DRAUGHT FINDER
TEST | LOCATE | REPORT | RATE

10 Hilltop Rise, Farmhill, Douglas, Isle of Man, IM2 2LF
M: 435052 | E: dfm@isleofman.com

Build It Right, Build it Tight – Right For Air Tightness

When Building a New Property make it Air Tight

Building or Refurbishing a new or old property with traditional cavity wall construction or with timber frame to achieve an air tight building can be daunting, but when you get your head around it, there are simple ways of achieving an air tight building. As long as you pay a little more attention to the small detailed amendments required and **THINK AIR TIGHTNESS** at each stage.

Why AIR TIGHT

Simply Regulation **-** Every new build on the Isle of Man that gained planning approval since the 1st October 2014 will require an Air Tightness Test Certification with a Pass result before the final habitation certificate can be issued by the Building Control Officer.

The new regulations are asking for even better air tightness than the previous regulations from a figure of 10.0m³ halved to 5.0m³

Energy Saving **-** Over the years building have had more insulation installed which has reduced energy consumption. Now most of the energy used by us to heat our buildings is used to heat air that has entered or left the building (wasted) through holes and gaps in the structure, uncontrolled, and now accounts for around 50% of the heating costs. From this and the occupiers perspective, addressing air leakage can be pinpointed as one of the most effective, cheap and permanent means, of improving the energy performance of their property!

More than this the new building regulations also require a higher level of thermal insulation and both of these requirements together mean that the energy demand for these buildings will be lower than previously constructed houses. Less energy used means the Island can reduce its total demand for fuel, all of which we currently import, this will reduce the need for any enlargement of the infrastructure to store an ever increasing demand for energy.

It is expected that at some point in the future this Air Tightness requirement will also be required for extensions to existing buildings and then to existing buildings when improvements are made to the building.

Thermal insulation is only truly effective if there is no air movement leakage within, around or through the insulation material. After all insulation is only a means of keeping the air within the insulation material still (This is how insulation works!). Air circulating around or through insulation can decrease the insulation effect by 480% ! (https://www.aecb.net/publications/the-impact-of-thermal-bypass/) When we go out in a wind we put on a "windcheater" jacket over a woolly jumper - if the jacket is removed would you feel as warm?

Colder air from outside a warm building that enters the building can cool the building and increase the ‘normal’ energy demand considerably, by over 50% depending on how draughty the building is.

When warm air leaves a building in an uncontrolled manner it also takes with it moisture and this moisture can condense within the structure when it reaches a colder area within the material. The water destroys the effectiveness of the insulation further increasing the energy demand on the heating system and consequential increase in the heating costs. Conditions become suitable for mould growth, and damage to the structural components of the building can begin due to rot which in turn increase maintenance repair costs.

As wind when air passes a building it has a twofold effect on the building. Pressure from the wind increases on one side "pushing" cold external air into the building through gaps in an uncontrolled manner. then as the wind gets past the building the pressure drops and this "sucks" warm moist air from inside the building out through gaps in an uncontrolled manner.

Both these air movements add up to an increase in costs as the heating system needs to heat the cold air entering from outside, which is replacing the air that has been removed on the leeward side of the building. Additional heat energy is required or wasted due to uncontrolled air losses that could be prevented.

We refer to these uncontrolled air movements as **Infiltration** and **Exfiltration.**

