



## Airtightness Testing



The essential guide to Part L of the Building  
(Amendment) Regulations 2007  
for dwellings plus good practice for commercial  
buildings

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The Stable Yard  
Slane Castle  
Slane  
Co Meath

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## 1.0 COMPLIANCE WITH THE 2007 BUILDING REGULATIONS

Air pressure testing should be carried out on a proportion of new dwellings on all development sites. A performance level of  $10 \text{ m}^3/(\text{h.m}^2)$  at 50 pascals represents a reasonable upper limit

*Technical Guidance Document L*

### 1.1 PART L - Generic Requirements

Part L applies to works to new dwellings, where the work commences or takes place on or after 1 July 2008. Airtightness compliance requires airtightness testing of samples of each dwelling type. Various generic forms of dwelling are considered as separate discreet types, these are detailed in SEAI's website, [www.seai.ie](http://www.seai.ie). Including:

- ☞ Change in method of construction e.g. timber frame and brick & block
- ☞ Ground floor, mid floor & top floor flats
- ☞ End of terrace & mid terrace
- ☞ Semi-detached & detached
- ☞ Significant changes in building floor area

### 1.2 Envelope areas

The envelope area or surface area as defined on pg.6 describes where the airtight continuous surfaces should be air sealed. However, there are additional areas to be included in these Regulations, as detailed below:

- For new dwellings, where areas have the potential to become part of the habitable dwelling area, e.g. attached garages, the external fabric elements should comply with the guidance. The envelope area therefore includes attached garages. (*Technical Guidance Document L paragraph 0.1.6*)
- The same applies to attached conservatory-style sunspaces, or the like, and should be treated as an integral part of the habitable area of the dwelling. (*Technical Guidance Document L paragraph 0.1.6*)

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→ Where a new dwelling has an attached room or space that is to be used for commercial purposes, such space should be regarded as part of the dwelling, if the commercial part could revert to domestic use. The envelope area therefore includes such spaces.

*(Technical Guidance Document L paragraph 0.1.5)*

### 1.3 Part L - DEAP Requirements

For the purposes of this guidance an air permeability at a pressure difference of 50 pascals equates to an air change rate of twenty times less. Therefore an air permeability of 10 m<sup>3</sup>/(h.m<sup>2</sup>) equates to an average hourly air change rate of 0.5 ac/h. *(Technical Guidance Document L paragraph 1.5.4.1).*

The DEAP software requires input of the air permeability of the dwelling and automatically calculates the air change rate. Additionally the DEAP software will request whether the dwelling has a draught lobby on the main entrance and, if not, will add 0.05 ac/h.

The DEAP software will request the number of storeys and for a 2 storey building will add 0.1 ac/h. The DEAP software will request the number of sheltered sides and will often reduce the air change rate. These individual portions of air changes per hour are summated to define an effective air change rate (ac/h) and used in the calculation process.

Thus a new dwelling with a low measured air permeability, includes a draught lobby, is low rise and is sheltered will result in a low effective air change rate.

Since the proposed new dwelling is required to use 40% less energy than the reference building, it follows that the required air permeability of the new dwelling may need to be less than 10 m<sup>3</sup>/(h.m<sup>2</sup>) at 50 pascals.

Where a number of apartment blocks are constructed on the same site, each block should be regarded as a separate development. *(Technical Guidance Document L paragraph 1.5.4.3)*

Table 3.2A: A proportion of dwellings on all development sites should be tested  
(Technical Guidance Document L Table 4)

Number of Units	Number of Tests Required
1-4	One Test **
5-40	Two Tests
41-100	5% of Dwelling Type
101+ (if target is reached)	2%
101+ (if target is not reached)	5%

The regulations apply to new dwellings where planning permission has been applied for on or after the 1st July 2008 and where substantial works are not completed before the 30th June 2009.  
\*\* For small developments, no more than three dwelling units, a specific pressure test may not be necessary. If it can be demonstrated by way of a report that during the preceding 12 months a dwelling of the same type constructed by the same builder achieved an acceptable standard.

