

## **Testing procedure for the energy-relevant and acoustic assessment of large Passive House ventilation units for certification as “components suitable for Passive Houses” (as at 11-2018, provisional)**

For assessing whether a ventilation device can be certified as a “component suitable for Passive Houses” by the Passive House Institute, at least the following tests must be carried by an inspection authority that has been approved by the PHI. All measured data and documentation by the testing authority must be made available to the PHI in full.

The manufacturer is obliged to deliver a model of the device from the series for testing by the independent testing authority. Specially prepared devices will not be accepted for testing and will be sent back at the cost of the manufacturer.

### **1 Applicability**

The testing criteria apply for central ventilation units with volumetric air flow rates from 600 m<sup>3</sup>/h. The criteria will only apply for recuperative heat exchangers initially. The test criteria for regenerative heat exchangers will be added later.

The classification of the central ventilation units into categories will take place in accordance with Table 1.

**Table 1: Classification of the ventilation units**

<b>Use Category</b>	<b>Range of volumetric flow</b>	<b>Area of application</b>
I Res. *)	600 to 2.000m <sup>3</sup> /h	Residential buildings
I Non-res. *)	600 to 2.000m <sup>3</sup> /h	Non-residential buildings
II	from 2.000 to 5.000m <sup>3</sup> /h	Non-residential/residential buildings
III	from 5.000 to 10.000m <sup>3</sup> /h	Non-residential/residential buildings
IV	from 10.000 to 15.000m <sup>3</sup> /h	Non-residential/residential buildings

\*) In residential constructions, the drop in pressure of the duct system is usually smaller than it is in non-residential buildings. The differential pressure that is to be used is therefore lower for the "I Res." category. If the testing criteria for "I Non-res." use are met, then the ventilation unit is also suitable for use in the "I Res." category.

## **2 Airtightness test**

The airtightness test should be carried out in accordance with the DIBt guidelines for negative as well as positive pressures before the start of the thermodynamic testing. The leakage volumetric flows thus ascertained should not be greater than 3% of the average volumetric flow in the area of application of the ventilation unit. The boundaries of the area of application are determined as explained in the Section about "Thermodynamic testing".

- Test pressure inside up to 400 Pa over-pressure and under-pressure
- Test pressure outside up to 400 Pa over-pressure and under-pressure

## **3 Exhaust air transfer**

The transfer of exhaust air in central ventilation units with regenerative heat exchangers must be measured in accordance with EN 308.

## **4 Thermodynamic testing**

The testing method for the thermodynamic test is mainly based on the guidelines of the DIBt, but with the following exceptions:

- The outdoor and exhaust air mass flows are adjusted for accuracy of measurement at the device (if the fans are not automatically regulated).
- All volumetric flows (ODA/EXA + SUP/ETA) are measured and recorded.
- Air temperature and humidity of all volumetric flows (ODA/EXA + SUP/ETA) are measured and recorded.

- The external air temperature should be as low as possible, but still high enough to ensure that condensation does not occur in the heat exchanger due to the humidity present in the external and exhaust air.
- The total electrical power consumption of the unit (including that of adjustment control) should be ascertained and recorded during the measurements.
- It should be ensured and substantiated by means of the documented measured data that the overall experimental setup has achieved a steady state for each of the series of measurements.

The application area of the volumetric flows is specified by the manufacturer. Before starting the thermodynamic test it must be checked whether the requirements for electrical efficiency even with maximum mass flows are complied with. The test facility measurement must be carried out for the following fresh air mass flows:

- if  $q_{\min}/q_{\max} > 0.77$ , then the test facility measurement must be carried out for  $q_{\max}$  at least.
- if  $0.77 \geq q_{\min}/q_{\max} > 0.62$ , then the test facility measurement must be carried out for  $q_{\max}$  and  $q_{\min}$  at least.
- if  $q_{\min}/q_{\max} \leq 0.62$ , then the test facility measurements must be carried out for three fresh air mass flows:  $q_{\max}$ ,  $(q_{\max} + q_{\min})/2$  and  $q_{\min}$

The required differential pressure (external pressure) depends on the category of the volumetric flow of the ventilation unit. The values can be found in Section 5. The applied external pressure decrease should be distributed evenly on the intake and pressure side (i.e. about 50% on each side).

The overall electrical power consumption of the unit (including that for adjustment control) should be determined for the standby operation as well as for the duration of the thermodynamic testing.

The measurements should take place at room temperature ( $21\text{ °C} \pm 2\text{ K}$ ).

## 5 External pressure

If just the unit with the heat exchanger and the fans is considered as the central device, then the filters (external air ISO ePM1 50%, exhaust air at least ISO Coarse 60%) and any post-heating coils or pre-heating coils for frost protection will be counted as the external pressure. The overall external pressure is determined in accordance with Table 2.

