Provisional criteria and calculation rules for Certified **Passive House**

Flue Systems

In cool, temperate climates, version 1.01, 12 September 2012

The criteria presented in this document are provisional. They still need to be validated in practice and are therefore subject to change**.**

Contents

1 Definition

Flue systems as referred to in this document ensure the supply of combustion air and removal of flue gases in combination with a room-sealed fireplace and ventilation system.

2 Functional requirements

Passive House buildings provide an optimum standard of thermal comfort with a minimal heating demand. In order to achieve this level of comfort, stringent requirements relating to thermal characteristics and building physics apply for components used in Passive Houses. These requirements are directly derived from the hygiene criterion and the thermal comfort criterion for Passive Houses:

2.1 Hygiene criterion

Maximum water activity (interior building components): $a_w \leq 0.80$

Mould growth may occur if water activity exceeds a value of 0.80.

In cool, temperate climates, the hygiene criterion is met if the minimum temperature factor is

$f_{Rsi=0.25\ m^2K/W} = 0.7$.

Boundary condition:

- Heat transfer resistances: $R_{si} = 0.25\ m^2K/W$

  $R_{se} = 0.04\ m^2K/W$

Verification is carried out by means of two-dimensional, or where necessary, three-dimensional heat flow simulations. Reference is made to ISO 10211 for the heat flow simulations.

2.2 Thermal comfort criterion

Minimum temperature of interior surfaces: $\boldsymbol{\theta_{si} \geq \theta_{op} - 4.2K}$

In contrast with the average operative temperature of the room, (which is 21.2 °C here); the minimum surface temperature must not differ by more than 4.2 K. With a larger difference, unpleasant down draft and radiation losses may occur.

In cool, temperate climates, this criterion is achieved for an average surface temperature of $\boldsymbol{\theta_{si} \geq 17°C}$ through the exterior surface of the uninterrupted building component. The lowest surface temperature may not differ by more than 10% from the minimum average surface temperature of 17°C. The thermal comfort criterion is applied only for the uninterrupted building components and not for penetrations.

Boundary conditions:

- Exterior temperature: $\theta_e = -10.0$ °C
- Interior temperature: $\theta_i = 20.0$°C
- Heat transfer resistance: $R_{si} = 0.13\ m^2K/W$

  $R_{se} = 0.04\ m^2K/W$

The exterior temperature should be used to ascertain the surface temperature inside the flue or supply air pipe.

Verification is carried out by means of two-dimensional heat flow simulations. The average surface temperature is determined as follows:

$$\theta_{Si,average} = \theta_i - R_{Si} * Q_{2D} / l_{circ}$$

with

$\theta_{Si,average}$: average temperature of the interior surface [°C]

θ_i: interior temperature [°C]

R_{Si}: interior heat transfer resistance [m²K/W]

Q_{2D}: heat flow from two-dimensional heat flow calculation [W/m]

l_{circ}: circumference of the flue inside the building [m]

3 Airtightness criteria

The maximum air change rate in the tested flue system is: **$V_{50} \leq$ 1.0 m³/(mh)**
(the additional leakage air exchange through the flue system must not jeopardise the functioning of the Passive House itself and must remain below 1.0 m³ per hour per meter of the flue system, at a pressure difference of 50 Pa.)

Verification of airtightness takes place using a 2-storey reference system inside the building, which must include the following components: base component, access hatches for chimney maintenance, flue tube connection, ceiling penetration and roof penetration. The overall leakage rate of the system must be ascertained and set in relation to the height of the flue system within the airtight layer. Alternatively, the individual components that have been mentioned can be tested, their values added and set in relation to the reference height.

If the certified component is to be used in a Passive House, it must be installed by the time the airtightness measurement (blower door test) is carried out for the building. The leakage due to the flue system must fulfil the Passive House criterion for airtightness in buildings ($n_{50} \leq 0.6$ 1/h). The construction itself, as well as the connection to the airtight layer of the building, must be carried out in an airtight manner. Appropriate connection possibilities for this must be determined.

For certification, it is required that the attached fireplace is equipped with flaps or slide valves that close tightly enough so that convective losses inside or through the chimney are reduced to a reasonable minimum when not in use. Alternatively, a shut-off device can be incorporated into the flue gas or combustion air pipes of the chimney if permitted by building regulations.

Verification of the airtightness criterion

The airtightness requirement of $V_{50} \leq 1.0$ m³/(mh) for the flue system can be verified by means of airtightness measurements at the test stand. In order to assess the airtightness of the flue system as a whole, examination of a two-storey reference flue system is carried out, which is set up as follows:

- one of each: flue tube connection, maintenance hatch, base component, penetration
- penetration through the floor/wall, if the combustion air is not taken in through the roof
- flue gas pipe (e.g. fireplace elements) without built-in parts. Total height 5 m
- combustion air pipe (additionally, if not integrated into flue gas pipe).