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.

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## 1.4 Remedial Measures

If the measured air permeability is worse than the value used in the DEAP calculation then it should be verified that the EPC is less than the MPEPC ( $EPC < MPEPC$ ) and that  $CPC < MPCPC$ . If not, remedial measures should be undertaken to reduce the air permeability until the above condition is met. (Technical Guidance Document L paragraph 1.5.4.6)

## 1.5 Small Developments

For small developments of three dwellings or less there is no requirement to pressure test the dwellings, provided that a satisfactory pressure test has been completed on a dwelling of the same type within the past twelve months. However, if the required airtightness on the new dwellings is less than the previously tested dwellings, then a pressure test will be required to confirm the requirements of DEAP. (Technical Guidance Document L paragraph 1.5.4.7)

## 1.6 Existing Dwellings

There is no requirement to test existing dwellings (extensions, material alterations, material change of use or window and door replacement), although there is guidance on reducing unintentional air leakage paths. (*Technical Guidance Document L paragraph 2.1.4.1*)

## 2.0 DEFINITION OF TERMS

**Airtightness** of a building is usually determined by air permeability in units of  $m^3/(h.m^2)$ . This is the flow rate of air required to pressurise or depressurise a building, normally to 50 pascals, divided by the surface area of the building.

**The surface area** used for air permeability is defined (using internal dimensions) as the sum of the area of the external walls, the area of the ground floor slab and the area of the roof, in units of square metres.

**DEAP** - Energy and CO<sub>2</sub> emissions should be calculated by the Dwelling Energy Assessment Procedure (DEAP) published by Sustainable Energy Authority of Ireland ([www.seai.ie](http://www.seai.ie)). The procedure essentially calculates the energy performance of the proposed new dwelling compared with a reference building. The notional reference building has an air permeability of 10  $m^3/(h.m^2)$  at 50 pascals, equating to 0.5 air changes per hour. (Technical Guidance Document L Appendix C)

**EPC** - Energy Performance Coefficient is the proposed energy consumption of the new dwelling kWh/( $m^2$ /year) divided by the reference building kWh/( $m^2$ /year).

**MPEPC** - Maximum Permitted Energy Performance Coefficient, which is currently set at 0.6. (Technical Guidance Document L paragraph 1.1.2) Essentially the EPC must be less than the MPEPC.

**CPC** - Carbon Performance Coefficient is the proposed carbon consumption of the new dwelling kgCO<sub>2</sub>/( $m^2$ /year) divided by the reference building kgCO<sub>2</sub>/( $m^2$ /year) .

**MPCPC** - Maximum Permitted Carbon Performance Coefficient, which is currently set at 0.69. (Technical Guidance Document L paragraph 1.1.2) Essentially the CPC must be less than the MPCPC. Both of the above criteria should be met for individual new dwellings, but an averaging procedure may be used for multiple dwellings in the same new building. (Technical Guidance Document L paragraph 1.1.3)

**Air change rate** - The measured air permeability divided by twenty, expressed in ac/h

**Effective air change rate** - The air change rate derived from above adjusted for the existence of a main entrance lobby, dwelling height and degree of shelter. This is calculated within DEAP.

### 3.0 AIRTIGHTNESS FOR COMMERCIAL BUILDINGS

Achieving an airtightness **target of 10 m<sup>3</sup>/(h.m<sup>2</sup>)** is not an arduous task. For many years specifiers have demanded significantly better standards of airtightness in quality buildings to ensure that the occupants enjoy a satisfactory state of comfort and well-being. For air-conditioned buildings, and buildings which aim to be low energy, a maximum air permeability standard of 3 m<sup>3</sup>/(h.m<sup>2</sup>) has been set by many building owners and operators.

The major benefits of a tighter airtightness standard are **far better control, fewer staff complaints and improved energy efficiency**. Many clients in the retail sector have adopted lower airtightness standards such as 2 m<sup>3</sup>/(h.m<sup>2</sup>) for new build projects. Even extensions to existing buildings can routinely achieve an air permeability target of 3 m<sup>3</sup>/(h.m<sup>2</sup>).

