AIR TIGHTNESS TESTING
FREQUENTLY ASKED QUESTIONS

Q: What is air tightness?

A: Air tightness, air leakage or air permeability all refer to the infiltration of cold/hot air into the building and/or the loss of heated/cooled air from inside through gaps, cracks, holes, etc in the building fabric. The loss or cooling/heating of this 'conditioned air' through 'uncontrolled ventilation' affects the energy consumption of the building, as additional energy will be required to re-heat or re-cool the air. It also impacts on the comfort levels of the building occupiers.

Q: Why is air tightness important?

A: Air tightness plays a significant role in the energy efficiency of buildings because:

- a link has been established between carbon emissions and global warming
- the production of energy emits carbon
- the built environment contributes about 50% of carbon emissions
- heated/conditioned air leaking from buildings requires the use of additional energy to maintain
- temperatures

By limiting the leakage of heated/conditioned air from buildings, it is possible to reduce energy consumption and costs.

The government has made commitments to reduce carbon emissions through the European Energy Performance of Buildings Directive (EPBD) and the Kyoto Agreement.

Part L is their method for addressing the conservation of fuel and power in buildings based on their overall 'Emission Rate' and as such places performance requirements on air tightness. Performance is proven through site testing of the completed building.

Q: What impact does air tightness have on carbon emission rates calculated using SAP or SBEM?

A: Air permeability is an important factor in assessing the overall carbon emission of a building via the appropriate calculation methodology:

- Standard Assessment Procedure (SAP) for dwellings under 450m² floor area – accredited software has been developed to make calculation easier
- Simplified Building Energy Model (SBEM) for buildings other than dwellings – software still under development

Before construction:
SAP or SBEM is used to calculate a Target Emission Rate (TER) in advance of starting building work. This is based on a range of factors including orientation, glazing, insulation, heating system/ fuel, etc.

The details of the above are entered into the software along with a 'Design Air Permeability' (what you hope the building will achieve under testing) which must be under 10m³/(h.m²) @ 50 Pa or 15m³/(h.m²) @ 50Pa if a poorer assumed value can be used.

The TER is effectively the performance the building would have achieved under 2002 regulations, with a 20% improvement factor applied, in line with wider government targets for reducing carbon emissions.

To achieve the TER, you may need to change the specification of products, orientation of buildings, heating system or commit to achieve air permeability lower than the basic regulatory requirement.

If you want to view how you might achieve the TER using your existing methods and products you can do so at www.playtheregs.com.

After construction:
The building is then constructed and the specification and configuration of the building may change over the course of the process. The actual details and tested air permeability figure are entered into

the software again to give a Dwelling or Building Emission Rate (DER or BER). The actual DER or BER must be lower or equal to TER.

This is a regulatory requirement under Approved Document L.

Q: Is air tightness testing mandatory?

A: Yes, buildings need to demonstrate a minimum level of air permeability (10m³/(h.m²)) and in the majority of cases this is done through an on-site, pre-completion test. This is not an onerous requirement in itself but the design air permeability for a particular building may need to be lower to achieve the overall carbon emission rate for the building and/or client specification.

Q: Which buildings need to be tested?

A:

- All new dwellings (based on a sampling rate)
- All new buildings other than dwellings
- 'Large' extensions to buildings other than dwellings

There are some exceptions to the above where buildings may be able to assume a poorer air permeability rather than undertake a test. The exceptions are explained below:

Dwellings
Approved Document L1A - Conservation of Fuel & Power (for England & Wales) requires air tightness testing of **new houses and flats** to achieve building control approval.

Refurbishments of and extensions to existing residential buildings do not require testing.

Small developments (1 or 2 houses) may avoid the need to test by accepting an assumed poor value for air permeability of 15 m³/(h.m²) @ 50Pa but this may add costs to other aspects of the building specification in order that the building meets overall targets for emissions. Alternatively it may be possible to re-use existing test evidence where building designs have been repeated within 12 months of conducting the original test.

