Airtightness measurements in Passive Houses in New Zealand

These instructions were adapted by the Passive House Institute New Zealand (PHINZ) from the original by the Passive House Institute in Germany (PHI)

Airtightness measurements in Passive House buildings need to be performed in accordance with AS/NZS ISO 9972:2015 apart from the calculation of the internal reference volume outlined in 6.1.1 of the standard. The air change rate at a pressure difference of 50 Pa is to be determined. The target value for Passive Houses is an n_{50}-value at or below $0.6h^{-1}$.

The pressure test shall only be carried out for the conditioned parts of the building. Roof spaces, conservatories, and other spaces outside of the thermal envelope of the building are neither included in the pressure test nor the reference volume. The pressure test shall preferably be performed by an institution or person independent of the client or any builders. If a pressure test has been carried out by the client or parties involved with the builders, this will only be accepted if the test result is signed by someone taking personal responsibility for the accuracy of the information provided.

Calculation of volumes	
Deviating from 6.1.1 of AS/NZS ISO 9972:2015, the internal air volume V as the reference for the air change rate must be determined and comprehensibly documented separately for each room. The floor area of the room shall be multiplied by the average clear height of the room. Estimates are not permitted.	**Room by room**
Note: The floor area to be used for this calculation differs from the treated floor area used for energy balance calculations. The air volume V_{n50} furthermore differs from the “enclosed volume”, as well as the volume of ventilated space used in PHPP. The calculated volume V_{n50} from the test report must therefore also be transferred to the appropriate field in the PHPP (“Net air volume for press. test”).	**not TFA, not VV instead, V_{n50}**
Irrespective of the degree of completion of the building, the dimensions used must always be those of the finished building, even if e.g. internal liners are partially missing at the time of the measurement. Air volumes above suspended ceilings do not count towards the total air volume. This is regardless of whether the ceiling already exists, is sealed to the wall, or has holes (“acoustic ceiling”).	**Final dimensions only**
A full and comprehensible room-by-room calculation of the volume must be provided for each airtightness measurement. Auxiliary calculations may be necessary and must also be provided. For odd-shaped spaces, triangular or prism calculations may be necessary. A proportionality factor can be taken into account (Figure 1).	**Documentation**

Room	Width	Depth	Area	Height	Factor	Volume
	m	m	m^2	m		m^3
GF-1	4.20	5.80	24.36	2.70		65.77
GF-2	4.20	6.80	28.56	2.70		77.11
GF-3	6.80	3.00	20.40	2.70		55.08
Total volume ground floor						**197.96**
UF-1	3.20	3.60	11.52	2.70		31.10
UF-2	3.60	4.10	14.76	3.20	0.50	47.23
UF-2	4.10	3.60	14.76	2.70		39.85
Total volume upper floor						**118.19**
Total volume						316.15

Figure 1: Example of documentation for room by room volume calculation.

Allowed simplifications include the volume of visible rafters, beams, plasterboard encasements, wall-mounted installations that do not have the same height as the room and similar. These are considered air space, and shall not be deducted .

Rafters, beams wall-mounted installations.

The volume of reveals of any openings in the thermal envelope is not taken into account (Figure 2).