The Building Energy Rating (BER) Assessor follows the Non-Domestic Energy Assessment Procedure (NEAP), which essentially means running the Simplified Building Energy Model (SBEM) computer programme. All the attributes of the building need to be input and includes Uvalues of walls, windows, roof, floor, etc., along with the building's heating and ventilation types and efficiencies. The air permeability of the building also has to be input into the building model and lower air permeabilities will result in a lower Building Energy Rating (BER).

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Setting an achievable airtightness target is an important element depending on the type of building. Clearly, some areas will require tight targets and special attention to achieving them, but designers should not choose airtightness targets which are very costly just to achieve the clients energy target. Changing other parameters in the design may be more cost effective.

The following table provides guidance on current normal and best practice. Normal practice can generally be easily achieved, but specifications substantially lower than best practice should be avoided unless it is a very special case.

### 3.1 Sensible and achievable airtightness targets

Table 4.1A: Normal and best practice in air permeability

Building type	Air permeability in m <sup>3</sup> / (h.m <sup>2</sup> ) at 50Pa	
	Normal practice	Best practice
<i>Offices</i>		
Naturally ventilated	7	3
Mixed-mode	5	2.5
Air-conditioned	5	2
Factories and warehouses	6	2
Superstores	5	1
Schools	9	3
Hospitals	9	5
Museums and archival storage	1.5	1
Cold stores	0.3	0.2
<i>Dwellings</i>		
Naturally ventilated	9	3
Mechanically ventilated	5	3

### 3.2 Offices

Air-conditioned and mixed mode offices should have a maximum specified air permeability of 5 m<sup>3</sup>/(h.m<sup>2</sup>) and preferably 3 m<sup>3</sup>/(h.m<sup>2</sup>) at 50 pascals in order to achieve good control for occupant satisfaction and minimise energy consumption. The only real difficulty with these building types is their individual design and diverse architectural variations. However, such designs should not be at the detriment of the integrity of the building envelope.

### 3.3 Factories, warehouses and superstores

There are major retail superstore/department store owners and operators in ROI, which have been specifying air permeability standards of 3 and 2 m<sup>3</sup>/(h.m<sup>2</sup>) for many years. They have also regularly achieved their required airtightness standards well. These types of structures, which have regular roof sheets/panels, regular walls of either panels or correctly specified blockwork lend themselves to good airtightness standards. Nevertheless, good specification and good quality control are still required, along with good detailing joints for wall to roof joints, apex joints and particularly service penetrations, etc. There are now also good airtightness quality loading bay panel doors and brush seals on dock levellers readily available.

### 3.4 Schools and hospitals

Schools, which generally have a low budget, and hospitals with complex shapes and many more services have not, to date, generally achieved their target air permeability values with the consistency of other commercial structures. They do tend to be unique one-off structures in a sector, which has not traditionally been so energy conscious. This situation needs to be addressed by education and specification. For the time being, a maximum air permeability specification of 7 m<sup>3</sup>/(h.m<sup>2</sup>) is a realistic target.

### 3.5 Museum and archival storage facilities

These building types generally require tight control over temperature and particularly humidity.

Excessive natural air infiltration has a very significant effect on humidity levels and these building types therefore require very tight air tightness standards. A maximum air permeability standard of 1.5 m<sup>3</sup>/(h.m<sup>2</sup>) is recommended. If international artefacts are to be displayed in the open area of museums, then tighter air tightness standards may well be required to accommodate their strict temperature and humidity control acceptance criteria.

### 3.6 Cold stores

These structures have very high internal to external temperature differences and require special attention to control product temperature and minimise very significant energy running costs.

The current maximum recommended air permeability specification is 0.3 m<sup>3</sup>/(h.m<sup>2</sup>), and have, now been regularly achieved for several years.

