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Criteria for the Passive House, EnerPHit and PHI Low Energy Building Standard

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1 Introduction

1.1 Structure of the criteria

The present document contains the complete criteria for the energy standards for buildings as defined by the Passive House Institute (PHI). The specific criteria for the three standards are specified in the first three subsections of Section 2 “Criteria". The requirements given in Section 2.4 "General minimum criteria for all Standards" must also be complied with irrespective of the chosen energy standard. Evidence of compliance with the criteria shall be provided using the Passive House Planning Package (PHPP) with the application of the boundary conditions listed in Section 2.5 "Boundary conditions for the PHPP calculation”.

If a building is to be certified by the Passive House Institute or one of the certifiers accredited by PHI, the examination shall take place in accordance with Section 3 "Technical regulations for building certification”. The documents to be submitted for the certification process are listed in Section 3.2.

1.2 Changes in this version of the certification criteria

Previously there were three separate documents with criteria for residential Passive House buildings, non-residential Passive House buildings and for EnerPHit retrofits. These have now been combined in one document and supplemented with the criteria for the new PHI Low Energy Building Standard. There are no longer any separate documents for residential and non-residential buildings.

The criteria were extended with regard to the following aspects:

- A new evaluation procedure based on Primary Energy Renewable (PER) which was recently developed by the Passive House Institute has been integrated. For the Passive House or EnerPHit Standard, one of the three classes Classic, Plus and Premium can now be achieved depending on the PER demand and the renewable energy generated. The requirement for the PER demand replaces the previous requirement for the non-renewable primary energy demand (PE); however, the old method based on PE may continue to be used in parallel during a transitional phase (only for the Classic and PHI Low Energy Building categories).
- The EnerPHit criteria for modernisation of existing buildings using Passive House components were previously only valid for the cool, temperate climate. They are now applicable worldwide. The requirements conform to classification in seven climate zones.
- The previous restriction to a cool, temperate climate ceases to apply also in the case of non-residential Passive House buildings.

Additionally, the criteria have been completely revised and restructured with the purpose of making them clearer and more comprehensible. The previous external document relating to the so-called "soft criteria" no longer applies. These criteria have been more precisely defined and integrated into the actual criteria.

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1.3 Coming into effect

This update of the criteria comes into effect with the release of version 9 of the Passive House Planning Package (PHPP). English PHPP 9 has been released on October 1st 2015. As other language versions of PHPP 9 are released subsequently, this new version of the criteria comes into effect later for users of these versions.

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2 Criteria

2.1 Passive House Standard

Passive Houses are characterised by an especially high level of thermal comfort with minimum energy consumption. In general, the Passive House Standard provides excellent cost-effectiveness particularly in the case of new builds. The categories Passive House Classic, Plus or Premium can be achieved depending on the renewable primary energy (PER) demand and generation of renewable energy.

Table 1 Passive House Criteria

			Criteria[1]			Alternative Criteria[2]
Heating						
Heating demand	[kWh/(m²a)]	≤	15			-
Heating load[3]	[W/m²]	≤	-			10
Cooling						
Cooling + dehumidification demand	[kWh/(m²a)]	≤	15 + dehumidification contribution[4]			variable limit value[5]
Cooling load[6]	[W/m²]	≤	-			10
Airtightness						
Pressurization test result n_{50}	[1/h]	≤	0.6			
Renewable Primary Energy (PER)[7]			Classic	Plus	Premium	
PER demand[8]	[kWh/(m²a)]	≤	60	45	30	±15 kWh/(m²a) deviation from criteria...
Renewable energy generation[9] (with reference to projected building footprint)	[kWh/(m²a)]	≥	-	60	120	...with compensation of the above deviation by different amount of generation

[1] The criteria and alternative criteria apply for all climates worldwide. The reference area for all limit values is the treated floor area (TFA) calculated according to the latest version of the PHPP Manual (exceptions: generation of renewable energy with reference to projected building footprint and airtightness with reference to the net air volume).

[2] Two alternative criteria which are enclosed by a double line together may replace both of the adjacent criteria on the left which are also enclosed by a double line.

[3] The steady-state heating load calculated in the PHPP is applicable. Loads for heating up after temperature setbacks are not taken into account.

[4] Variable limit value for the dehumidification fraction subject to climate data, necessary air change rate and internal moisture loads (calculation in the PHPP).

[5] Variable limit value for cooling and dehumidification demand subject to climate data, necessary air change rate and internal heat and moisture loads (calculation in the PHPP).

[6] The steady-state cooling load calculated in the PHPP is applicable. In the case of internal heat gains greater than 2.1 W/m² the limit value will increase by the difference between the actual internal heat gains and 2.1 W/m².

[7] The requirements for the PER demand and generation of renewable energy were first introduced in 2015. As an alternative to these two criteria, evidence for the Passive House Classic Standard can continue to be provided in a transitional phase by proving compliance with the previous requirement for the non-renewable primary energy demand (PE) of $Q_P \leq 120$ kWh/(m²a). The desired verification method can be selected in the PHPP worksheet "Verification". The primary energy factor profile 1 in the PHPP should be used by default unless PHI has specified other national values.

