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Quality Assurance :

BlowerDoor Measurement - Air Tightness Testing (EN 13829) in Passive Houses

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Quality Assurance of Passive Houses: Incorporating and Testing Air-Tightness with the BlowerDoor according to the European Standard EN 13829

- **Measuring airtightness according to the European standard EN 13829**
- **Airtightness specifications in some standards and good examples**
- **Typical air leakages of the air barrier in buildings: We find them during the BlowerDoor test. If the test is performed before the interior works it is possible to repair air leakages. And I will show you some advanced methods and materials.**
- **Good reasons for a good airtightness**
- **The best way to good airtightness, especially in passive houses: Better planning – and using the BlowerDoor test!**

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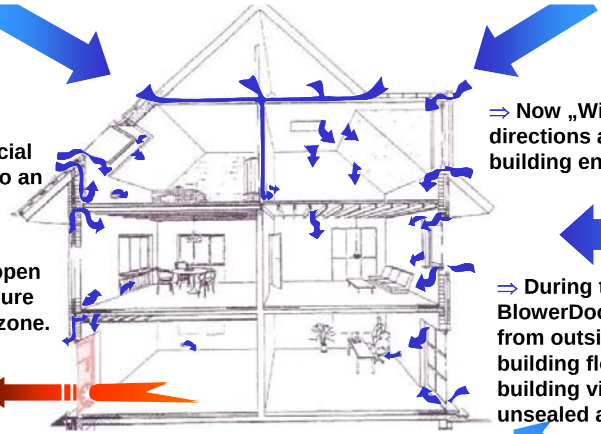
The European Standard is EN 13829: Determination of Air Permeability of Buildings - Fan Pressurization Method



The BlowerDoor has a special ventilator which is built into an opened outside door.

Shut all the windows and open all the inner doors to measure the whole building as one zone.

The fan draws air out of the building, generating a vacuum of –50 Pa called “depressurization mode”. ⇒

⇒ Now „Wind from all directions affects the building envelope.”

⇒ During the BlowerDoor test, air from outside of the building flows into the building via all the unsealed areas.

The air volume flowing out of the building is measured, giving the air exchange rate n_{50}.

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Airtightness Specifications

To calculate the air change rate (ACH) at 50 Pa:

n_{50} = air leakage rate at 50 Pa / internal volume V

Example of an airtight single family house:

188 m³/h / 350 m³ => ***n_{50} = 0.54 h^{-1} (ACH)***

If an energy-saving passive house is constructed, then

n_{50} should lie below 0.6 h^{-1}

(airtightness specification of Passive House Institute of Dr. Wolfgang Feist).

In comparison see the German targets:

(EnEV – Energy Savings Decree, Standard DIN 4108-7 – Airtightness)

If a building is ventilated by windows: **n_{50} must not exceed 3 h^{-1},**

in buildings with ventilation systems: **n_{50} must not exceed 1.5 h^{-1} .**

Airtightness of big Buildings

You can test buildings with a volume up to 150,000 m³ with several BlowerDoor fans.

Not only single family houses but also administrative blocks have to be measured with the BlowerDoor:

For this building we measured n_{50} = 0.21 h^{-1} (ACH at 50 Pa).

(Air volume: 31,500 m³. Measured with one fan)

Quality Assurance in Passive Houses with the BlowerDoor

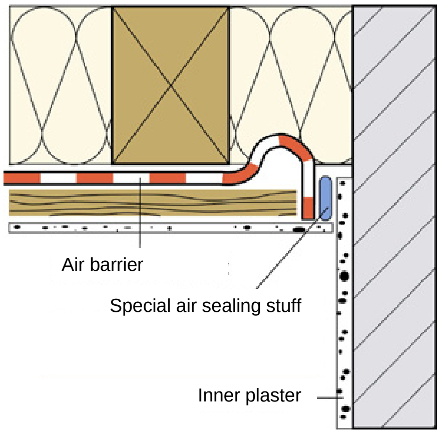
With the „wind-machine" BlowerDoor we depressurize the house, and at -50 Pa we search and find the air leakages:

Here I **feel** the air-draught with my **hand**.

At –50 Pascals we make **air-infiltration** visible with **fog** from outside (here: at the entrance door).

The velocity of infiltrating air can be shown on the display of an **thermal anemometer** (3.4 m/s).

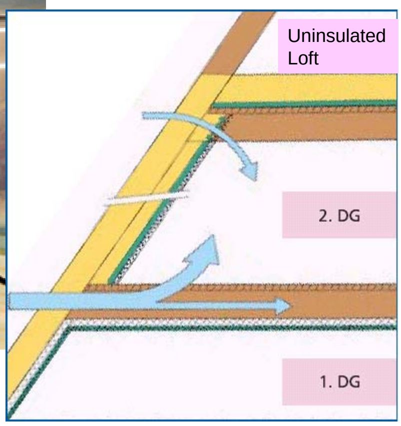
Durable airtight Connections of external Walls to the Roof



To guarantee good airtightness of a building envelope, a comprehensive sealed layer that encompasses the building's interior, should be designed and implemented within the building's interior.