## 4.0 HOW DO I SPECIFY AN AIRTIGHTNESS TEST ?

- ☞ Specify the airtightness target at an early design stage (such as the design air permeability used to derive the EPC and CPC)
- ☞ Specify the air seal line at a very early stage. The inside surface of the structure is usually the airtight surface. The airtight surface should be brought inside rooms which will be ventilated to outside, such as boiler rooms, plant rooms, electrical switch rooms and lift shafts.
- ☞ Require air sealing detail drawings from the architect or design and build contractor.
- ☞ In liaison with the testing organisation, specify all aspects of the airtightness contract process (see pg.19 for sample clauses). Where necessary, specify penalty charges for failures not rectified in a reasonable timescale.
- ☞ Consider specifying an airtightness consultant such as **Navitus** to inspect the building during the construction process.
- ☞ Clearly communicate the requirements to all design and construction parties.

## 5.0 AIRTIGHTNESS CHECKLIST

<b>Typical examples of air leakage paths</b>	<b>Check</b>	<b>Comments</b>
Seal hollow concrete beams at the ends before delivery to site since internal penetrations of the beams would allow air to pass into the cavity.		
Seal profiles in profiled metal sheeting - for ceiling where concrete is poured on to profiled metal sheeting, the underside will have indents in the profile. These should be sealed with mastic or similar.		
Where there are raised floors and suspended ceilings, the quality of blockwork is important if these areas are not plastered. Blockwork may leak by up to 60m <sup>3</sup> /(h.m <sup>2</sup> )The manufacturers should have data on the air leakage of the blockwork.		
Painting good quality blockwork reduces the air leakage but painting poor quality blockwork has very little effect.		
Seal joints of profiled metal decking. The underside of profiled metal decking roofs is the air tight membrane. All joints will require to be effectively sealed during the laying of the sheets. Perforated liner sheets and using the vapour barrier should be avoided since they usually underperform.		
Effectively seal all walls to ceiling and roof joints.		
Fill all expansion joints between concrete beams and blockwork to blockwork with an airtight compound.		
Drylining systems should be sealed to the floor, roof and walls and all service penetrations sealed. Care should be exercised where internal walls meet those external walls to avoid a lattice of air leakage paths.		
Seal joints of curtain walling systems to other building systems where problems are most likely to occur.		
Seal riser shafts effectively to avoid air penetrating the cavity and or plant rooms.		
Seal windows and door frames effectively to the inside surface of the structure and seal the cavity preferably before the final finishes are carried out.		

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Seal steelwork penetrations through the inside surface of the structure adequately.		
Seal pipework and electrical penetrations through the building envelope including penetrations to the plant room, electrical switch rooms, external lighting systems, and power and communications in to the building.		
Provide adequate seals for lift shaft doors below raised floors to prevent air penetrating the lift shaft.		
Check doors and shutters. Loading bay doors should preferably be of the panel type with adequate seals. Security shutters are not particularly good from an airtightness point of view.		
Fill water traps and condensate traps before testing the structure.		
Take extra care with sealing details for renewables, such as light pipes through to roofing sheets, mounting, pipe and cables penetrations for solar water heating and photovoltaics. Even mounts and cables for wind generators mounted on roofs of buildings should be carefully sealed.		
Do not use unfaced mineral wool or equivalent to fill gaps.		
Do not use tape to seal joints in buildings.		
Avoid the use of expanding foam.		

## 6.0 WHAT DOES AN AIRTIGHTNESS TEST INVOLVE ?

### 6.1 BUILDING PRESSURE TESTS

A professional airtightness testing service should include a full proposal comprising a method statement and a clear quotation. Special contract terms may be included to cover the possibility of cancellation of testing due to high wind speeds which can invalidate a result. An airtightness test can be undertaken in about 10-15 minutes after set-up, but may take longer if the process is not automated or well organised. Good documentation will be required.

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The tester will need the following information to respond to an enquiry:

- Site location
- Building plans will be needed to determine envelope areas
- Design air permeability (available from the DEAP assessment). (To what standard is the building being tested?)
- Will the client require a smoke test or thermographic survey should the building not meet the required specification?
- Are there any specific requirements for the airtightness test? (e.g. will it need to be performed outside working hours?)