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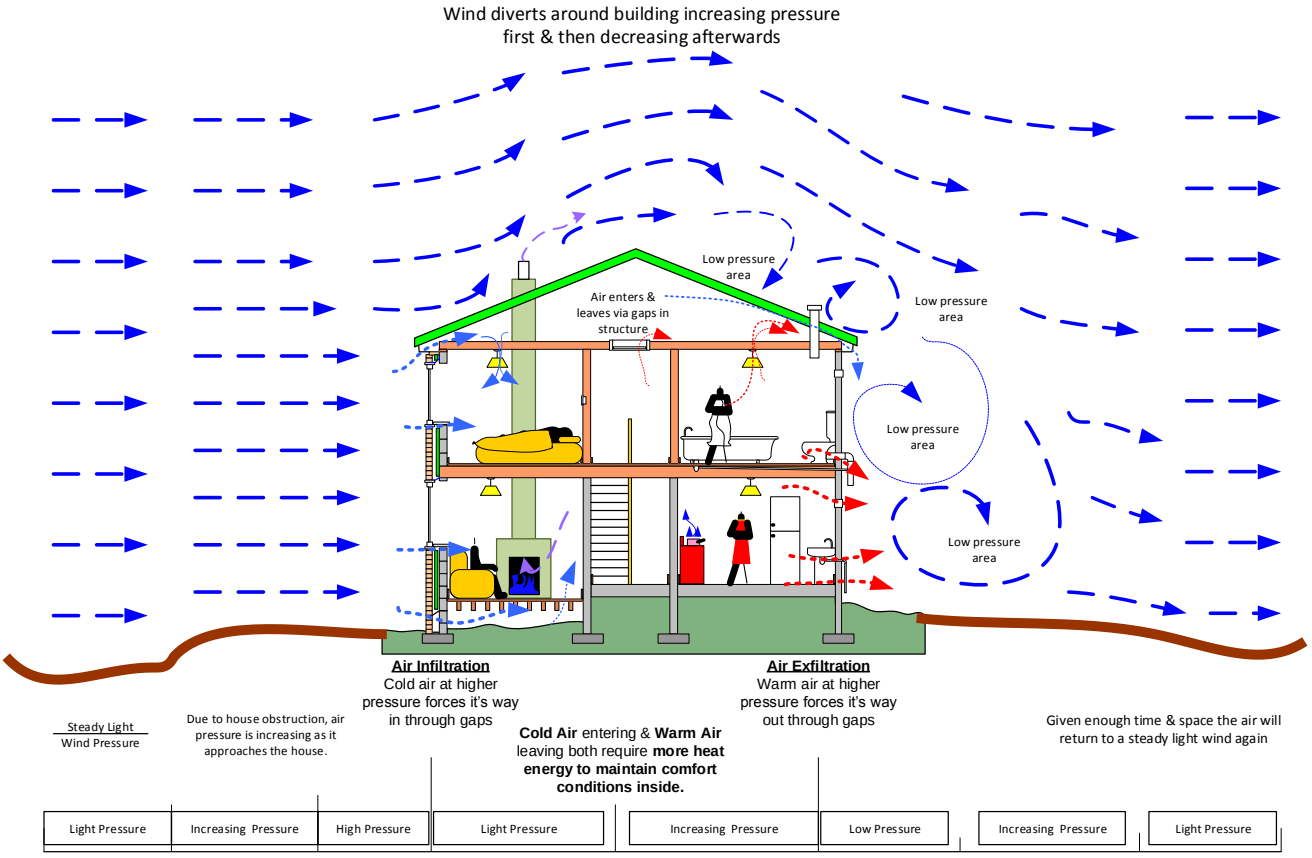

Isle of Man Government – Agenda for Change – Service Delivery Plan 2013 - 2016

Environment & Infrastructure

The Department will:

- Development of a national energy strategy
- Work with partners to introduce a Manx Homes Energy Efficiency Scheme
- We will reduce our energy use through the implementation of new technologies and careful consideration of our energy usage

The Council of Minister's Environment and Infrastructure Committee (EIC) was created to ensure the Isle of Man's policy on energy is sustainable for future generations. The three key aims are to:

- Maintain the security of energy supply;
- Secure the efficient use of affordable energy and
- Minimise the impact of our energy use on the Environment.

Improving the energy efficiency of the domestic housing stock and commercial properties will impact on the amount of;

1. Fuel (Gas & Oil) that the Island imports,
2. Save the residents money on heating costs
3. Improve the bottom, line for businesses Profit & Loss
4. Reduce the cost of maintenance for those who get their properties Air Tight!
5. Remove the "Fudge" factor for Heating & Ventilation designs which again will reduce energy demand, and capital costs on new or replacement equipment.