Missing Integrations of the Joists within intermediate Floors

Cold air will flow into the rooms and through the floors!

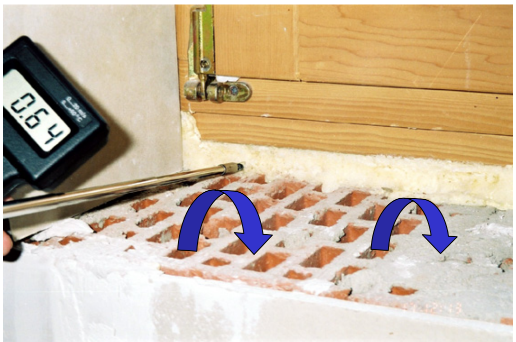


Avoid all unnecessary penetrations through the air barrier – no (wooden) joist should go outside!

Cold Air draughts at the Window

Here the window is "sealed" with polyurethene foam – but this material is *not* airtight!

And of course porous constructions of bricks without an inner plaster under the window-board are *not* airtight *at all*!



We find air leakages at the windows where the airtight layer is interrupted or broken, or where construction parts interconnect:

Typical air leakages in the ground floor or the intermediate floors

In multiple dwellings and administrative blocks, both the *exterior and interior of the building* have to be sealed correctly to avoid undesirable air flows between individual flats, in stairwells, and between smoke and fire zones. In particular, air flows through cabling connections and ducts, through joints in ceilings, dividing walls or even through doors can cause annoying odours, noise pollution or even fire to spread.

The Installation Wall is not the airtight layer, which is behind!

Cold air draughts at the built-in water closet and at pipes and ducts (air velocity, measured at depressurization of -50 Pa: 1.5 and 2.5 m/s).

To solve these problems, **at first** you have to built in the air barrier:

- **fill in concrete at penetrations of service entries through the floor**
- **put an inner plaster or roughcast on porous constructions of bricks**
- **or seal the polyethylen to the floor and the penetrations.**

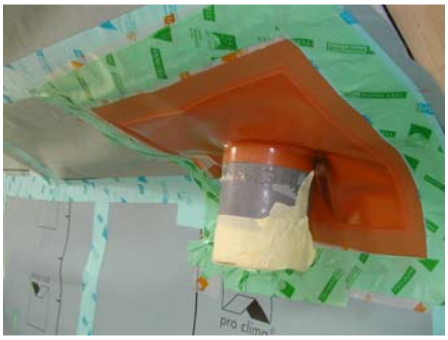
Afterwards you may built in the installations and the wall.

Sealing Installation Penetrations with advanced Materials!

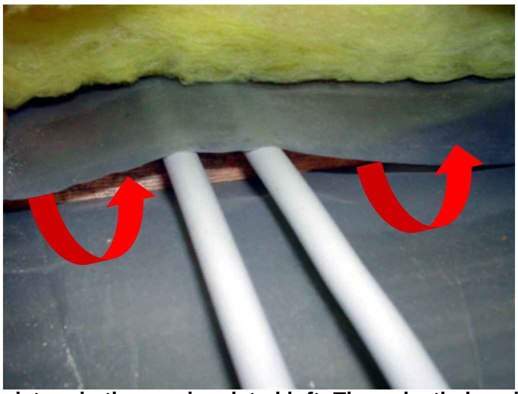
To solve these problems **at first** you have to **reduce penetrations**!

Afterwards you **have to work out a detailed plan with defined materials and methods**.

This is a special sealing sleeve the plumber himself has to pull over his pipes or ducts and stick with suitable sealing tapes to the air barrier.



Condensation Causes Damage through Damp

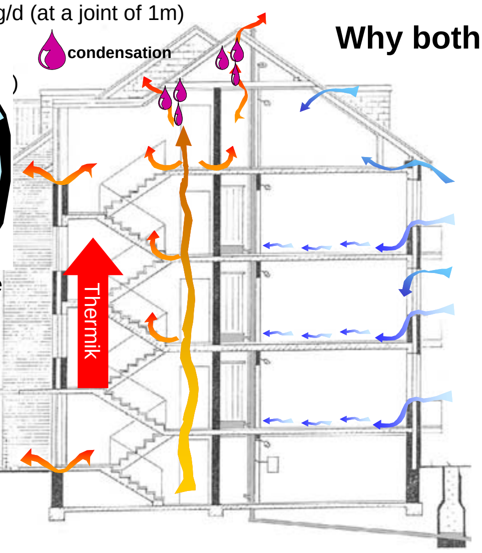


The best method is first to reduce penetrations and second to define the adequate material:
This is a special sealing sleeve the electrician himself should pull over his wirings and stick to the air barrier.