[8] Energy for heating, cooling, dehumidification, DHW, lighting, auxiliary electricity and electrical appliances is included. The limit value applies for residential buildings and typical educational and administrative buildings. In case of uses deviating from these, if an extremely high electricity demand occurs then the limit value can also be exceeded after consultation with the Passive House Institute. Evidence of efficient use of electrical energy for all significant devices and systems is necessary for this with the exception of existing devices which have already been owned by the user previously and for

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which an improvement of the electrical efficiency by means of upgrading or renewal would prove uneconomical over the lifecycle.

[9] Renewable energy generation plants which are not spatially connected to the building may also be taken into account (except for biomass use, waste-to-energy plants, and geothermal energy): only new systems may be included (i.e. systems which did not start operation before the beginning of construction of the building) which are owned by the building owner or the (long-term) users (first-time acquisition).

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2.2 EnerPHit Standard

The Passive House Standard often cannot be feasibly achieved in older buildings due to various difficulties. Refurbishment to the EnerPHit Standard using Passive House components for all relevant structural elements in such buildings leads to extensive improvements with respect to thermal comfort, structural integrity, cost-effectiveness and energy requirements.

The EnerPHit-Standard can be achieved through compliance with the criteria of the component method (Table 2) or alternatively through compliance with the criteria of the energy demand method (Table 3). Only the criteria of one of these methods must be met. The climate zone to be used for the building's location is automatically determined on the basis of the chosen climate data set in the Passive House Planning Package (PHPP).

As a rule, the criteria mentioned in Table 2 correspond with the criteria for certified Passive House components[1]. The criteria must be complied with at least as an average value[2] for the entire building. A higher value is permissible in certain areas as long as this is compensated for by means of better thermal protection in other areas.

In addition to the criteria in Table 2 or Table 3, the general criteria in Table 4 must always be met. The EnerPHit categories Classic, Plus or Premium may be achieved depending on the renewable primary energy (PER) demand and generation of renewable energy .

[1] The criteria for certified Passive House components and data sheets for all certified components can be found on the Passive House Institute website (www.passivehouse.com).
[2] Note: When calculating average U values for insulated building components, the area weighted mean of the U-value, not the average insulation thickness, applies. Thermal bridges must only be taken into account during the calculation of the average value if they are part of the standard structure of the building component (e.g. wall ties). For multiple ventilation systems, the average value weighted by volumetric flow applies.

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Table 2 EnerPHit criteria for the building component method

Climate zone according to PHPP	Opaque envelope[1] against...				Windows (including exterior doors)					Ventilation	
	...ground	...ambient air			Overall[4]			Glazing[5]	Solar load[6]		
	Insu-lation	Exterior insulation	Interior in-sulation[2]	Exterior paint[3]	Max. heat transfer coefficient ($U_{D/W,installed}$)			Solar heat gain coefficient (g-value)	Max. specific solar load during cooling period	Min. heat reco-very rate[7]	Min. hu-midity re covery rate[8]
	Max. heat transfer coefficient (U-value)			Cool colours							
	[W/(m²K)]			-	[W/(m²K)]			-	[kWh/m²a]	%	
Arctic	Deter-mined in PHPP from project specific heating and cooling degree days against ground.	0.09	0.25	-	0.45	0.50	0.60	U_g - g*0.7 ≤ 0	100	80%	-
Cold		0.12	0.30	-	0.65	0.70	0.80	U_g - g*1.0 ≤ 0		80%	-
Cool-temperate		0.15	0.35	-	0.85	1.00	1.10	U_g - g*1.6 ≤ 0		75%	-
Warm-temperate		0.30	0.50	-	1.05	1.10	1.20	U_g - g*2.8 ≤ -1		75%	-
Warm		0.50	0.75	-	1.25	1.30	1.40	-		-	-
Hot		0.50	0.75	Yes	1.25	1.30	1.40	-		-	60 % (humid climate)
Very hot		0.25	0.45	Yes	1.05	1.10	1.20	-		-	60 % (humid climate)

[1] Opaque building envelope

If the heat transfer resistance (R-value) of existing building components is taken into account for the improvement of the heat transfer coefficients (U-value) of modernised building components, this must be demonstrated in accordance with the accepted technical standards. It is sufficient to adopt a conservative approximation of the thermal conductivity of the present building materials from suitable reference charts. If building component assemblies of existing buildings are not clearly identifiable, standardised estimates according to the year of construction as taken from appropriate component catalogues (e.g. "EnerPHit-Planerhandbuch", PHI 2012, only available in German) can be used as long as these are comparable with the component at hand.

In refurbishments of existing buildings, it is not always possible to achieve absence of thermal bridges with justifiable effort as is necessary for Passive House new builds. Nevertheless, thermal bridge effects must always be avoided or minimised as much as possible while ensuring cost-effectiveness. Thermal bridges that are part of the construction system, e.g. wall ties, must be taken into account in the evaluation of the heat transfer coefficient of this construction.

[2] Interior insulation

An important reason for the lower requirements for interior insulation (compared with exterior insulation) is that it reduces the useable area, therefore in principle only exterior walls are regarded as having interior insulation (if applicable), but roofs, basement ceilings and floor slabs are not.

[3] Exterior colour

Cool colours: colours which have a low absorption coefficient in the infrared part of the solar spectrum.

This criterion is defined by the solar reflectance index (SRI) which is calculated from the absorptivity and emissivity in the PHPP in accordance with the international standard ASTM E1980-11.