If filters or heater coils are already integrated into the device, their pressure drop is measured and deducted from the overall external pressure. Limit values are given as upper limits for the filter and the heater coil (filter: maximum 50Pa)

**Table 2: Required differential pressure subject to the category of volumetric flow.**

<b>Use Category</b>	<b>Range of volumetric flow</b>	<b>Overall differential pressure required for the measurement (external pressure) [Pa]</b>
I Res.	600 to 2.000m <sup>3</sup> /h	230
I Non-res.	600 to 2.000m <sup>3</sup> /h	270
II	from 2.000 to 5.000m <sup>3</sup> /h	320
III	from 5.000 to 10.000m <sup>3</sup> /h	360
IV	from 10.000 to 15.000m <sup>3</sup> /h	400

## **6 Measuring the power consumption and determining the standby losses**

The overall electrical power consumption of the unit (including that for adjustment control) should be determined for standby operation as well as for the duration of the thermodynamic testing.

### **Measuring the power consumption for adjustment control**

In contrast with small home ventilation units, large ventilation units do not always have an adjustment control mechanism integrated into or supplied with them.

If a regulating mechanism is not supplied with the device, an overall general value is allowed for the specific power consumption.

### **Electrical efficiency**

The limit value for the specific power consumption is set at 0.45 Wh/m<sup>3</sup> for the scale of external pressures described above.

## **7 Certification of a model range**

If devices are offered in various sizes by the manufacturer, then certificates can be issued for the whole model range in certain cases, if the measured values are adhered to with an accuracy of +/- 1.5 percentage points at three interpolation points using the manufacturer's software.

## **8 Soundproofing**

It can be assumed that large devices will be installed in utility rooms. The limit values correspond with the respective standards applicable for the utilisation. The measurement of the sound power radiated by the device is carried out in accordance with DIN EN ISO 3743-1 (installation of the device in the testing rooms in accordance with manufacturer's instructions).

Additionally, the sound power is measured in the outdoor/exhaust /extract/supply air ducts in accordance with DIN EN ISO 5136 (October 2003). The measurement results are given in third octave bands (31.5 Hz – 8000 Hz). Suitable sound absorbers should be suggested for complying with the required 25 dB(A) (residential buildings) or 30dB(A) (special buildings).

The acoustic measurements should take place at maximum fresh air mass flow  $q_{\max}$  (see Section 4).

## **9 Comfort criterion**

Evidence of compliance with a minimum supply air temperature of 16.5°C upto –10°C outdoor air temperature should be provided.

The measurement is carried out at a maximum fresh air mass flow  $q_{\max}$  (see Section 4).

## **10 Frost protection shutdown for hydraulic heater coils in the supply air**

In order to prevent frost damage to any downstream hydraulic heater coils (Passive House fresh air heating), the device must have an emergency shutdown for the supply air fan (with a corresponding error message) if the supply air temperature falls below ca.+5°C. This is tested by closing the exhaust air nozzle and decreasing the external air temperature.

## **11 Checking the frost protection shutdown for the heat exchanger**

The frost protection of the device must be ensured for standard operation of the device (in the balanced state). The procedure for adjusting the temperature limit for the frost protection must be described clearly in the assembly instructions supplied with the device. If an internal frost protection mechanism is not present in the device to be tested, the measurement should be carried out using a suitable external apparatus and recorded appropriately.

## **12 Miscellaneous**

All the test rules mentioned apply for typical cases. For uncommon types of devices, other or additional examinations may be needed. It is suggested that these are coordinated with the Passive House Institute at an early stage.

If individual air conditions cannot be achieved through the equipment available in the particular test facility, an arrangement should be made with the PHI early on, which approximates the intention of the requirement as far as possible.

## 13 Criteria

Due to the possibility of dispensing with a separate heating system, Passive Houses place high demands in terms of the quality of the building components used. A highly efficient heat recovery unit is an essential component of comfort ventilation in the Passive House.