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How do we find these uncontrolled Air Leaks?

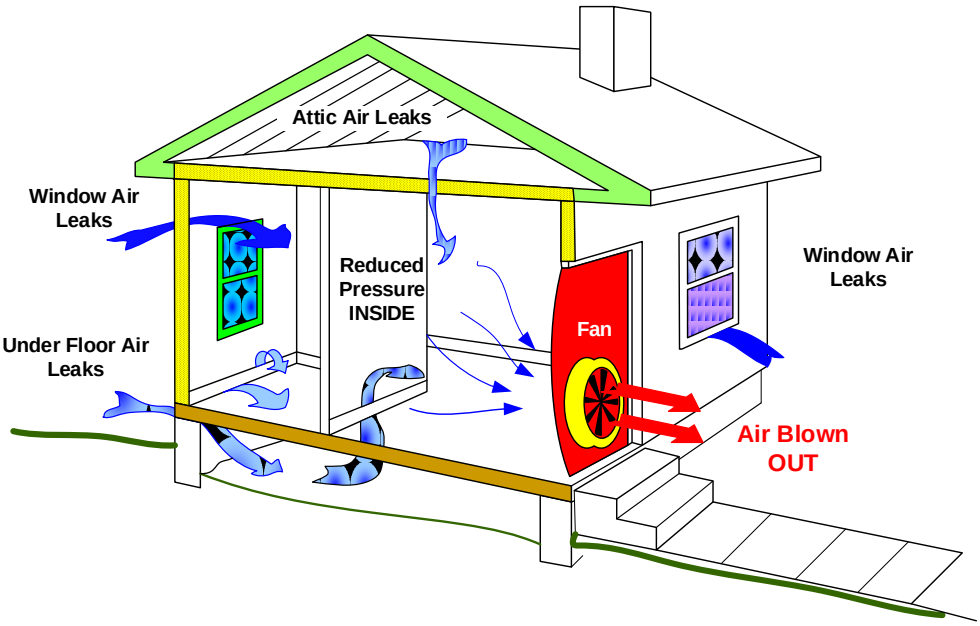
The Building Control department have within the building regulations, stated that all new build properties will be Tested for Air Tightness. Each building must have a certificate of Air Tightness that shows how Air Permeable the building is. (*How much Air leaks uncontrolled into & out of the structure*)

Air is invisible, but you can "feel" air movement if there is a temperature difference. Also with having a difference in temperature we can use this to "see" where any air paths are cooling or heating the structure at the point where the air enters the building by using an Infrared Thermal Camera.

But first we must create the right conditions to perform the Air Tightness Test which can be repeated at any time in the future. This makes the test valid and allows testing at any time of year, we don't need to wait for the weather to produce the right stormy conditions!

What is an Air Tightness Test?

Once we accept that uncontrolled air entering our buildings will seriously affect our buildings energy demand, we should understand the need to prevent as much air from entering or leaving the building as is possible. The benefit of this **low cost solution** to lower energy bills is also **PERMANENT**, as well as reduced maintenance costs in repairing damage to buildings from internal structure rot the comfort conditions within the property also improve, and can allow the thermostat to be turned down, further reducing your energy bills!



The **Air Tightness Test** involves the use of a large fan (Blower Door) installed in a temporary frame in one of the buildings doorways and closing all other external windows and doors. Any 'intentional' ventilation openings are closed or temporarily sealed during the test. (*Chimney, boiler flue, window vents, cooker hood and ventilation systems etc*.) All internal doors are kept open while the test is run.

The blower door fan is turned on and the pressure inside the building is reduced, a number of readings are taken over a series of different pressures and these are processed through a computer software programme to crunch the numbers and produce the test result.

While the blower door fan is running, air from outside will enter the building through the uncontrolled holes, gaps and fissures in the building structure. The test result can provide a figure for the Equivalent Hole Size that all these holes, gaps and fissures amount to.

If you were seated in your lounge with a hole the size of a football in your wall, surly you would fill and seal that hole?