Flat roofs (inclination ≤ 10°): SRI ≥ 90

Sloped roofs and walls (inclination > 10° and < 120°): SRI ≥ 50

Measured values of areas exposed to weathering for at least 3 years must be used. If measured values are only available for the new state then the absorptivity should be converted using the auxiliary calculation in the PHPP worksheet "Areas" provided for this purpose. For simplification, the emissivity can be kept as it is.

In the following cases, this criterion does not have to be met:

"greened" surfaces; areas which are covered with rear ventilated solar collectors or photovoltaic panels (including the distance required between the panels); penetrations in building components and the associated equipment; accessible

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(roof) terraces or paths; areas that are strongly shaded or do not face the sun.
Other measures can also be undertaken as an alternative to the use of cool colours (e.g. increasing the insulation thickness beyond the applicable criterion for the building component), if this does not increase the overall cooling demand compared with the use of cool colours.

[4] Windows, overall

The illustrations show the respective inclination of the installed window. In each case the criterion for inclination of components will apply which most closely approximates the actual inclination of the window. There will be no interpolation between two criteria. However, since the glazing U-value changes with the inclination due to physical processes, the glazing U-value U_g corresponding to the actual inclination must be set for the window itself.
In the case of small windows above an average frame length to window area ratio of 3 m/m² the limit value mentioned in the table is steadily increased . The limit value to be applied is automatically calculated and shown in the PHPP worksheet "Verification" in accordance with the following formula:
Addition to the limit value [W/m²K]: (l/A-3)/20
l: length of window frame
A: window area

[5] Glazing

The limit value only applies for actively heated buildings with a heating demand above 15 kWh/(m²a).

[6] Solar load

The limit value only applies for actively cooled buildings with a sensible cooling demand above 15 kWh/(m²a). It refers to the solar radiation entering the building per m² of glazing area after taking into account all reduction factors due to shading etc., and must be complied with for the average value of all identically aligned windows. If the limit value is exceeded, then suitable measures must be undertaken to reduce the solar load to the point where the limit value can be complied with again. These include movable shading elements, shading overhangs and anti-sun glazing (latter only in pure cooling climates).

[7] Ventilation, minimum heat recovery efficiency

The heat recovery criterion must be complied with beyond the criteria for "Certified Passive House Components" for the entire ventilation system, i.e. also including the heat losses of the warm ventilation ducts located in the cold area and of the cold ducts located in the warm area.

[8] Minimum moisture recovery efficiency A "humid climate" prevails with dry degree hours for dehumidification ≥ 15 kKh (based on a dew-point temperature of 17 °C). This is automatically determined in the PHPP.

Table 3 EnerPHit criteria for the energy demand method (as an alternative to Table 2)

Climate zone according to PHPP	Heating	Cooling
	Max. heating demand	Max. cooling + dehumidification demand
	[kWh/(m²a)]	[kWh/(m²a)]
Arctic	35	equal to Passive House requirement
Cold	30	
Cool-temperate	25	
Warm-temperate	20	
Warm	15	
Hot	-	
Very hot	-	

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Table 4 General EnerPHit criteria (always applicable, irrespective of the chosen method)

			Criteria[1]			Alternative Criteria[2]
Airtightness						
Pressurization test result n_{50}	[1/h]	≤	1.0			
Erneuerbare Primärenergie (PER)[3]			Classic	Plus	Premium	
PER demand[4]	[kWh/(m²a)]	≤	$60 + (Q_H - Q_{H,PH}) \cdot f_{ØPER,H} + (Q_C - Q_{C,PH}) \cdot 1/2$	$45 + (Q_H - Q_{H,PH}) + (Q_C - Q_{C,PH}) \cdot 1/2$	$30 + (Q_H - Q_{H,PH}) + (Q_C - Q_{C,PH}) \cdot 1/2$	±15 kWh/(m²a) deviation from criteria...
Renewable energy generation[5] (with reference to projected building footprint)	[kWh/(m²a)]	≥	-	60	120	...with compensation of the above deviation by different amount of generation

[1] Criteria and alternative criteria apply for all climate zones worldwide. The reference area for all limit values is the treated floor area (TFA) calculated according to the latest version of the PHPP Manual (exceptions: generation of renewable energy with reference to projected building footprint and airtightness with reference to the net air volume).

[2] Two alternative criteria which are enclosed by a double line together may replace both of the adjacent criteria on the left which are also enclosed by a double line.

[3] The requirements for the PER demand and generation of renewable energy were first introduced in 2015. As an alternative to these two criteria evidence for the Passive House Classic Standard can continue to be provided in a transitional phase by proving compliance with the previous requirement for the non-renewable primary energy demand: $Q_P \leq 120$ kWh/(m²a) + (Q_H - 15 kWh/(m²a)) • 1.2 + Q_C - $Q_{C,\text{ Passive House criterion}}$
In the above mentioned formula if the terms "(Q_H - 15 kWh/(m²a))" and " Q_C - $Q_{C,\text{ Passive House criterion}}$" are smaller than zero, then zero will be adopted as the value.
The desired verification method can be selected in the PHPP worksheet "Verification". The primary energy factor profile 1 in the PHPP should be used by default unless PHI has specified other national values.