The PHI stipulates the following requirements for the “Component suitable for Passive Houses – Heat recovery unit” certificate (details and explanations are included in the Appendix to the certificate):

Passive House comfort criterion	Minimum supply air temperature of 16.5°C
Efficiency criterion (heat)	<p>The effective dry heat recovery efficiency must be greater than 75% with balanced mass flows at outdoor temperatures between – 15 and + 10 °C and dry extract air (ca 20 °C).</p> $\eta_{\text{WRG,t,eff}} = \frac{(\mathcal{G}_{Ab} - \mathcal{G}_{Fo}) + \frac{P_{el}}{\dot{m} \cdot c_p}}{(\mathcal{G}_{Ab} - \mathcal{G}_{Au})}$
Electrical efficiency criterion	The total electrical power consumption of the ventilation unit for the designed mass flow may not exceed 0.45W per (m <sup>3</sup> /h) of transferred volumetric fresh air flow.
Adjustment and controllability	It must be possible to balance the supply air and extract air mass flows with a nominal volumetric flow.
Indoor air hygiene	fresh air filter at least ISO ePM1 50%, exhaust air filter ISO Coarse 60%
Frost protection	<p>Frost protection for heat exchangers without interrupted fresh air supply, frost protection for post-heating coils in case of failure of the extract air fan or the frost protection heater coils.</p> <p>If frost protection is not planned for the heat exchanger in the unit, then the manufacturer should suggest solutions which will enable operation without interruption of the fresh air supply.</p> <p>If no postheating coils are integrated into the central unit, then the manufacturer must at least recommend suitable measures for frost protection of downstream postheating coils.</p>

## **Testing procedure for the energy-relevant and acoustic assessment of large Passive House ventilation units for certification as “components suitable for Passive Houses” (as at 11-2018)**

### **Amendment: External pressure requirements**

Values for the desired overall differential pressure (external pressure) [Pa] will be presented below subject to the operational range of the volume flow rate. The external pressure applies for volume flow rates that exceed the given volumetric fresh air flow (e.g. an external pressure of 190Pa is required for a volume flow rate greater than 600m<sup>3</sup>h, requirement for non-residential buildings). The maximum volume flow rate of the operational range is relevant for determining the external pressure.

With reference to the definition of external pressure, if just the device with the heat exchanger and the fans is considered as the central device, then the filters (external air ISO ePM1 50%, exhaust air at least ISO Coarse 60%) and any post-heating coils or pre-heating coils for frost protection will be counted as the external pressure. If filters or heater coils are already integrated into the device, their pressure drop is measured and deducted from the overall value of the external pressure. Limit values are given as upper limits for the filter and the heater coils.

Depending on the area of application, a distinction is made in the requirement for the differential pressure that is to be used. In residential constructions, the drop in pressure of the duct system is usually smaller than it is in non-residential buildings. The differential pressure that is to be used is therefore lower for the testing criterion “residential”. If the testing criteria for “non-residential” use are met, then the ventilation unit is also suitable for use in residential buildings.



## Amendment: External pressure requirements

Volumetric fresh air flow [m <sup>3</sup> /h]	External pressure [Pa]	
	Requirement for non-residential buildings	Requirement for residential buildings
upto 600m <sup>3</sup> /h	190	155
upto 650m <sup>3</sup> /h	195	160
upto 700m <sup>3</sup> /h	200	165
upto 750m <sup>3</sup> /h	204	169
upto 800m <sup>3</sup> /h	208	173
upto 900m <sup>3</sup> /h	215	180
upto 1000m <sup>3</sup> /h	222	187
upto 1100m <sup>3</sup> /h	228	193
upto 1200m <sup>3</sup> /h	233	198
upto 1300m <sup>3</sup> /h	238	203
upto 1400m <sup>3</sup> /h	243	208
upto 1500m <sup>3</sup> /h	247	212
upto 1600m <sup>3</sup> /h	251	216
upto 1700m <sup>3</sup> /h	255	220
upto 1800m <sup>3</sup> /h	259	224
upto 2000m <sup>3</sup> /h	265	230
upto 2200m <sup>3</sup> /h	271	236
upto 2400m <sup>3</sup> /h	276	241
upto 2600m <sup>3</sup> /h	281	246

Volumetric fresh air flow [m <sup>3</sup> /h]	External pressure [Pa]
	Requirement for non-residential buildings
upto 2800m <sup>3</sup> /h	286
upto 3000m <sup>3</sup> /h	290
upto 3200m <sup>3</sup> /h	294
upto 3400m <sup>3</sup> /h	298
upto 3600m <sup>3</sup> /h	302
upto 4000m <sup>3</sup> /h	308
upto 4500m <sup>3</sup> /h	316
upto 5000m <sup>3</sup> /h	322
upto 5500m <sup>3</sup> /h	328
upto 6000m <sup>3</sup> /h	333
upto 6500m <sup>3</sup> /h	338
upto 7000m <sup>3</sup> /h	343
upto 7500m <sup>3</sup> /h	347
upto 8000m <sup>3</sup> /h	351
upto 8500m <sup>3</sup> /h	355
upto 9000m <sup>3</sup> /h	359
upto 10000m <sup>3</sup> /h	365
upto 11000m <sup>3</sup> /h	371
upto 12000m <sup>3</sup> /h	376
upto 13000m <sup>3</sup> /h	381
upto 14000m <sup>3</sup> /h	386
upto 15000m <sup>3</sup> /h	390

## **Testing conditions for energy and sound evaluation of large ventilation units (> 600 m<sup>3</sup>/h) for certification as „Passive House suitable component“ (11/2014)**

### **Addition: Requirements for regenerative heat exchangers**

#### **Internal airtightness/ Extract air transport**

The unintended transport of extract air to the supply air stream should be measured using the tracer-gas method following e.g. EN 308. External pressure should be redistributed as follows: 1/3 on outside/exhaust air side and 2/3 on supply/extract air side.