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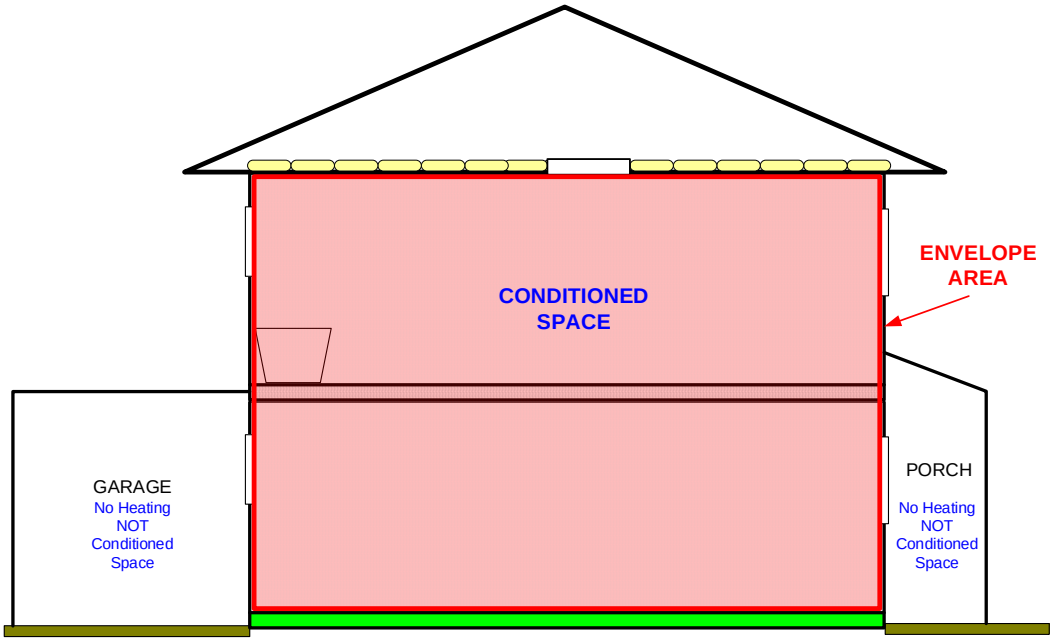
Yet, because we cannot easily see these holes, gaps or fissures, we forget they are there. Realising that this uncontrolled flow of air into and out of the building is increasing the cost of our heating bills should encourage everyone to do something about it!

Terms Used in Air Tightness Testing

Some specific terms are used for Air Tightness Testing:-



Sketch - Indicating the Envelope Area & Conditioned Space

1. ***Conditioned Space*** - Air Testers refer to the Conditioned Space as being the space within the building where normally a heat source is supplied (Conditioned), this heat source may be radiator, under floor heating or warm air circulation. In this example all rooms except the garage and porch are heated, the conditioned space does NOT include the garage or porch.

2. ***Envelope Area*** - Air testers also need to know what the area of the building Envelope is, and is measured in square meters. The envelope area is normally the internal surface area of the conditioned space. (*Floor, wall and ceilings*) and is generally the inside surface of the insulated structure. In the example above this will be the ground floor area excluding the garage and porch, the perimeter wall area and the ceiling area. [*Also to the floor area of the garage roof if a room is above and the walls around the garage walls if next to the conditioned space*]

3. **Infiltration & Exfiltration** - When air enters a building "uncontrolled" it is referred to as 'Infiltration' and when air leaves the building "uncontrolled" it is called 'Exfiltration'. Generally during windy weather, both are happening at together. Except during an Air Tightness test when the pressure difference conditions are artificially induced.

4. ***Air Permeability*** - A permeable material is defined as "*Capable of being passed through or permeated, especially by liquids or gases*" or impermeable - preventing fluids to pass or diffuse through; "an impermeable layer".

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To reduce the amount of air leaking through the building we need a barrier to slow down or stop this air movement, the more we slow the air down the less energy we need to maintain conformable conditions inside the building.