[4] Energy for heating, cooling, dehumidification, DHW, lighting, auxiliary electricity and electrical appliances is included. The limit value applies for residential buildings and typical educational and administrative buildings. In case of uses deviating from these, if an extremely high electricity demand occurs then the limit value can also be exceeded after consultation with the Passive House Institute. For this, evidence of efficient use of electrical energy is necessary, with the exception of existing electricity uses for which an improvement of the electrical efficiency by means of upgrading or renewal would prove uneconomical over the lifecycle.
Q_H: heating demand
$Q_{H,PH}$: Passive House criterion for the heating demand
$f_{ØPER,\ H}$: weighted mean of the PER factors of the heating system of the building
Q_C: cooling demand (incl. dehumidification)
$Q_{C,PH}$: Passive House criterion for the cooling demand
If the terms "(Q_H - $Q_{H,PH}$)" and "(Q_C - $Q_{C,\ PH}$)" are smaller than zero, zero will adopted as the value.

[5] Renewable energy generation plants which are not spatially connected to the building may also be taken into account (except for biomass use, waste-to-energy plants, and geothermal energy): only new systems may be included (i.e. systems which did not start operation before the beginning of construction of the building) which are owned by the building owner or the (long-term) users (first-time acquisition).

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Exemptions for EnerPHit

The limit values in Table 2 for the heat transfer coefficients of the exterior envelope building components may be exceeded if absolutely necessary based on one or more of the following compelling reasons:

- ☐ If required by the historical building preservation authorities
- ☐ If the cost-effectiveness of a required measure is no longer assured due to exceptional circumstances or additional requirements
- ☐ Due to legal requirements
- ☐ If implementation of the required standard of thermal insulation would result in unacceptable restriction of the use of the building or adjacent outer areas
- ☐ If special, additional requirements (e.g. fire safety) exist and there are no components available on the market that also comply with the EnerPHit criteria
- ☐ If the heat transfer coefficient (U-value) of windows is increased due to a high thermal transmittance (psi value) of the window installation offset to the insulation layer in a wall that has interior insulation
- ☐ If reliably damage-free construction is only possible with a smaller insulation thickness in the case of interior insulation
- ☐ If other compelling reasons relating to construction are present

If the thickness of the thermal insulation is restricted due to any of the reasons mentioned above, and an exemption is applicable, then the insulation thickness that is still possible must be implemented with a high-performance insulation material with a thermal conductivity $\lambda \leq 0.025$ W/(mK) if this can be implemented cost-effectively and in a damage-free way (in the case of interior insulation). In this case, the additional application of a surrounding insulation skirt should be considered in the case of floor slabs and basement ceilings. The measure should be implemented if this is economically viable.

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2.3 PHI Low Energy Building Standard

The PHI Low Energy Building Standard is suitable for buildings which do not fully comply with Passive House criteria for various reasons.

Table 5 PHI Low Energy Building criteria

			Criteria[1]	Alternative Criteria[2]
Heating				
Heating demand	[kWh/(m²a)]	≤	30	
Cooling				
Cooling + dehumidification demand	[kWh/(m²a)]	≤	Passive House requirement[3] + 15	
Airtightness				
Pressurization test result n_{50}	[1/h]	≤	1.0	
Renewable Primary Energy (PER)[4]				
PER demand[5]	[kWh/(m²a)]	≤	75	Exceeding the criteria up to +15 kWh/(m²a) is permitted...
Renewable energy generation[6] (with reference to projected building footprint)	[kWh/(m²a)]	≥	-	...with compensation of the above deviation by additional generation

[1] Criteria and alternative criteria apply for all climate zones worldwide. The reference area for all limit values is the treated floor area (TFA) calculated according to the latest version of the PHPP Manual (exceptions: generation of renewable energy with reference to projected building footprint and airtightness with reference to the net air volume).

[2] Two alternative criteria which are enclosed by a double line together may replace both of the adjacent criteria on the left which are also enclosed by a double line.

[3] The basis is the maximum of the two alternative Passive House criteria for the cooling demand. The Passive House criterion for the cooling load does not apply. The criterion applicable for the respective building is automatically calculated in the PHPP and displayed in the worksheet "Verification".

[4] The requirements for the PER demand and generation of renewable energy were first introduced in 2015. As an alternative to these two criteria, evidence for the PHI Low Energy Building Standard can be provided in a transitional phase by proving compliance with the requirement for the non-renewable primary energy demand (PE) of $Q_P \leq 120$ kWh/(m²a). The desired verification method can be selected in the PHPP worksheet "Verification". The primary energy factor profile 1 in the PHPP should be used by default unless the PHI has specified other national values.

[5] Energy for heating, cooling, dehumidification, DHW, lighting, auxiliary electricity and electrical appliances is included. The limit value applies for residential buildings and typical educational and administrative buildings. In case of uses deviating from these, if an extremely high electricity demand occurs then the limit value can also be exceeded after consultation with the Passive House Institute. Evidence of efficient use of electrical energy for all relevant devices and systems is necessary for this with the exception of existing devices which have already been owned by the user previously and for which an improvement of the electrical efficiency by means of upgrading or renewal would prove uneconomical over the lifecycle.

[6] Renewable energy generation plants which are not spatially connected to the building may also be taken into account (except for biomass use, waste-to-energy plants, and geothermal energy): only new systems may be included (i.e. systems which did not start operation before the beginning of construction of the building) which are owned by the building owner or the (long-term) users (first-time acquisition).

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2.4 General minimum criteria for all Standards

Besides a high level of energy efficiency, Passive House buildings and buildings refurbished to the EnerPHit Standard offer an optimum standard of thermal comfort and a high degree of user satisfaction as well as protection against condensate related damage. In order to guarantee this, the minimum criteria mentioned below must also be complied with in addition to the criteria in Sections 2.1 to 2.3. With the exception of the minimum U-values for thermal comfort (Table 6, on the right), these requirements also apply for PHI Low Energy Buildings.