For the measurements, an airflow rate at the upper limit of the certified range should be used. The airflows at the outside/exhaust air side must be balanced. The external pressure must correspond to PHI testing procedures.

Determined air leakages cannot be higher than 3% of the average airflow of the certified airflow range. By proper construction (i.e. correct positioning of the fans and purge chamber), even better values can be reached (< 0.5 %), which is recommended by PHI.

For units with discontinuous operation (i.e. alternating airflow direction), the effective average value shall be determined over a sufficiently long measurement period.

Depending on the functional principle of unit, odours and aerosols could be transferred from the extract air stream to the supply air stream. This is of particular significance in industrial kitchens. The appropriateness of regenerative heat exchangers must be evaluated for each project, especially in cases where odours and aerosols could be transmitted to different occupied areas (e.g. different flats in multi-family homes).

#### **Purge air and heat recovery efficiency**

In order to avoid the transfer of pollution from the extract to the supply air stream, a purge chamber for the exchanger, which uses additional outside air, is often installed. The mass flows on the outside/exhaust air side in case of optimal airtight device differ by the amount of the purge air. (1).

$$m_{PA} = m_{ODA} - m_{SUP} \quad [1]$$

This does not influence the operational airflow range, where the supply air stream should be used for its definition.

The amount of purge air should be taken into account when calculating the heat recovery efficiency (2).

$$\eta_{HR,eff} = \frac{m_{SUP} \cdot \vartheta_{ETA} + m_{PA} \cdot \vartheta_{ODA} - m_{ODA} \cdot \vartheta_{EHA} + \frac{P_{el}}{c_p}}{m_{SUP} \cdot (\vartheta_{ETA} - \vartheta_{ODA})} \quad [2]$$

## Nomenclature

$m_{SUP}$	Supply air mass flow	[kg/h]
$m_{PA}$	Purge air mass flow	[kg/h]
$m_{OUT}$	Outdoor air mass flow	[kg/h]
$m_{DIS}$	Disbalance mass flow	[kg/h]
$m_{EHA}$	Exhaust air mass flow	[kg/h]
$\vartheta_{ETA}$	Extract air temperature	[°C]
$\vartheta_{ETA}$	Outdoor air temperature	[°C]
$\vartheta_{ETA}$	Exhaust air temperature	[°C]
$P_{el}$	Electric consumption	[W]
$c_p$	Specific heat capacity of the air	[Wh/(kg.K)]
$\eta_{HR,eff}$	Effective heat recovery efficiency	[-]

## **Testing procedure for the energy-relevant and acoustic assessment of large Passive House ventilation units for certification as “components suitable for Passive Houses” (06/2020)**

### **Supplementary Sheet: Moisture Recovery for ventilation units > 600 m<sup>3</sup>/h**

For the central ventilation units with moisture recovery the moisture recovery rate can be additionally determined.

The general testing procedure for the energy-relevant and acoustic assessment of large Passive House ventilation units for certification as “components suitable for Passive Houses” [1] are not affected by this supplement. The experimental set-up described in the main document applies for all tests, unless otherwise specified. For devices with a regenerative operation (rotors) the respective supplementary sheet is also to be considered.

The moisture recovery is determined for the standardised extract air conditions of 21°C/50% rH and for outdoor air conditions of 4°C/80% rH.

$$\eta_x = \frac{x_{AB} - x_{FO}}{x_{AB} - x_{AU}} \quad [5]$$

The moisture recovery will be listed in the certificate.

In order to prevent damage from occasional excessive humidity, units with a moisture recovery of  $\eta_x > 0.6$  must have a regulated air flow rate, which is controlled by the indoor air humidity. For certification, the method of regulation should be explained.

## Symbols and abbreviations

$\eta_x$	Moisture recovery	[-]
$x_{AB}$	Absolute humidity extract air	[g/kg]
$x_{FO}$	Absolute humidity exhaust air	[g/kg]
$x_{AU}$	Absolute humidity outdoor air	[g/kg]

[1] Testing procedure for the energy-relevant and acoustic assessment of large Passive House ventilation units for certification as “components suitable for Passive Houses” (as at 11-2018, provisional)