5. The ***Air Barrier*** - The important features of an air barrier system in a building are:

   - ***Continuity*** - (A continuous plane of Airtightness must be traced throughout the building enclosure with all moving joints made flexible and sealed)
   - ***Structural Support*** - (must resist the loads that are imposed on component without rupture, displacement or undue deflection then be safely transferred to the structure)
   - ***Air Permeability*** - (have a high resistance to air passing through the barrier material)
   - ***Durability*** - (must perform their function for the expected life of the structure; otherwise it must be accessible for periodic maintenance)

In summary, air barrier system requires:

- Connections between roof air barrier, wall air barrier, window frames, door frames, foundations, floors over crawl spaces, ceilings under attics and across building joints, must be flexible to withstand building movements due to thermal, seismic, moisture content changes and creep; any joint must support the same air pressures as the air barrier material without displacement.
- Penetrations through the air barrier must be sealed.
- An air barrier must be provided between spaces that have either significantly different temperature or humidity requirements.
- Lighting fixtures are required to be special low leakage gasket fixtures when installed through the air barrier or the air barrier must be designed around the fixture.

Note: There are some common building materials that will not prevent air passing through, however there are other materials that are used in current construction methods that can and do reduce this air passage. The weak points are the joints between the same and different materials and intended openings, doors and windows and any penetrations that pass through the envelope areas wall structure. There are also specialised materials available that perform much better than the traditional materials. A water vapour barrier is more of a requirement to prevent building damage, although many Air barrier systems will also stop vapour from travelling across the envelope.

The Air Test Result - What does it mean?

We measure how Air Permeable a building is by calculating how much air can pass through the Envelope Area in an hour at a specific pressure difference between the inside and outside of the conditioned space. This is done with the above "Blower Door Fan" Test and the associated computer software.

The test result is generally referred to as a number without the rest of the information being mentioned. i.e. the test result was 4.2 and the building passed (Standard of 5.0 to pass)

This means that the Air Permeability of the building will allow
4.2 cubic meters or air to enter (or leave) the building for each
Square Meter of Envelope Area
per Hour
@ a pressure difference of 50 Pascal's between inside and outside the building

This would be shown on the report as 4.20m³/m²/hr@50Pa

So for every square meter of internal wall surface, 4.2 cubic meters of air will enter or leave the building, think about it ..... that is an awful lot of air!

TREVOR CLARK
Independent Qualified L1 Thermographer for InfraRed Surveys
Building Air Tightness Testing to EN:13829 UK TSL1 Standards

Registered & Approved by Department of Infrastructure
Building Control & Standards for purpose of Isle of Man Building Regulations 2014