A picture in the non insulated loft: The polyethylen air barrier is not sealed round the electrical wirings. Red arrows symbolize the exfiltration of warm and humid indoor air into the loft. The insulation above was wet, and mould growth had begun on the wood!

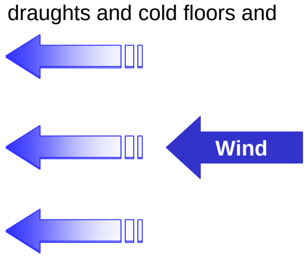
Why bother with airtightness?

Per convection: 360 g/d (at a joint of 1m)



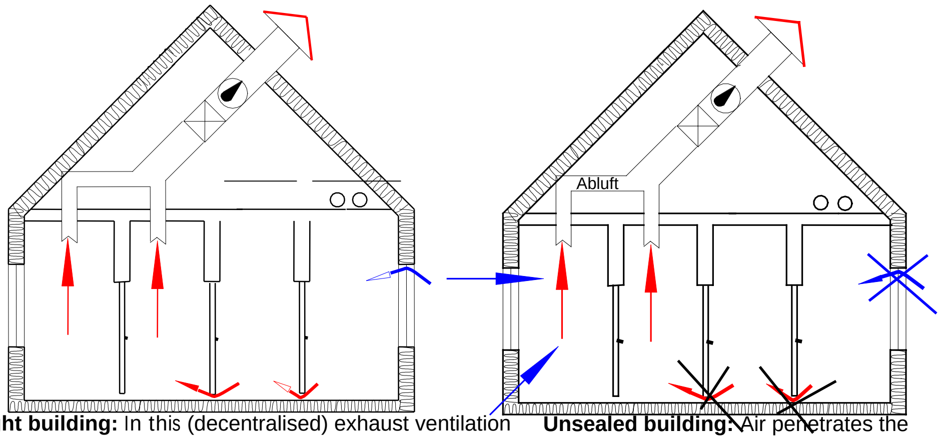
On the lee side of the building and in the roof area, humid, conditioned air will escape. This causes higher heating costs and condensation causes damage through damp and mould growth within the construction.

In winter, the windward side of the building will allow cold air to flow into the building, causing draughts and cold floors and



even allowing pollutant building materials to enter the building (fibres, dust).

High Airtightness guarantees a good Function of Air Ventilation Systems

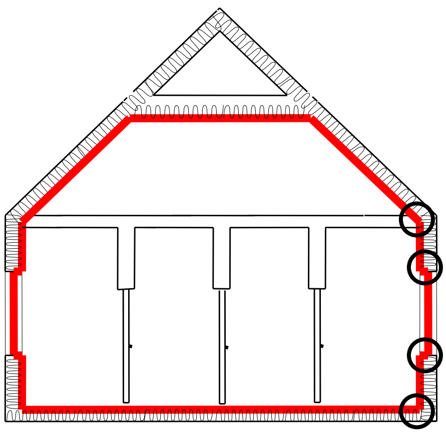


Airtight building: In this (decentralised) exhaust ventilation system the fresh air infiltrates through the outside air inlets and flows to the exhaust openings in the kitchen and bathroom where it will be extracted - **as planned.**

Unsealed building: Air penetrates the building via joints and gaps instead of the outside air inlets. In this case the living room **will not be ventilated**.

Airtightness has to be designed!

The best way to good airtightness – especially in a passive house:



- **At first plan the air barrier for all construction parts of the building. Draw a red line around the house – on the inner side of the construction: It has to be uninterrupted.**
- **Avoid all unnecessary penetrations: e.g. all service entries only *one times* penetrate the air barrier = 12 penetrations at maximum!**
- **At all gasket joints and penetrations you have to work out a detailed plan with defined materials and methods to make sure that the craftsmen are able to build in this way.**

Quality Assurance during Construction – and the subsequent official Air Tightness Test

Better planning and using the BlowerDoor Test, will pay off. Nowadays, building airtightness is a quality feature and the only way to keep energy consumption down:

- **Write the airtightness requirements in the contract, e.g. "n_{50} should lie below 0.6 h^{-1}".**
- **Take a preliminary BlowerDoor test of the air barrier to repair air leakages. This test should be performed before the interior works (i.e. gypsum boards) are made. In the beginning all craftsmen should be in the building during the test to learn from errors.**
- **At last take the BlowerDoor test meeting EN 13829 and you will see that your house is in compliance with the airtightness specification of the standard you have given in the contract!**