Window reveals

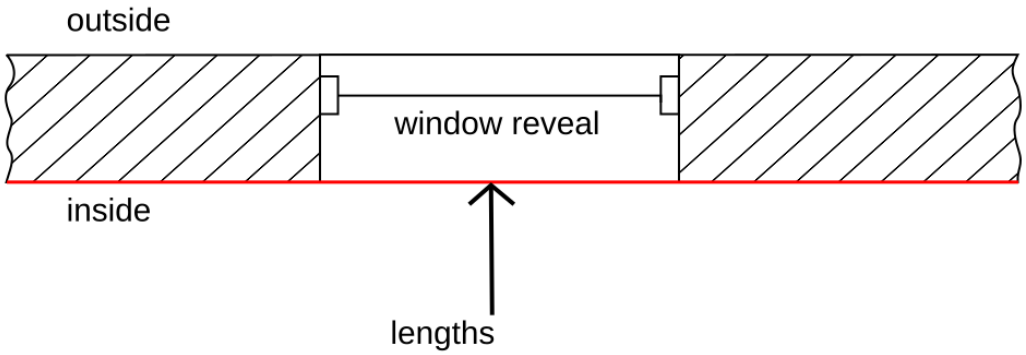
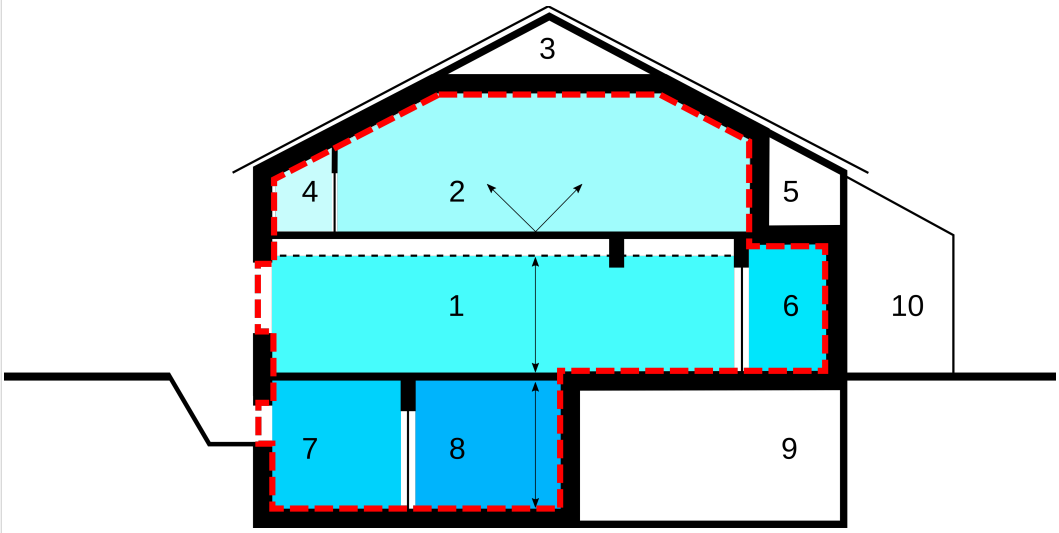


Figure 2: The volume of reveals is disregarded

The volume of a stairwell or lift is fully taken into account, and construction elements are not deducted from it. The floor area of the stairwell or lift can thus be multiplied with the clear height of the storey.

No deduction of the stairwell volume

Figure 3 summarises the requirements for volume calculations:



Room	Inside airtight envelope?	Volume calculation
1	Yes	Clear height up to suspended ceiling; no deduction for the beam, no account for reveal
2	Yes	Complete volume considering roof tilt
3	No	Volume not taken into account
4	Yes	Complete volume considering roof tilt
5	No	Volume not taken into account
6	Yes	Clear height up to ceiling
7	Yes	Clear height up to ceiling; no account for reveal
8	Yes	Clear height up to ceiling
9	No	Volume not taken into account
10	No	Volume not taken into account

Figure 3: Guidelines for calculating the air volume inside the airtight layer of a building. The dashed red line represents the airtight layer and blue shades the volumes for calculation.

Time of measurement

Quality assurance measurements

The compliance measurement is carried out after completion of the building; however, by this time services penetrations, screed, cladding etc. will typically be inaccessible, and remaining leaks in the airtight layer can no longer be remedied.

It is therefore advisable to carry out quality assurance measurements directly after completion of the airtight layer (e.g. window installation, airtightness sheeting in the roof etc.). Leaks in the airtight layer are then easily located and remedied. There are no Passive House specific requirements for this test.

Compliance measurements

For the compliance test, the building must be completed and in an as-use state, which makes leak detection problematic. If however remaining leaks are detected during the compliance test, the construction manager in charge must ensure that no new damage to the airtight layer is affected by subsequent construction work. Should there be cause for concern, another measurement has to be carried out. In most cases however, one airtightness measurement is sufficient.