Buildings other than dwellings
Approved Document L2A - Conservation of Fuel & Power (for England & Wales) requires air tightness testing of **new buildings other than dwellings** to achieve building control approval. This includes all buildings using fuel or power for heating i.e. industrial units, warehouses, schools, hospitals, residential care homes, hotels, offices, retail units, etc

'Small' commercial buildings (with a floor area less than 500m^2) may avoid the need to test by accepting an assumed poor value for air permeability (15m³/(h.m²) @ 50Pa) but this may add costs to other aspects of the building specification in order that the building meets overall targets for emissions.

'Large' extensions to buildings other than dwellings
Approved Document L2B - Conservation of Fuel & Power (for England & Wales) requires air tightness testing of **'large' extensions to buildings other than dwellings** to achieve building control approval.

'Large' is defined as an extension greater than 100m^2 AND greater than 25% of the useful floor area of the existing building.

Q: Do I need to test every building?

A:

- Yes for buildings other than dwellings (industrial units, warehouses, schools, hospitals, residential care homes, hotels, offices, retail units, etc)
- No for dwellings (flats and houses)

For **buildings other than dwellings** developments, where testing is required, each individual building unit will need to be tested i.e. if the 'unit' is not connected to adjoining units and intended to be occupied/operated separately.

For **dwellings** a sampling rate applies depending on:
- Dwelling Types
- Adoption of 'Accredited Construction Details'

Dwelling Type
For housing developments, a sample of units from different 'dwelling types' are tested to prove compliance. Separate blocks of flats are considered as different developments.

Dwelling types are defined based on:

1. Position – this is likely to be:
- Detached house (no party walls)
- End terrace/semi-detached house (1 party wall)
- Mid terrace house (2 party walls)
- Ground/bottom floor flat (party floor below - may be over car parking, drive through, etc.)
- Intermediate floor flat (2 party floors)
- Top floor flat (party floor below)

2. Construction type – where there is variation in floor, wall and roof construction details and/or construction method. For simplicity it is likely that this would be based on whether there is variation in those aspects covered by the Accredited Construction Details. This is likely to relate most obviously to variation in storey height i.e. duplex rather than single storey flats or 2.5 storey (warm roof) rather than 2 or 3 storey (cold roof). Plus whether similar units are being built using different methods i.e. traditional/masonry, timber frame, steel frame.

Building Control may choose to define additional dwelling types based upon:
- Size: Part L makes reference to size but fairly vaguely: 'small changes in ground floor area do not constitute a change in dwelling type'. 'Small' is not defined so is open to interpretation. Ultimately, Building Control will define what constitutes a significant change in size but as a basis for estimating it is safe to assume this will not affect the dwelling types. ATTMA suggest 15% variation although in practice 50% to 100% variation is more likely to be considered 'significant'.
- Significant penetrations: i.e. number of windows, doors and flues.
- Position of a flat on a floor e.g. corner plot rather than mid plot

Your air tightness testing body should be able to provide you with an approximation of dwelling types but Building Control will have the final say.

Site plans and schedules are normally sufficient to define dwelling types and identify the number of each.

Accredited Construction Details
Part L1A refers to Accredited Construction Details (ACD), these can be found on the Planning Portal website (http://www.planningportal.gov.uk).

The details refer to insulation as well as air permeability and are divided into construction types:
- Timber frame
- Steel frame
- Masonry (cavity insulation)
- Masonry (internal insulation)
- Masonry (external insulation)

They include details for the important elements of the dwelling, including:
- Ground floor to wall
- Wall to ceiling
- Party walls and floors to external walls
- Eaves
- Windows and Doors

The details take the form of a site checklist.

Adoption of these details will need to be verified by Building Control or the Approved Inspector.

Sampling for Dwellings

Accredited construction details adopted?	No. of units	Sample to be tested
Yes	Any number	1 unit of each dwelling type
No	1 to 4	1 unit of each dwelling type
No	5 to 40	2 units of each dwelling type
No	41 or more	5% of units (unless the first 5 units achieve the design air permeability, then the frequency can be reduced to 2%)

Q: Who selects which buildings to test and when?

