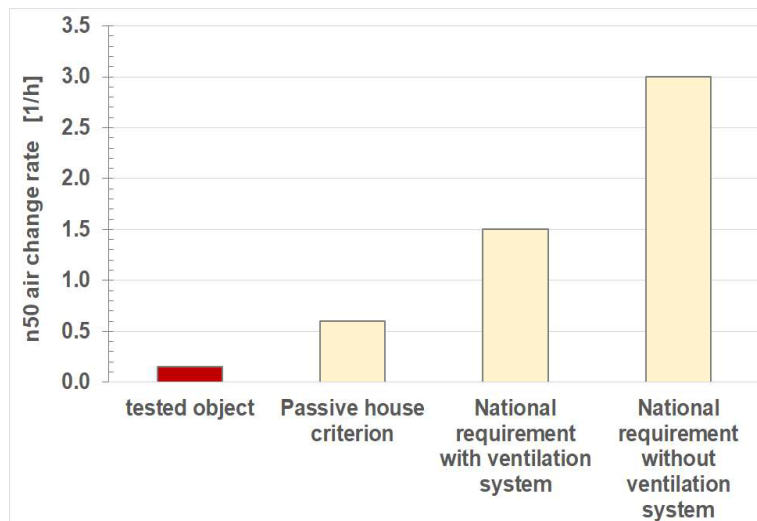


Determination of air permeability of buildings according ISO 9972:2015

Tested Object:

Villa M. Musterfrau
Testweg 1
12345 Testhausen

Test Date: 16.05.2023



Customer:

M. Musterfrau
Testweg 1
12345 Testhausen
Phone: 123456789
Email: max.musterfrau@aktiv.de

Tester:

Darmstadt, 22.05.2023 S. Peper

The test report consists of 8 pages incl. cover sheet.



Purpose of Measurement

Air permeability measurement is used to check the airtightness of the building.

Requirements according to: **PHI**

Test Result

The measurement results are based on a differential pressure of 50 Pa between the inside of the building and the outside environment (reference pressure difference).

| Test Result at 50 Pa | | | Depressurization | Pressurization | Average | Requirement ¹ |
|---|------------------------|-------------------------------------|------------------|-----------------|-----------------|--------------------------|
| Air Leakage Rate | q₅₀ | m ³ /h | 98,41 ± 1 % | 102,58 ± 3 % | 100,49 ± 2 % | - |
| Air Change Rate | n₅₀ | 1/h | 0,15 | 0,15 | 0,15 | 0,6 |
| Air Permeability | q_{E50} | m ³ /(h·m ²) | - | - | - | - |
| Specific Leakage Rate per Floor Area | q_{F50} | m ³ /(hm ²) | - | - | - | - |

¹ PHI

The limiting value ist met

Note:

With the method of air permeability measurement, certain flows in the air barrier can be detected. Other (hidden) leaks cannot be excluded.

| Test | Standard | and | Method |
|----------------|---|-----|------------------|
| Test Standard: | ISO | | 9972:2015 |
| Method: | Procedure 1 - Testing of the building in the state of use | | |

Customer

Name: Max Musterfrau

Address: Testweg 1
12345 Testhausen
Germany

Phone: 123456789

Fax:

Email: max.musterfrau@aktiv.de

Website: www.passiv.de

Business Information

Name: Passive House Institute

Address: Rheinstrasse 44/46
D-64283 Darmstadt
Germany

Phone: 0049-6151-82699-0

Fax: 0049-6151-82699-11

Email: mail@passiv.de

Website: www.passiv.de

Information Inspected Object

Label: Villa M. Musterfrau

Address: Testweg 1
12345 Testhausen
Germany

Year of Construction: 2023

Interior volume: 670 m³ (calculated according to EN 13829 or PHI)

Net floor area: - m² (calculated according to ISO 9972)

Building envelope: - m² (calculated according to ISO 9972)

Uncertainty of the reference values: 3 %

Building/room height (optional): - m

Type of heating: heat pump

Type of air conditioning: none

Type of Ventilation: Ventilation with heat recovery (passive HRV)

Measurement Series and Climate Data

Depressurization Test :

Temperature and Wind Conditions

| internal temperature (°C) | outside temperature (°C) | Barometric pressure (Pa) | wind force (Beaufort) |
|------------------------------|-----------------------------|-----------------------------|--------------------------|
| 13,0 | 15,0 | 101325 | 3 |

Baseline Pressure

before measurement

| Δp_{01} (Pa) | Δp_{01+} (Pa) | Δp_{01} (Pa) |
|----------------------|-----------------------|----------------------|
| -0,14 | 0,10 | -0,09 |

after measurement

| Δp_{02} (Pa) | Δp_{02+} (Pa) | Δp_{02} (Pa) |
|----------------------|-----------------------|----------------------|
| -0,97 | 0,39 | -0,06 |