2.4.1 Frequency of overheating

Percentage of hours in a given year with indoor temperatures above 25 °C

☐ without active cooling: ≤ 10 %

☐ with active cooling: cooling system must be adequately dimensioned

2.4.2 Frequency of excessively high humidity

Percentage of hours in a given year with absolute indoor air humidity levels above 12 g/kg

☐ without active cooling: ≤ 20 %

☐ with active cooling: ≤ 10 %

2.4.3 Minimum thermal protection

The criteria for the minimum level of thermal protection according to Table 6 are always applicable irrespective of the energy standard and must be complied with even if EnerPHit exemptions are used. They apply for each individual building component on its own (e.g. wall build-up, window, connection detail). Averaging of several different building components as evidence of compliance with the criteria is not permissible.

As a rule, the minimum level of thermal protection is already covered by the much more stringent criteria mentioned in Sections 2.1 to 2.3. The following minimum criteria are therefore effective only in exceptional cases.

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Table 6 Criteria for minimum thermal protection

Climate zone	Hygiene[1]	Comfort[2]			
	Min. temperature factor	Max. thermal transfer coefficient			
	$f_{Rsi=0.25\ m^2K/W}$	U-value			
	[]	[W/(m²K)]			
Arctic	0.80	0.45	0.50	0.60	0.35
Cold	0.75	0.65	0.70	0.80	0.50
Cool-temperate	0.70	0.85	1.00	1.10	0.65
Warm-temperate	0.60	1.10	1.15	1.25	0.85
Warm	0.55	-	1.30	1.40	-
Hot	-	-	1.30	1.40	-
Very hot	-	-	1.10	1.20	-

[1] Hygiene criterion

Besides the requirement for the temperature of the building component's interior surface ($f_{Rsi=0,25\ m^2K/W}$) mentioned in Table 6, all standard cross-sections and connection details must also be planned and executed so that excessive moisture build-up in the building component can be ruled out with the intended building use.

[2] Thermal comfort

The limit values do not apply for areas which are not adjacent to rooms with prolonged occupancy and to separate areas smaller than 1 m². Exceeding the limit value is permissible in the case of windows and doors if low temperatures arising on the inside are compensated by means of heating surfaces or if, for other reasons, there are no concerns relating to thermal comfort.

For building components in contact with the ground, the requirement for the U-value can be divided by the reduction factor f_T ("ground reduction factor" in the PHPP sheet "Ground").

For inclined building components the required value which most closely approximates the actual inclination of the window (according to the sketch "building component inclination" in Table 6) will apply. There will be no interpolation between two criteria.

Alternatively, the criteria for thermal comfort will be deemed to have been fulfilled if evidence of the comfort conditions is provided in accordance with DIN EN ISO 7730.

The thermal comfort criteria in Table 6 (last four columns) do not apply for PHI Low Energy Buildings.

2.4.4 Occupant Satisfaction

Exemptions to the below requirements are possible in justified cases as long as there is no significant likelihood of occupant satisfaction being impaired.

- ☐ All rooms with prolonged occupancy must have at least one operable window.
- ☐ It must be possible for the user to operate the lighting and temporary shading elements. Priority must be given to user-operated control over any automatic regulation.
- ☐ In case of active heating and/or cooling, it must be possible for users to regulate the interior temperature for each utilisation unit.
- ☐ The heating or air-conditioning technology must be suitably dimensioned in order to ensure the specified temperatures for heating or cooling under all expected conditions.

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- ☐ Ventilation system:
  - ☐ Controllability:
    The ventilation volume flow rate must be adjustable for the actual demand. In residential buildings the volume flow rate must be user-adjustable for each accommodation unit (three settings are recommended: standard volume flow / standard volume flow +30 % / standard volume flow -30 %).
  - ☐ Ventilation in all rooms
    All rooms within the thermal building envelope must be directly or indirectly (transferred air) ventilated with a sufficient volume flow rate. This also applies for rooms which are not continuously used by persons provided that the mechanical ventilation of these rooms does not involve disproportionately high expenditure.
  - ☐ Excessively low relative indoor air humidity
    If a relative indoor air humidity lower than 30 % is shown in the PHPP for one or several months, effective countermeasures should be undertaken (e.g. moisture recovery, air humidifiers, automatic demand-based (zone) control, extended cascade ventilation, or monitoring of the actual relative air humidity with the option of subsequent measures).
  - ☐ Sound level
    The ventilation system must not generate noise in rooms with prolonged occupancy. Recommended values for the sound level are
    - ☐ ≤ 25 db(A): supply air rooms in residential buildings, and bedrooms and recreational rooms in non-residential buildings
    - ☐ ≤ 30 db(A): rooms in non-residential buildings (except for bedrooms and relaxation rooms) and extract air rooms in residential buildings
  - ☐ Draughts
    The ventilation system must not cause uncomfortable draughts.