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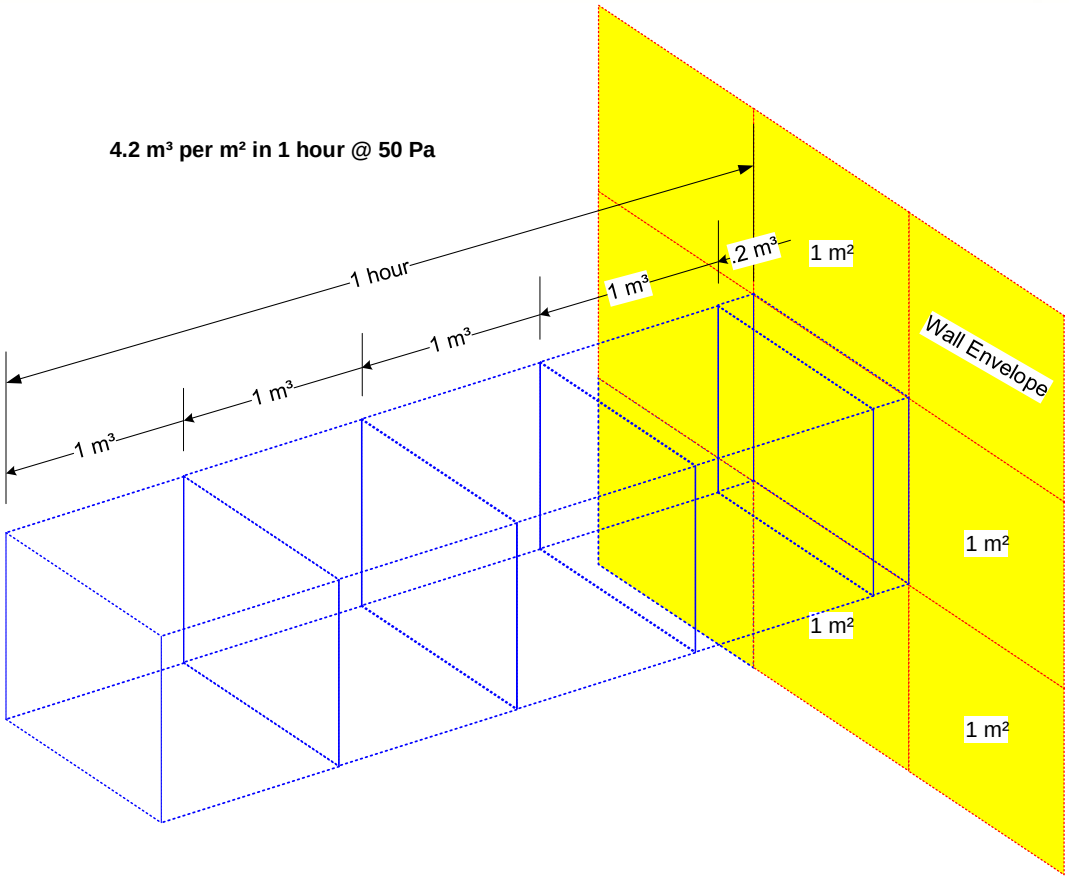

Sketch - Illustrating 4.2m³/m²/hr@50Pa

Previously, when the Air Test required a result of less than 10.0m³/m²/hr@50Pa it was said that "**A good garden shed would pass this test**" !

How do we achieve an air tight building?

This is achieved by starting at the design stage and thinking about what measures will be needed to get the building air tight and what materials we need to use to form an efficient Air Barrier.

Understanding the materials used for construction and how air may pass around or through the material.

It can be surprising just what materials air will actually pass through!

Understanding what air is capable of and thinking about air tightness as each stage of the build by all trades concerned, and ensuring that **EVERY** hole made in the Envelope Area is re-sealed, will help the building achieve a good Air Tightness Result!

Where can we find air leaks?

The following pie chart indicated where most common air leaks can be found.

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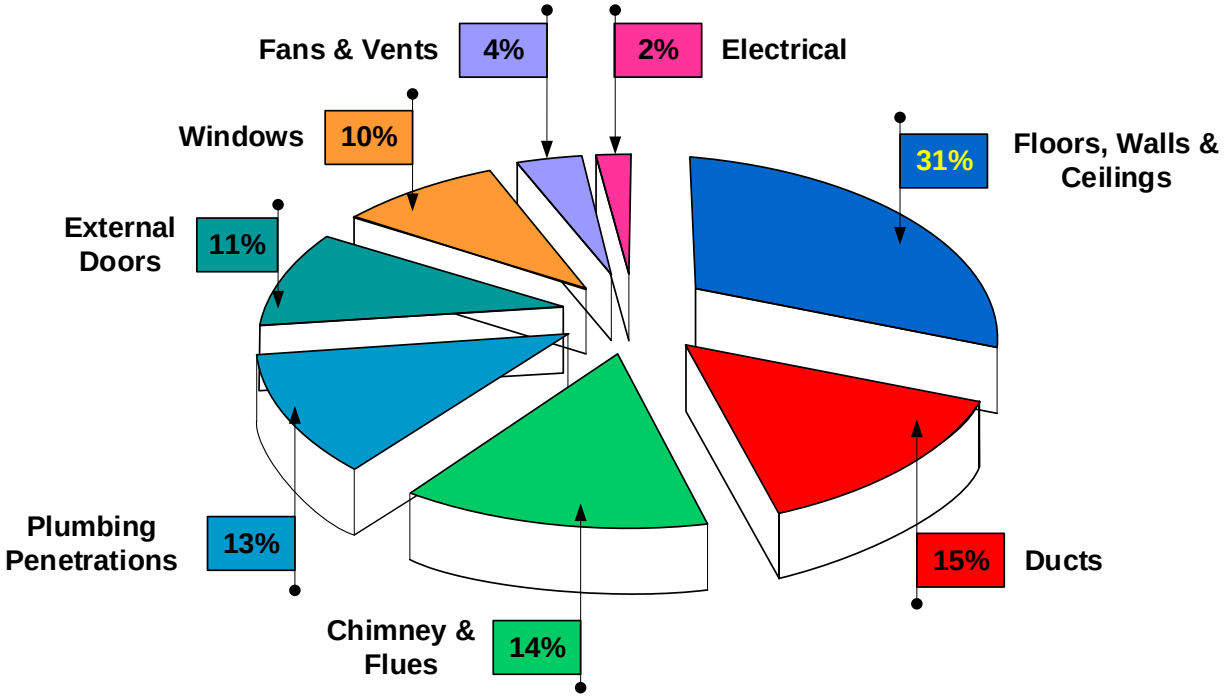

