Passivhaus Institut
Rheinstr. 44/46, 64283 Darmstadt
Tel +49 (0)6151/826 99 0
Fax +49 (0)6151/826 99-11
mail@passiv.de / www.passiv.de

Requirements and testing procedures for energetic and acoustical assessment of Passive House (façade integrated) ventilation systems

A) Single-room decentralized ventilation – Preliminary 07/2015

1. Preface

The certification criteria applies to ventilation devices for single rooms (in residential buildings) without duct connection.

For the certification of ventilation units as Passive House components, the following requirements must be verified by a PHI-approved independent inspecting authority. All measured data and documentation must be made available to PHI.

The manufacturer must provide the independent authority with a standard unit for testing. Specially prepared appliances will not be accepted for testing and must be taken back at the cost of the manufacturer. The inspecting authority must guarantee a testing procedure in accordance with these testing regulations.

2. Requirements

In contrast to centralized units providing overflow of the airflow from supply air rooms (such as sleeping and living rooms) to functional rooms (such as kitchens and bath rooms), the double-use of the airflow isn't provided in single-room ventilation devices. In order to keep the overall ventilation heat loss similar to centralized units, a demand control strategy is highly recommended for single-room ventilation devices.

Efficiency criterion (Heat)	The effective dry heat recovery efficiency must be higher than 75 % with balanced mass flows at an outdoor air temperature of 4 °C (+/- 1 K) and dry extract air of 21 °C (+/- 1 K).

	$$\eta_{hr,t,eff} = \frac{(\vartheta_{ETA} - \vartheta_{EHA}) + \frac{P_{el}}{\dot{m} \cdot c_p}}{(\vartheta_{ETA} - \vartheta_{ODA})}$$
Control strategy	Demand control based on CO_2 or relative humidity is required in order to avoid higher ventilation heat losses compared to equivalent centralized ventilation units.
Electrical efficiency criterion	At the designed mass flow rate, the total electrical power consumption of the ventilation device may not exceed 0.45 Wh/m³.
Passive House - comfort criterion	No draught risk in living areas (which are defined with a distance of 0.5 m from the outside wall).
Leakage	The internal leakage must be lower than 3 % of the average airflow rate (according to 3.1). The external leakage must be lower than 3 % of the average airflow rate (according to 3.1) at a pressure difference of 50 Pa.
Ventilation efficiency	Without duct connection, ventilation devices have higher risks of short circuit. The short circuit inside and outside must be lower than 3 % of the average airflow rate.
Acoustic inside	Corresponding to the installation room, the sound pressure level for continuous operation shouldn't exceed 25 dB(A) in living rooms and 30 dB(A) in functional areas such as kitchens or bathrooms. For demand operation the above-mentioned requirements are not obligatory. A sound pressure level of 35 dB(A) should serve as a guiding value.
Acoustic outside	To be measured in order to provide adequate design values: Reference is made to [TALaerm98] according to which in residential areas a sound level of 35 dB(A) at nighttime is recommended.
Sound reduction index	To be measured in order to provide adequate design values: Reference is made to [DIN 4109] according to which in noise areas of category III (61-65 dB(A)) the sound reduction index of openings in the wall should be better than 30 dB.
Room air hygiene	Outdoor air filter at least F7, extract air filter at least G4.
Frost protection	Frost protection for heat exchanger without imbalance due to supply air interruption down to an outdoor air temperature of -15 °C.

Wind pressure sensitivity	Reference is made to [EN 13141-8]: With a pressure difference of +/- 20 Pa the deviation of supply and extract airflow rate shouldn't exceed 10 % of the respective higher airflow (classification S1/ EN 13141-8).
Condensate	Depending on the type of heat exchanger, condensate might occur on the exhaust air side which – at low out door temperatures - might lead to icicles. This danger should be avoided by adequate measures.

3. Measurement setup and test conditions

The following described measurement conditions apply for the installation of the unit according to practical installation conditions and manufacturer recommendations.

3.1 Certified Airflow range

In deviating from the centralized ventilation units, the certified airflow range of decentralized ventilation devices is determined according to the achievable sound level. Within the certificate two operation levels will be documented: one for continuous operation and another one for demand operation. The certified airflow range depends on the achievable sound pressure level in the respective room category.

3.2 Airtightness

External Leakage	Reference is made to EN 13141-8: The measurement is performed at a pressure difference of +/- 20 Pa (according to EN 13141-8), and at +/- 50 Pa (additional measurements in step with actual practice).
Internal Leakage	The measurement should be performed according to the tracer gas method described in [EN 13141-8]. Alternatively the measurement could be performed based on the pressure testing method according to [EN 13141-8] with an additional measurement point at +/- 50 Pa (obligatory measurement at +/- 20 Pa).

3.3 Ventilation effectiveness

Ventilation devices ventilating only one room with an air inlet and an air outlet close to each other have a higher risk of mixing exhaust air with fresh outdoor air (or fresh supply air with the extract air) due to short-circuit flow.

EN 13141-8 appendix C describes a suitable measurement procedure in order to quantify the amount of air transfer through the heat exchanger that can't be used for ventilation purpose.

3.4 Airflow balance

Constant heat recovery rates require continuously balanced operation modes irrespective of changing pressure differences in the duct work or influences of wind. The last one is especially important for devices installed in or at the façade.