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2.5 Boundary conditions for the PHPP calculation

When verifying the criteria using the Passive House Planning Package (PHPP), the following boundary conditions must be fulfilled:

☐ Zoning
The entire building envelope (e.g. a row of terraced houses, an apartment block or an office building with several thermally connected units) must be taken into account for calculation of the specific values. An overall calculation can be used to provide evidence of this. If all zones have the same set temperature, then a weighted average based on the TFA from individual PHPP calculations of several sub-zones may be used. Combination of thermally separated buildings is not permissible. For the certification of refurbishments or extensions, the area considered must contain at least one external wall, a roof surface and a floor slab or basement ceiling. Single units inside a multi-storey building cannot be certified. Buildings which are adjacent to other buildings (e.g. urban developments) must include at least one exterior wall, a roof area and a floor slab and/or basement ceiling to be eligible for separate certification.

☐ Internal heat gains
The PHPP contains standard values for internal heat gains in a range of utilisation types. These are to be used unless PHI has specified other values (e.g. national values). The use of the individually calculated internal heat gains in PHPP is only permitted if it can be shown that actual utilisation will and must differ considerably from the utilisation on which the standard values are based.

☐ Internal moisture gains
Average value over all annual hours (also outside of the usage period):
residential building: 100 g/(person*h)
non-residential building without significant moisture sources beyond moisture released by persons (e.g. office, educational buildings etc.): 10 g/(Person*h)
non-residential building with significant moisture sources beyond moisture released by persons: plausibly substantiated estimation based on the anticipated utilisation.

☐ Occupancy rates
Residential buildings: standard occupancy rate in the PHPP; if the expected number of persons is significantly higher than the standard occupancy rate, then it is recommended that the higher value should be used.
Non-residential buildings: Occupancy rates and periods of occupancy must be determined on a project-specific basis and coordinated with the utilisation profile.

☐ Indoor design temperature
Heating, residential buildings: 20 °C without night setback, non-residential buildings: standard indoor temperatures based on EN 12831 apply. For unspecified uses or deviating requirements, the indoor temperature is to be determined on a project-specific basis. For intermittent heating (night setback), the indoor design temperature may be decreased upon verification.
Cooling and dehumidification: 25 °C and 12 g/kg absolute indoor air humidity

☐ Climate data
Climate data sets (with a seven-digit ID number) approved by the Passive House Institute should be used. The selected data set must be representative for the climate of the building's

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location. If an approved data set is not yet available for the location of the building, then a new data set can be requested from an accredited Passive House Building Certifier.

☐ Average ventilation volumetric flow
Residential buildings: 20-30 m³/h per person in the household, but at least a 0.30-fold air change with reference to the treated floor area multiplied by 2.5 m room height.
Non-residential buildings: The average ventilation volumetric flow must be determined for the specific project based on a fresh air demand of 15-30 m³/h per person (higher volumetric flows are permitted in the case of use for sports etc. and if required by the applicable mandatory requirements relating to labour laws). The different operation settings and times of the ventilation system must be considered. Operating times for pre-ventilation and post-ventilation should be taken into account when switching off the ventilation system. For residential and non-residential buildings, the mass flows used must correspond with the actual adjusted values.

☐ Domestic hot water demand
Residential buildings: 25 litres of 60 °C water per person per day unless PHI has specified other national values.
Non-residential buildings: the domestic hot water demand in litres of 60 °C water per person per day must be separately determined for each specific project.

☐ Balance boundary for electricity demand
All electricity uses that are within the thermal building envelope are taken into account in the energy balance. Electricity uses near the building or on the premises that are outside of the thermal envelope are generally not taken into account. By way of exception, the following electricity uses are taken into account even if they are outside of the thermal envelope:

- ☐ Electricity for the generation and distribution of heating, domestic hot water and cooling as well as for ventilation, provided that this supplies building parts situated within the thermal envelope.
- ☐ Elevators and escalators which are situated outside provided that these overcome the distance in height caused by the building and serve as access to the building
- ☐ Computers and communication technology (server including UPS, telephone system etc.) including the cooling necessary for these, to the extent they are used by the building's occupants.
- ☐ Household appliances such as washing machines, dryers, refrigerators , freezers if used by the building's occupants themselves
- ☐ Intentional illumination of the interior by externally situated light sources.

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3 Technical regulations for building certification

3.1 Testing procedure

Passive House buildings and buildings refurbished to the EnerPHit Standard are buildings in which comfortable indoor conditions can be achieved throughout the year with extremely low energy input. They must meet very stringent requirements regarding their design, planning and execution.

Subject to a thorough quality check, buildings can be certified in accordance with the criteria for the respective energy standard as mentioned in Section 2. If the technical accuracy of the required documentation for the tested building is confirmed in accordance with Section 3.2. and the criteria in Section 2 are fulfilled, the respective applicable seal will be issued.

Passive House seal

EnerPHit seal

EnerPHit^{+i} seal (for buildings with mostly interior insulation)

PHI Low Energy Building seal

EnerPHit certification is only possible for buildings for which modernisation to the Passive House Standard for new builds would be uneconomical or impossible in practical terms due to the existing building characteristics or building substance. In principle, an EnerPHit certificate cannot be issued for new builds. If more than 25 % of the opaque exterior wall area of an EnerPHit retrofit has interior insulation, then the designation EnerPHit^{+i} ("+I" in superscript form) is used[3].

For building certification, the current certification criteria and technical regulations for building certification (i.e. this document; current version always available at www.passivehouse.com) apply and take precedence over the calculation methodology described in the PHPP User Manual and the PHPP software, which shall apply subordinately. PHI reserves the right to adapt criteria and calculation procedures to reflect technical advances and developments. An informal application for the certificate can be made with the chosen Passive House Institute accredited Building Certifier. The required documents according to Section 3.2 must be submitted in full to the certifier. The

[3] Does not apply in warm, hot and extremely hot climate zones.