Carrying out compliance measurements	
The state of the building during typical operation is relevant for the energy balance and durability of a building. Airtightness measurements in Passive House in New Zealand are therefore carried out to Method 1 of AS/NZS ISO 9972:2015, even though there is typically no difference between Method 1 and 2 in the case of Passive Houses. As a rule, the only intended openings are the outdoor air and exhaust air openings of the ventilation system which must be sealed for the measurement. In a Passive House building, openings which are sealed according to Method 2 need to be implemented for compliance tests so that these can be closed (e.g. smoke extraction in elevator shafts).	**Building as used**
Sealing the ventilation system Balanced ventilation systems in residential buildings are temporarily closed or sealed for the measurement (e.g. by taping over the exhaust and intake ducts or using a ball bladder to the same effect).	**Residential buildings: sealing the ventilation system**
In non-residential Passive House buildings (schools, offices etc.), ventilation systems are often operated intermittently. In such cases, ventilation systems must have tightly shutting flaps at the intake and exhaust air terminals to prevent the building from losing additional heat due to stack effects and strong winds when the ventilation system is switched off. For buildings with intermittent operation, the existing sealing flaps must be closed during the airtightness measurement, but they must not be taped over in addition. Fans for mechanical summer ventilation may not be taped over either.	**Non-residential buildings: closed flaps for ventilation terminals only**
No openings (keyholes, leaks in windows, cat flaps etc.) in the building envelope may be sealed for the measurement.	**No further sealing**
The only exception are a small number of uncritical, missing building components, which affect the airtightness (e.g. missing door sill, missing S-trap). A detailed record must be included in the test report of any such sealings.	**Exception: Missing building components**
Both negative and positive pressure results are required when measuring the airtightness in Passive Houses. In this way, the reliability of the measurement results is significantly improved, with a minimum of extra effort. The air change rate n_{50} of he building is determined as an average value from the negative and positive pressure results with 1 decimal. Rounding is permitted.	**Measurement with negative and positive pressure**
If testing EnerPHit buildings results in values between 0.6 h^{-1} and 1.0 h^{-1}, extensive leakage detection must be carried out during the airtightness test, during which leakages which may cause structural damage or impair comfort are to be sealed. This must be confirmed in writing and signed by the person responsible, see section 3.2.10 of *Criteria for the Passive House, EnerPHit and PHI Low Energy Building Standard, version 9f, revised 15.08.2016*.	**EnerPHit**

Buildings with an interior air volume exceeding 1,500 m^3	
Buildings with multiple units should preferably be tested as individual units for quality assurance, and tested as a whole building where staircases/lifts form part of the thermal envelope. The certification threshold is applicable to the whole airtight envelope, and testing the building as a whole is permitted when all conditioned volumes within it can be connected.	**Pressure testing buildings with multiple units, n_{50} target value**
In buildings with an interior air volume exceeding 1,500 m^3, the n_{50}-value loses significance due to the low surface area to volume ratio. It is therefore recommended that the leakage ratio through the exterior surface of the building is ascertained in addition, and that a value of q_{E50} = 0.6 $m^3/(h\ m^2)$ not be exceeded. Lower values may be required for special types of buildings (e.g. swimming pools).	**Surface area target value**
For buildings with an interior air volume exceeding 1,500 m^3, both the n_{50}-value and the q_{E50}-value need to be given in the test report. If the recommended value for q_{E50} is exceeded, extensive leakage detection must be carried out during the airtightness test, during which leakages which may cause structural damage or impair comfort are to be sealed. This must be confirmed in writing and signed by the person in charge.	**n_{50} and q_{E50} values required**
The envelope area is the total area of all floors, walls and ceilings enclosing the volume under consideration, including all walls and floors that are below ground level, or abutting unconditioned parts of the building. The overall internal width and depth are to be used, refer to Figure 1 of AS/NZS ISO 9972:2015. Deviating from AS/NZS ISO 9972:2015, the envelope area calculated in the PHPP may be used for simplification. The exterior dimensions used in the PHPP lead to negligible differences.	**Calculating the envelope area**
In terraced or row houses, the party walls of the building also count towards the envelope area; for apartments in multi-storey buildings this also applies to all floors, walls and ceilings abutting other parts of the building. These areas must only be taken into account if each accommodation unit is measured separately.	**Surface area of multi-unit buildings**
PHINZ requests that the result of a blower-door test for certification purposes is also reported using the overall internal volume of the building without subtracting internal walls or floors. The reason for this is to facilitate comparison with the results of non-Passive Houses in a national airtightness database (to be established). Thank you.	**Additional reporting: overall internal volume as reference**

May 2017

Passive House Institute New Zealand
www.phinz.org.nz
enquiries@phinz.org.nz