Depressurization

| Measured Building-Pressure $\square p_m$ (Pa) | Induced Building-Pressure $\square p$ (Pa) | Fan-pressure - (Pa) | Measured airflow q_f (m ³ /h) | Corrected airflow q_{env} (m ³ /h) | Airflow at standard conditions (m ³ /h) | % Error (Regression) | Ring - |
|---|--|---------------------------|--|---|---|-------------------------|-----------|
| -66,72 | -66,64 | 36,06 | 122,49 | 121,97 | 122,53 | 0,86 | C |
| -59,36 | -59,28 | 29,95 | 111,31 | 110,83 | 111,34 | -0,13 | C |
| -59,23 | -59,15 | 29,39 | 110,19 | 109,77 | 110,28 | -0,94 | C |
| -49,63 | -49,55 | 23,36 | 97,93 | 97,51 | 97,96 | 0,21 | C |
| -46,19 | -46,11 | 20,75 | 92,12 | 91,74 | 92,16 | -0,63 | C |
| -41,24 | -41,16 | 18,09 | 85,85 | 85,46 | 85,85 | 0,61 | C |

| Leakage curve parameters | | | confidence interval (95%) | |
|--------------------------|--|------|---------------------------|------|
| | | | Min | Max |
| flow coefficient | C_{env} (m ³ / h / Pa ^{0,73}) | 5,57 | 4,50 | 6,88 |
| leakage coefficient | C_L (m ³ / h / Pa ⁿ) | 5,59 | 4,52 | 6,91 |
| flow exponent | n (-) | 0,73 | 0,68 | 0,79 |
| coeff. of determination | r^2 (-) | 1,00 | | |
| correlation coefficient | r (-) | 1,00 | | |

Pressurization Test:**Temperature and Wind Conditions**

| internal temperature (°C) | outside temperature (°C) | Barometric pressure (Pa) | wind force (Beaufort) |
|------------------------------|-----------------------------|-----------------------------|--------------------------|
| 13,0 | 15,0 | 101325 | 3 |

Baseline Pressure**before measurement**

| Δp_{01} (Pa) | Δp_{01} (Pa) | Δp_{01} (Pa) |
|----------------------|----------------------|----------------------|
| -0,02 | 0,12 | 0,10 |

after measurement

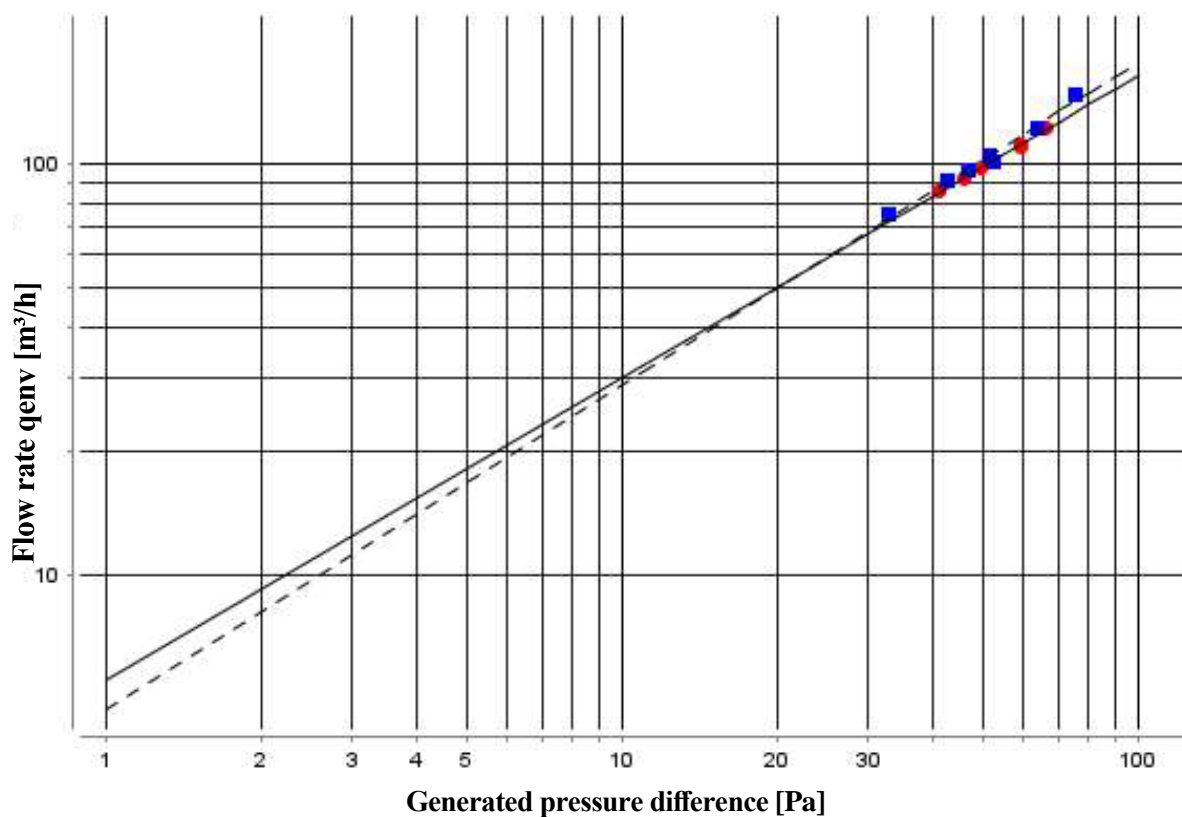
| Δp_{02} (Pa) | Δp_{02} (Pa) | Δp_{02} (Pa) |
|----------------------|----------------------|----------------------|
| -0,44 | 0,25 | -0,09 |