The accuracy of the pressure test will be affected by local wind conditions. Ideally the wind speed at the time of the test should be less than 6 m/s. If the wind speed is higher than this, the test may need to be carried out on a calmer day.

An essential check is to measure the pressure difference between the inside and outside of the

building, with the test fans sealed and all required pre-test actions taken, such as sealing mechanical ventilation openings. It must be within +/- 5 Pascals (Pa) to satisfy the test standard. A valid test cannot be determined outside these limits.

## 6.2 Domestic Pressure Tests

Step 1	Set up the blower fan, close all external doors and windows and tape up other intentional openings, such as bathroom extracts, cooker hoods and fireplaces
Step 2	Carry out the pressure test, measure the results and report to the client
Step 3	Dismantle the blower door and fans and remove all temporary seals

### 6.3 Commercial Pressure Tests

#### *Before the test*

1. The integrity of the structure should be complete for the tests
2. Minimum door size 2.08m high x 0.85m wide.\*
3. All plant equipment should be turned off
4. All mechanical ventilation openings should be sealed with polythene sheet or Cordek and self-adhesive tape. Smoke extract fans should not be sealed.
5. Sufficient access to a door is required for the test equipment. The airtightness contractor will advise contractors of the amount of space needed which varies according to the size of building and air permeability.
6. All internal doors should be wedged open.
7. 3 off 16a 110 volt electrical supply (separate circuits), within 25 metres of the doorway will be required.\*

#### *During the test*

8. All exterior doors and windows need to be kept closed during the actual pressurisation tests.
9. The actual test (after set-up) is usually completed in well under one hour. During this period no personnel should enter or exit the building. It is preferable if the building is unoccupied.
10. There should be no movable objects near the fan unit inside the building, since they would be displaced by the air flow.

#### *Additionally for smoke tests*

11. A longer period of time is required for the building to be evacuated for smoke tests.
12. For a complete building smoke test, three sockets will be required on each floor
13. Sufficient observers on the outside of the building to identify the egress of smoke from the building.
14. Notification of the Fire Brigade that this test is about to be undertaken.

#### *After the test*

15. A statement of the air leakage rate is immediately available, and a full report with corrections for air density and air volume will be provided.

## 7.0 ADDITIONAL DIAGNOSTIC TOOLS FORM AIRTIGHTNESS

### 7.1 Thermal Imaging

A good thermal image requires the building to be depressurised and optimally the internal to external temperature difference should be more than 10°K.

The technique not only identifies air leakage paths but also poorly insulated areas, discontinuous insulation and thermal bridges. To carry out the thermography test, the infrared camera should be set up for the correct background temperatures, distance and emmissivities.

The camera should be in focus and reflections should be avoided. The inside and outside of the building should be scanned for temperature anomalies that exist prior to the building being depressurised. All such locations should be noted and recorded.

Once the building has been depressurised for a little while, the building should be scanned and new thermal anomalies noted and recorded. The surveyor should check for local sources of heat, check whether they were there before depressurisation, and eliminate the possibility of other causes.

The location of each anomaly should then be checked against the construction details. A report should be issued showing thermograms, location of anomalies and detailing conformance to the environmental conditions as set out above.

### 7.2 Smoke Tests

Local leakage can usually be identified using a smoke pencil, which is a simple handheld device used to find leaks around window frames, window sills and other visible or accessible joints. To identify hidden or inaccessible gaps in the building envelope a smoke test can be performed using a portable smoke generator or, in the case of a whole-building smoke test, multiple static generators.

A thermographic survey can also be conducted using an infrared thermographic camera. For larger buildings, the most useful approach is to distribute smoke generators around the whole building and leave them switched on for a period of up to an hour. The building should then be pressurised to between 20 and 30 Pa and the smoke egress from the building observed and preferably recorded on video. Such tests take less than three hours, even for quite large buildings, and give building contractors a good idea of the location of problem areas.