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certification documents must be checked at least once. Depending on the procedure, further checks may also be arranged.

Note: if possible, checking the relevant documents should be carried out during the planning stage so that any necessary corrections or suggestions for improvement can be taken into account in the implementation. In the absence of experience with Passive House construction, at least one consultation prior to planning and if applicable, also a consultation during the project is advised.

After the assessment, the client will receive results with corrected calculations and suggestions for improvement, if applicable. Inspection of construction work is not automatically covered by the certification. Additional quality assurance of the construction work by the certifying body is particularly useful if the construction management has no previous experience with the construction of Passive House buildings or with EnerPHit retrofits.

The awarding of the certificate only determines the correctness of the documents submitted according to the technological development relating to the standards as defined in Section 2 at the time of certification. The assessment relates neither to the supervision of the construction works, nor to monitoring of the user behaviour. The liability for the planning remains with the responsible planners and all liability for the implementation lies with the construction management.

In individual cases, it is possible that although a building meets the criteria in full, it may have serious deficiencies in other areas which greatly restrict its usability, safety or user satisfaction. If the certifier becomes aware of any such defects then it is at the certifier's discretion to retain the certificate until it can be proven that these defects have been sufficiently rectified.

The Certified Passive House, EnerPHit and PHI Low Energy Building seals may only be used with the associate certified building. The certificate is valid for the construction implementation and building use documented in the booklet accompanying the certificate. The energy-relevant characteristic values of the building may be changed due to any extensive conversions or change of use that may take place in the future, in which case the certificate will become invalid.

The documents submitted for certification may be used by the Passive House Institute for anonymised scientific evaluations and statistics.

3.2 Documents to be submitted

The use of components[4] certified by the Passive House Institute is advised because all necessary parameters have been reliably tested and are available and as a rule can be used for building certification without the need for any further verification. The applicant is liable to provide evidence of the characteristic values of products which have not been certified by the Passive House Institute.

[4] Data sheets for certified components can be found at www.passivehouse.com

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3.2.1 Passive House Planning Package (PHPP)

Compliance with the criteria must be verified using the latest version of the PHPP. However, transfer of data to a newer PHPP version published when the project is already under way is not necessary. The PHPP calculation should be submitted as an Excel file with at least the following calculations:

Worksheet

- ☐ Property data, summary of results ..... **Verification**
- ☐ Selection of the climatic data set ..... **Climate**
- ☐ Calculation of U-values of regular building components ..... **U-values**
- ☐ Summary of areas with allocation of radiation balance data, thermal bridges ..... **Areas**
- ☐ Calculation of reduction factors against ground, if used ..... **Ground**
- ☐ Building component database ..... **Components**
- ☐ Determination of the U_W values ..... **Windows**
- ☐ Determination of shading coefficients ..... **Shading**
- ☐ Air quantities, heat recovery efficiency, input of pressure test results ..... **Ventilation**
- ☐ Dimensioning of ventilation systems with several ventilation units (if used) ..... **Additional vent**
- ☐ Calculation of the heating demand using monthly method based on EN 13790 (if heating used) **Heating**
- ☐ Calculation of the heating load of the building [5] (if heating used) ..... **Heating Load**
- ☐ Determination of summer ventilation ..... **SummVent**
- ☐ Assessment of summer climate [5] ..... **Summer**
- ☐ Specific useful cooling demand (if active cooling is used) ..... **Cooling**
- ☐ Latent cooling demand (if active cooling is used) ..... **Cooling Units**
- ☐ Calculation of the cooling load of the building[5] (if active cooling is used) ..... **Cooling Load**
- ☐ Heating distribution losses; DHW demand and distribution losses ..... **DHW+Distribution**
- ☐ Solar DHW provision (if solar heating system exists) ..... **SolarDHW**
- ☐ Photovoltaic electricity generation (if PV system is used) ..... **PV**
- ☐ Calculation of shared and domestic electricity demand (only for residential buildings) **Electricity**
- ☐ Utilisation profiles of non-residential buildings ..... **Use non-res**
- ☐ Electricity demand of non-residential buildings ..... **Electricity non-res**
- ☐ Calculation of the auxiliary electricity demand ..... **Aux Electricity**
- ☐ Calculation of internal heat gains (only for residential buildings) ..... **IHG**
- ☐ Calculation of internal heat gains (only for non-residential buildings) ..... **IHG non-res**
- ☐ PER and PE value ..... **PER**
- ☐ Annual utilisation factor for heat generators ..... **Compact, HP, HP Ground, Boiler or District Heating**

[5] The PHPP calculations for the heating load, summer ventilation and cooling load have been developed for buildings with homogeneous utilisation. More in-depth studies/other methods should be referred to for buildings with intermittent ventilation or heating/cooling operation and greatly fluctuating internal loads.

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3.2.2 Planning documents for architecture

- ☐ Site plan including the building's orientation, position and height of relevant shading elements (neighbouring buildings, prominent trees, possibly elevated terrain, etc.); photographs of the plot and surroundings. The shading situation must be clearly understandable.
- ☐ Implementation plans (floor plans, sections, elevations) with comprehensible dimensioning for all area calculations (room dimensions, envelope areas, rough window opening sizes).
- ☐ Comprehensible calculation of the treated floor area.
- ☐ Location plans of envelope areas which allow easy and clear allocation of the areas in the PHPP to the planning drawings. Alternatively, if an existing DesignPH file can fulfil this function, this may also be submitted.