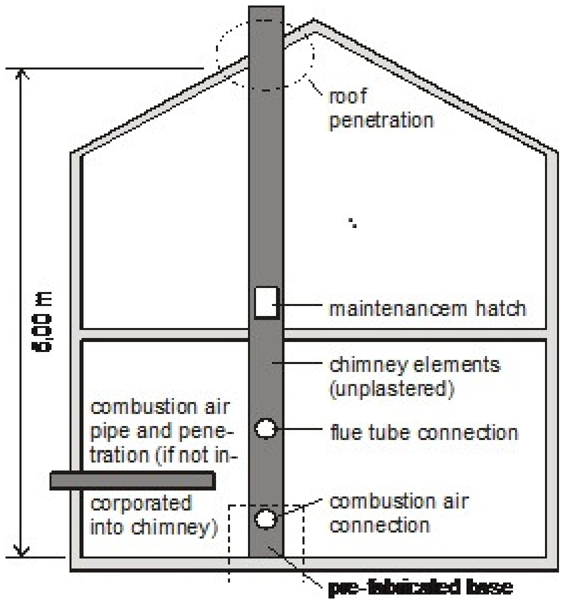

Figure 1: Schematic structure of the two storey reference chimney.

The flue system is tested using the structure in Figure 1. The air exchange due to leakages is divided by the chimney height. Alternatively, the system's air exchange due to leakages can be determined via the leakage rate of the individual components:

If determination of the individual component leakage is chosen, then the volume flow rates due to the leakages of each component are added divided by the length of the system:

  Leakage volume flow rate of flue tube connection [m^3/h/unit]
\+ Leakage volume flow rate of combustion air connecting pieces [m^3/h/unit]
\+ Leakage volume flow rate of base components [m^3/h/unit]

+ Leakage volume flow rate of maintenance hatches [m^3/h/unit]
+ Leakage volume flow rate of roof penetrations
+ Leakage volume flow rate of floor or wall penetration, if present
+ Leakage volume flow rate of chimney wall elements [m^3/h/m] * number required to achieve the reference height of 5 m
+ Leakage volume flow rate of joints between chimney wall elements * number of joints
= Leakage volume flow rate of the 2-storey flue system [m^3/h]
÷ Length of the flue system [5 m]
= Leakage rate of the flue per metre [m^3/(mh)]

Note: It is also admissible to combine the leakage volume flow rates of several individual components in a single measurement.

4 Safety criteria

The flue system must allow efficient operation of the fireplace and must also be implemented in a sufficiently soot-fire resistant, condensation-proof and corrosion resistant manner. It must be capable of operation independent from indoor air. Verification of this is carried out through W3G identification in accordance with EN 1443. The requirements must be met without rear-ventilation. Verification can either take place internationally by means of a European Technical Approval, or through national approval or certificate of conformity based on the relevant system norms.

The flue system must ensure removal of the flue gases at all times. In the process, a fireplace suitable for operation independent from indoor air must be used so that reliable functionality is assured in combination with the airtight building envelope and the ventilation system obligatory for Passive Houses (see certification criteria for Passive House ventilation systems). Verification of suitability of used fireplaces should be provided separately.

5 Spatially separate conduction of combustion air from flue gas

If spatially separate conduction of combustion air from flue gas e.g. through the exterior wall, basement or floor slab is possible with the system, then the applicable criteria will apply, with the exception of the W3G requirement for combustion air conduction. Identical pressure conditions must be ensured for the combustion air and flue gas pipes. The combustion air pipe must be installed in a way that allows it to be dismantled.

6 Relevant values in the certificate

The following values are displayed in the certificate or data sheet:

- Leakage volume flow rates of the individual components.
- Leakage volume flow rate of the reference system, based on a one metre length of the flue system.
- Thermal bridge loss coefficient (linear) of the system (thermal bridge loss coefficient of both conduits in case of separate flue gas and combustion air) at comfort criteria boundary conditions.
- Thermal bridge loss coefficient (point thermal bridge) of all penetrations through the flue system (including combustion air conduit) or weakening of the thermal building envelope with two variants (in case of roofs: at least one flat roof and one sloped roof (inclination 45°) at comfort criterion conditions.
- Average and minimum surface temperatures at the comfort criterion boundary conditions.
- The minimum temperature factor at the boundary conditions of the hygiene criterion.

7 Using the thermal bridge loss coefficient in the PHPP

The linear thermal bridge loss coefficient of the chimney is reduced by a factor of 1 and multiplied by the storey height for the storey at which the flue system penetrates the thermal envelope. Since the temperature of the air in the flue system adapts to the indoor temperature with increasing distance from the opening, the reduction factor can be halved for each further storey.

Point thermal bridge loss coefficients for penetration of exterior components are applied in full and multiplied by the applicable reduction factor.