Competitive prices (we will not normally decline on price)
- Service levels....
Why Stroma?

- **Service levels**
  - Fast report turnarounds.. 24/48 hours
  - Envelope Calcs included
  - All-day audits, with report delivered on site
    - Initial briefing meeting
    - Thorough site inspection
    - Very detailed, fully referenced report written on site
    - Same-day handover for full comprehension
  - FOC post test audits after failed tests – only reports charged extra
  - Fan hire service
  - Component Testing
  - Project management of more challenging jobs
Key accounts...

- Bovis Homes
- Taylor Winpey
- Hill Partnership
- Countryside Properties
- Higgins
- Laing O’Rourke
- Galliford Try
- Miller Construction
- BBCL
- Carillion
- Willmot Dixon
We install all forms of fire-stopping and passive fire protection of steelwork… with air-tightness in mind!

If we are awarded the planned work packages….

Air tightness works for same site are discounted (or FOC).

BRE accredited

Vigilant to air-tightness issues.
Stroma Credentials

- Over 2000 air-tightness projects completed….
  - From single rooms to aircraft hangers
  - Often drafted in for complex buildings
- Over 50 years accumulated experience
- Fully accredited by UKAS, and members of ATTMA and BINDT (as specified in the Regs).
- ISO9002 & 14001 accredited
- Preferred by numerous major contractors and volume house-builders