EN 13141-8 describes a measurement procedure for proving the airflow balance. The following measurement must be performed for at least one ventilation level (average) and for the extract as well as for the supply air side: measurement of the airflow rates for different external pressure conditions of 0 Pa, +20 Pa and -20 Pa.

The measurement for the supply air and the extract air side can be performed simultaneously or successively.

3.5 Thermo-dynamic testing

Devices for single-room ventilation usually don't have any duct connections. After the installation of the unit according to manufacturer recommendations (with all required additional components), there is no need to consider additional external pressure differences.

The heat recovery rate is determined according to the following formula:

$$\eta_{hr,t,eff} = \frac{(\vartheta_{ETA} - \vartheta_{EHA}) + \frac{P_{el}}{\dot{m} \cdot c_p}}{(\vartheta_{ETA} - \vartheta_{ODA})}$$

The following boundary conditions should be considered for the measurements:

- outdoor air temperature 4 °C (+/- 1 K),
- extract air temperature 21 °C (+ 0 / - 1 K), dry (relative humidity ≤ 35 %),
- balanced operation mode.

Required measured data (as soon as a stationary state has been reached):

- all four humidities and temperatures,
- supply airflow rate and extract airflow rate,
- electric power consumption of the whole device.

Note:

- The airflow balance is proven with an additional measurement.
- The measurement set-up should consider a compensation for additional pressure drops that might be necessary in order to provide accurate measurements.

Deviating from the above described test, it is also possible to determine the heat recovery efficiency by means of a calorimetric measurement. A test set-up for such measurements provide measurements of the energy required to keep certain pre-set air conditions in balance. It is recommended to agree upon measurement details with PHI before the measurement starts.

3.6 Electrical efficiency

The electric power consumption is measured at the upper airflow rate (or at the demand operation level) along with the thermodynamic measurement.

3.7 Acoustical testing

3.7.1 Sound emission of the apparatus

The measurement of the acoustic power emitted by the ventilation unit is according to DIN EN ISO 3743-1 or DIN°EN°ISO 3741 (installation of the device according to manufacturer's instructions). The test should be performed at several airflow rates, that afterwards the continuous operation mode and demand operation mode can be clearly defined.

The test is to be performed for the sound power emitted to inside and outside, which leads to two test set-ups, the measurement of the sound emitted to the inside is more critical.

3.7.2 Sound reduction index

The measurement of the sound insulation of the ventilation device integrated in the façade is to be performed according to ISO 10140-2, which describes a measurement of airborne sound insulation.

3.8 Frost protection

In order to prevent the heat exchanger from icing, a suitable frost protection strategy without imbalance due to supply air interruption is required.

A suitable frost protection test is described in [PHI frost]. Potential deviations from the described frost protection test (e.g. due to different frost protection measures) are to be discussed with PHI before the measurement starts.

3.9 Comfort criterion

A comfortable supply air intake is required, which can be achieved either with adequate supply air temperature or with an air inlet allowing comfortable conditions in the living area (according to ISO [ISO 7730])

Measurements of the air temperature and velocity in the living area (which is defined with distance of 50 cm from the outdoor wall) are recommended in order to prove the draught free air inlet.

3.10 Standby

The electrical power consumption of the ventilation unit (including controls, as well as any essential external systems) is to be ascertained purely for stand-by operation of the apparatus. In the stand-by mode, a consumption of 1 W should not be exceeded, otherwise the manufacturer should provide the possibility of a complete disconnection from the electrical supply as a standard.

3.11 Restart after power failure

It must be ensured that the apparatus automatically starts regular operation after a power failure without any user intervention. The operation must be continued at the same setting as prior to the power failure. The test is to be carried out by pulling out the main plug and waiting for ten minutes.

Literatures references

[PHI 09] Requirements and testing procedures for energetic and acoustical assessment of Passive House ventilation systems < 600 m³/h for Certification as Passive House suitable component, Passivhaus Institut, 2009

[PHI frost] Supplementary test of frost protection, Passivhaus Institut, 2014

[EN 13141-8] Ventilation for buildings – Performance testing of components/ products for residential ventilation – Part 8: Performance testing of un-ducted mechanical supply and exhaust ventilation units (including heat recovery) for mechanical ventilation systems intended for a single room, EN 13141-8: 2014

[EN ISO 3743-1] Acoustics -- Determination of sound power levels and sound energy levels of noise sources using sound pressure -- Engineering methods for small

movable sources in reverberant fields -- Part 1: Comparison method for a hard-walled test room; 2010

[EN°ISO 3741] Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure -- Precision methods for reverberation test rooms; 2010

[DIN 4109] Schallschutz im Hochbau – Anforderungen und Nachweise, DIN 4109: 1989, DIN Deutsches Institut für Normung e.V., Berlin

[TA Laerm] Sechste Allgemeine Verwaltungsvorschritf zum Bundes-Immissionsschutzgesetz (Technische Anleitung zum Schutz gegen Lärm – TA Lärm), 1998

[ISO 10140-2] Acoustics-Laboratory measurement of sound insulation of building elements part 2: measurement of airborne sound insulation, ISO 10140-2:2010

[ISO 7730] Ergonomics of the thermal environment – Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria; 2005