A: In theory, it is the responsibility of Building Control or the Approved Inspector to randomly select which units to test. The aim is to prevent certain building units being constructed specifically for testing and therefore not necessarily reflecting the air tightness of similar units.

Approved Document L encourages the testing of units as early in the construction process as possible to allow any problem identified under test to be addressed on future units, rather than completed units of the same type having to undergo costly and disruptive remedial work.

These two factors are a little contradictory in that if you test the first completed unit of a dwelling type the sample will not be random (as there is only one to choose from).

There is also a practical consideration when scheduling the testing, it will be significantly cheaper and less disruptive to test 4 dwelling types on a single day compared to over 4 separate days.

There will need to be discussion between the contractor, testing body and controlling authority to achieve a pragmatic solution.

In practice, It is likely that the air tightness testing body will propose a test regime based on information provided by the building contractor and the building inspector will approve this. The units to be tested are most likely to be the first completions of each type but Building Control should feel confident that all units of the tested type are being completed to the same standard.

Q: What are the most common air leakage/infiltration paths?

A: See TI-0809 – Achieving Air Tightness: In Buildings.

Q: Who can carry out the testing?

A: Approved Document L says that Building Control can accept evidence from BINDT Registered testers.

BINDT registration for Part L1 requires:

- training of individuals by a BINDT approved training body and calibration of their equipment

OR

- company membership of the Air Tightness Testing & Measurement Association (ATTMA).

BINDT Registration for Part L2 requires:

- company membership of the ATTMA

ATTMA membership requires a technical review of training, reports and procedures and accreditation by the United Kingdom Accreditation Service (UKAS).

UKAS accreditation verifies:

- that the testing body works to appropriate procedures
- test engineers have the necessary training and competency levels
- equipment is correctly calibrated within defined parameters to ensure the accuracy of readings through annual site inspection and system audits.

Q: When does testing take place in the construction process?

A: Basically when the building is completed, typically everything has been finished apart from the carpets being laid, but before handover.

Inviting the test body to site too early is likely to jeopardise the result, making testing impossible or not meeting the requirements of the building inspector. This does place extra pressure on getting things right first time, remedial works at this stage may be awkward and cause expensive delays.

It is important that the air barrier is complete and any penetrations have been fitted and finished.

For dwellings we have produced a checklist to gauge whether the units are sufficiently complete.

Q: What information is required to produce a quote for air tightness testing?

A: For dwellings, sufficient information is required to identify the different dwelling types and the number of each e.g. General Arrangement/Site Plan and Schedule (including other important details such as variation in storey height or construction method).

For buildings other than dwellings, the approximate envelope area is the key factor for quoting. It is required to establish the necessary fan arrangement. This affects the time on site and potentially the number of people. This can be calculated from drawings – floor plans AND elevations.

The testing body may also need to identify the potential aperture(s) into which test equipment is to be installed, in some circumstances this may require additional time on site, extra people or bespoke templates to be made.

Q: What preparation needs to take place in advance of testing?

A: We provide a simple checklist for building preparation, which includes the following:

- The building should be 'completed'
- All external doors and windows closed
- All internal doors wedged open
- All fire dampers, ventilation louvres and trickle vents closed but not sealed
- Mechanical ventilation turned off with inlet/outlet grilles sealed
- All combustion appliances switched off
- Drainage traps must contain water

This needs to go to site. The preparation would ideally be undertaken by the contractor in advance of the test body arriving on site to maximise the testing time in a day. Chiltern Dynamics will undertake the preparation where this has been arranged in advance.

For dwellings it may also be necessary to agree the test programme with the building inspector before arriving on site.

Where possible, it is helpful to accurately calculate the envelope area and confirm the fan installation arrangements based on architectural drawings before coming to site.

Q: What does air tightness testing involve?

A: The objective is to measure the volume of conditioned air escaping through the building envelope via uncontrolled ventilation at an induced pressure difference of 50Pa.