To heat one cubic metre of air by one degree Celsius requires approximately 0.36 watt, not much by itself but now multiply this figure by the number of air changes in a building with a volume of 200m³ (an average 2 bed house would have 4 air changes per hour - 200 x 4 = 800m³)

800 x 0.36 = 288 watts per hour or 6.912 kW per 24 hours for just 1°C rise in temperature.

During winter the temperature difference between inside and outside can be as much as 25° degrees, so over a 24 hour period if the heating is required to maintain a temperature of 20°C and it is -5°C outside we will need to supply 172.8 kW of heat energy (or spend **£25.92** each day! @ 15p/kW) It is a good job we are not living in Canada where it can be even colder.

Each cubic meter that enters or leaves the buildings conditioned space needs the energy previously used to heat it, to now be replaced or the building will cool - leaving it uncomfortable & Cold!

The less air we loose from our buildings, the less our heating bill will be.

Ventilation is IMPORTANT

A word of caution is due at this point, while we are attempting to ensure we build an air tight property, we should realise that certain parts of the building NEED to have air circulation to remain in good condition for the life of the building!

"Everything NEEDS to Breathe"

Air *MUST* be allowed to circulate around the following parts of the building;

1. The underside of any timber on the ground floor.
2. The cavity wall.
3. The unheated attic space.

If air is not allowed to circulate around these parts of the structure water will gather and overtime lead to conditions most suitable for rotting, which in turn will lead to major structural problems and a great deal of expense to rectify it!

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Ventilation of the Building

As of the 1st October 2014 the new building regulations require that a suitable ventilation system is installed and maintained. the designed needs to ensure that enough ventilation is provided to maintain comfortable conditions and may just be trickle vents with kitchen hood and bathroom fans.

The ventilation system should be designed with the Air Permeability borne in mind, the result of the Air Tightness Test will be important in ensuring the ventilation system is neither to large nor too small as this will impact on the initial cost of the ventilation system and the running costs of the system fans. It will allow the designer to remove some of the "fudge" factors that are inherent when allowing for the unknown amount of air that enters a leaky building. Some 10 to 15% is added to designs to allow for this "unknown" amount of uncontrolled air leakage.

Ventilation controls moisture, which in turn can eliminate the problems of condensation and consequential mould growth and the health issues that can result.

However the biggest factor in condensation control remains as "Occupational Usage".

The drying of clothes inside the house on radiators, or unvented dryers, wet towels left to dry after bathing, not using the cooker hood or bathroom fan to extract the damp air from these rooms. All increase the possibility of condensation, and the risk to health that mould gives rise too.

These are all under the control of the occupants and how they use the building. The occupants have the responsibility of understanding that to maintain good comfort conditions in the home requires good ventilation and being aware of the damage that can be done by moist air. The ventilation system needs to have a good automatic control system, be switched on and maintained throughout its lifetime.

Trevor Clark - 09.08.2015