Pressurization

| Measured Building-Pressure $\square p_m$ (Pa) | Induced Building-Pressure $\square p$ (Pa) | Fan-pressure - (Pa) | Measured airflow q (m ³ /h) | Corrected airflow q_{env} (m ³ /h) | Airflow at standard conditions (m ³ /h) | % Error (Regression) | Ring - |
|---|--|---------------------------|--|---|---|-------------------------|-----------|
| 76,00 | 75,99 | 53,10 | 149,56 | 147,37 | 148,13 | 3,79 | C |
| 63,63 | 63,63 | 36,64 | 123,58 | 121,71 | 122,35 | -1,32 | C |
| 52,33 | 52,33 | 25,47 | 102,42 | 100,90 | 101,42 | -4,82 | C |
| 51,62 | 51,61 | 27,09 | 105,75 | 104,16 | 104,70 | -0,45 | C |
| 46,77 | 46,77 | 23,23 | 97,70 | 96,23 | 96,73 | -0,63 | C |
| 42,83 | 42,83 | 20,94 | 92,57 | 91,20 | 91,68 | 0,93 | C |
| 32,77 | 32,77 | 14,30 | 76,01 | 74,92 | 75,31 | 2,27 | C |

| Leakage curve parameters | | | confidence interval (95%) | |
|--------------------------|---|------|---------------------------|------|
| | | | Min | Max |
| flow coefficient | C_{env} (m ³ / h / Pa ⁿ) | 4,72 | 2,98 | 7,48 |
| leakage coefficient | C_L (m ³ / h / Pa ⁿ) | 4,75 | 3,00 | 7,51 |
| flow exponent | n (-) | 0,79 | 0,67 | 0,90 |
| coeff. of determination | r^2 (-) | 0,98 | | |
| correlation coefficient | r (-) | 0,99 | | |

Leakage Curve



Meas. values under-p.

Meas. values over-p.

Regress. Under-p.

Regress. Over-p.

Measurement Equipment

| device type | model description | serial number | calibration date |
|-----------------------------|---------------------------------|---------------|------------------|
| Fan | Minneapolis BlowerDoor Modell 4 | CE1234 | 01.01.2023 |
| Differential pressure gauge | DG700 | 654321 | 01.01.2023 |

Position of Air-moving Equipment

Front door

Measured extent

Entire building incl. basement (within the thermal envelope)

Condition of Building at the Time of Measurement

Building ready for occupancy

Building Preparation

Sealing of the ventilation system in the unit (outside and exhaust air)

Leakages

small leakage at the sealing of the front door (bottom)
Missing point cable penetration satellite rivet-dish (attic).
No other significant leaks were found

Comments

The measurement is based on ISO 9972

Deviations:

- the lowest pressure level was set too high (should set be 10 Pa).
- the difference between the pressure levels are not uniform.

Annex

| Volume calculation (room by room according to EN 13829) | | | | | |
|--|----------------------------|-------------------------|-----------------------|---------------|---------------|
| Villa MaxMustermann | | | | | |
| room | Net area chargeable | Clearance height | Area deduction | Height | Volume |
| Basement | | | | | |
| Basement corridor | 7.27 | 2.66 | 2.73 | 0.29 | 18.6 |
| Technics | 7.52 | 2.50 | | | 18.8 |
| Hobby room | 29.75 | 2.15 | | | 64.0 |
| Storeroom | 20.06 | 2.50 | | | 50.1 |
| 1 First floor | | | | | |
| corridor | 7.84 | 2.87 | | | 22.5 |
| WC | 2.52 | 2.87 | 0.38 | 2.87 | 6.1 |
| Hallway | 7.53 | 3.15 | 3.85 | 0.29 | 22.6 |
| Study | 16.55 | 2.87 | 0.42 | 2.87 | 46.2 |
| kitchen-living room | 30.31 | 3.22 | | | 97.5 |
| 2nd floor | | | | | |
| corridor | 10.65 | 2.80 | 5.85 | 0.29 | 28.2 |
| bedroom 2 | 14.87 | 2.52 | 0.54 | 2.52 | 36.0 |
| bedroom 3 | 14.87 | 2.52 | | | 37.4 |
| bedroom 5 | 20.03 | 2.52 | | | 50.4 |
| bathroom | 4.41 | 2.52 | 0.35 | 2.52 | 10.2 |
| Attic | | | | | |
| corridor | 7.53 | 3.45 | | | 26.0 |
| bedroom | 31.39 | 1.98 | | | 62.0 |
| Dormer | 10.19 | 2.13 | | | 21.7 |
| Bathroom | 7.53 | 3.45 | 0.46 | 2.50 | 24.8 |
| Storeroom | 20.40 | 1.38 | 0.48 | 2.50 | 26.9 |
| Total volume | | | | | 669.9 |