The following basic steps are typical:

1. Check site preparation / Prepare site – including temporary sealing
2. Calculate the envelope area if not done previously
3. Explain the process to relevant staff and sub-contractors working on or near the building
4. Take environmental condition measurements – wind speed, temperatures, barometric pressures
5. Install template(s) into suitable aperture(s)
6. Install fan(s) into template(s)
7. Connect monitoring equipment
8. Check the static pressure
9. Take multiple pressure difference readings and record fan flow rate(s) – allowing sufficient time for the pressure readings to stabilise

10. Check the static pressure
11. Process the readings through appropriate software – check that readings fulfil the requirements of the standard
12. If the building fails, attempt to identify/quantify air leakage/infiltration paths
13. Disconnect measurement equipment
14. Remove the fan(s)
15. Remove the template(s)

Q: What is the envelope area?

A: The envelope area is the total internal surface area of the conditioned areas of the building i.e. the sum of floor area, wall areas and ceiling area (of the heated space).

This should be calculated or verified by the air tightness test body as the accuracy of the envelope area has a significant impact on the final air permeability result.

The building inspector should check this is being done correctly and/or approximately verify the area.

Q: How is air tightness calculated?

A: Air permeability is essentially a function of the pressure difference between the inside and outside of the building and air flow rate through the fan(s) to produce that pressure difference. This is averaged out over the envelope area.

The result takes account of environmental conditions.

The final air permeability at 50Pa is based on a logarithmic graph of pressure difference and flow rate, the graph should:

- Have at least 7 points (ideally 10 or more)
- The highest figure should be at least 35Pa but preferably would be in excess of 50Pa and ideally higher than 60Pa
- The lowest figure should be at least 10Pa or 5 times the 'static pressure' (the pressure difference between inside and outside without the fans) – which in itself MUST be less than 5Pa to limit uncertainty
- The readings should be no more than 10Pa apart
- The correlation of the graph should be at least 98%
- The gradient of the graph (n) should be between 0.5 and 1.0

These are aspects that the BCB should be checking carefully if choosing to accept air permeability results from non-accredited testing bodies.

Q: When will I get the results?

A:

- An indicative result is available immediately
- Certificates can usually be issued on the same day, where required
- Reports with certificates are typically sent within 2 working days

Q: What test evidence is required?

A: A test certificate from a test engineer and/or test body that is registered with the British Institute of Non-destructive Testing (BINDT).

The test certificate should include sufficient information to describe the building tested e.g. location, type and size (the envelope area is an important component in calculating the air permeability and must be accurate) plus the design air permeability as well as the actual result. In addition, if the result has been achieved with temporary sealing outside that allowed in TS1, this should be detailed in the certificate. In some cases this may be a missing trickle vent and in other cases whole sections of the building. Building Control should satisfy themselves that the building tested was representative of the actual performance.

The certificate should refer to BINDT registration and/or membership of the Air Tightness Testing & Measurement Association (ATTMA). This can be cross-referenced via their respective websites.

The test engineer/body should also produce a full test report that meets the requirements of ATTMA Technical Standard 1. This will include the building pre-test preparations as well as full test data and should be available from the contractor if required.

Q: What happens if the building fails?

A: At Chiltern Dynamics, we will endeavour to help you identify the probable air leakage/infiltration paths.

There are a number of methods we employ to do this of increasing complexity:

- Smoke pencils – smoke can be used to identify where air is moving when the building is being tested
- Depressurise the building – we tend to pressurise the building under testing which forces air out, by reversing the fans and depressurising the building air is drawn in and normally can be felt or even seen as 'draughts'
- Smoke testing – if the air paths are less direct it may be necessary to use smoke puffers and/or fill the building with smoke and pressurise/depressurise again. Points of air ingress and egress should be identifiable.
- Thermography – if it is still not apparent where air is escaping, infra-red cameras can be used to identify hot spots and cold spots on the internal and external surfaces of the building. This requires a temperature difference between the inside and outside and is usually done at night.

In the vast majority of cases the first two methods are sufficient to identify the most significant air leakage paths. These can be temporarily or permanently sealed and the test repeated to quantify the effect of addressing these areas. Where problems are larger and/or cannot be addressed on the day, the building may need to be re-tested at a later date.

For dwellings, the same unit should be tested, plus another example of the same dwelling type (assuming one exists).

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