3.2.3 Standard and connection details

- ☐ Location plans of thermal bridges (if present) for clear allocation of the entries in the PHPP.
- ☐ Detailed drawings of all building envelope connections, e.g. the exterior and interior walls at the basement ceiling or floor slab, exterior wall at the roof and ceiling, roof ridge, verge, attachment of balconies etc. The details should be given with dimensions and information about materials used and their conductivities. The airtight layer should be indicated and its execution at connection points should be described.
- ☐ Evidence regarding the thermal bridge loss coefficients based on EN ISO 10211 as used in the PHPP. Alternatively, comparable documented thermal bridges can be used (e.g. in certified Passive House/EnerPHit construction systems, PHI publications, thermal bridge catalogues).
- ☐ Manufacturer, type and technical data sheets, especially of insulation materials with very low conductivity (λ_R < 0.032 W/(mK)). Rated values of the thermal conductivity according to national standards or building authority approvals are permissible.
- ☐ Evidence regarding radiation properties of the building's exterior surface (only in hot and very hot climates); for roof products: measured values for absorptivity or reflectance and emissivity determined in accordance with ANSI/CRRC-1 (or comparable methods). For wall products: on account of poorer availability of data, no requirements currently apply for the source of the specific values. All values must be determined after a period of exposure to weathering of at least 3 years (or conversion from new condition values in the PHPP).
- ☐ Proof of protection against excessive moisture build-up (only in doubtful cases)

3.2.4 Windows and doors

- ☐ Location plans for windows and doors for clear allocation of the entries in the PHPP.
- ☐ Information about the window and door frames to be installed: manufacturer, type, U_f value, $\Psi_{Installation}$, $\Psi_{Glazing\ Edge}$, graphical representations of all planned installation situations in the exterior wall. The calculated values should be computed in accordance with EN ISO 10077-2.
- ☐ Information about the glazing to be fitted: manufacturer, type, build-up, U_g value according to EN 673 (mathematically computed, accuracy to two decimal places), g-value in accordance with EN 410, type of edge spacer.

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3.2.5 Ventilation

- ☐ Building services plans for ventilation: representation and dimensioning of ventilation units, volumetric flows (Final Protocol Worksheet for Ventilation Systems: "Design", see PHPP CD), sound protection, filters, supply and extract air valves, openings for transferred air, outdoor air intake and exhaust air outlet, dimensioning and insulation of ducts, subsoil heat exchanger (if used), regulation, etc.
- ☐ Information about the subsoil heat exchanger (if used): length, depth and type of installation, soil quality, size and tube material and verification of the heat recovery efficiency (e.g. with PHLuft[6]). For subsoil brine heat exchangers: regulation, temperature limits for winter/summer and verification of the heat transfer efficiency
- ☐ Evidence regarding heat recovery efficiency and electricity demand of the ventilation system in accordance with the Passive House Institute method (see www.passivehouse.com). In cooling climates heat dissipated by the fans reduces the efficiency of the heat recovery as it represents an additional heat load. However, for simplification the existing method of PHI is currently still used for proof of heat recovery efficiency also in cooling climates. Exhaust air systems without heat recovery (e.g. fume hoods and fume cabinets etc.) should be included. Different operation settings and operation times should be taken into account.
- ☐ Manufacturer, type, technical data sheets and verification of the electricity demand of all components of the ventilation system such as the heating coils, frost protection etc.
- ☐ HRV commissioning report: at minimum, the report must include the following: description of the property, location/address of the building, name and address of the tester, time of adjustment, ventilation system manufacturer and type of device, adjusted volume flow rates for standard operation, mass flow/volumetric flow balance for outdoor air and exhaust air (maximum imbalance of 10 %). A report should be provided regarding the adjustment of all supply air and extract air valves. If this is not possible in individual non-residential buildings for technical reasons, then at least the volume flow rates in the ventilation unit (outdoor air/exhaust air) and in the principal ducts of the ventilation system should be measured. Recommended: “Final Protocol Worksheet for Ventilation Systems”, source PHPP CD or www.passivehouse.com.

3.2.6 Heating/cooling (if used), DHW and waste water

- ☐ Building services plans for heating/cooling (if used): DHW and waste water: representation of heat generators, heat storage, heat distribution (pipes, heating coils, heating surfaces, pumps, regulation), hot water distribution (circulation, single pipes, pumps, regulation), aerated drain pipes including their diameters and insulation thicknesses, representation and dimensioning of cooling and dehumidification systems.
- ☐ Short description of the planned building services supply systems, if necessary with schematic diagrams.
- ☐ Manufacturer, type, technical data sheets and verification of the electricity demand for heat generators for heating and hot water, heat storage, pumps, cooling of the building (if used), pressure increase, lift pumps etc.
- ☐ In buildings without active cooling: evidence regarding summer comfort. The PHPP procedure for determining overheating in summer only indicates the average value for the whole building;

[6] PHLuft: Programme facilitating planning of Passive House ventilation systems. Free download from www.passivehouse.com

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nevertheless, individual parts may become overheated. If this is suspected, a detailed analysis should be carried out (e.g. by means of a transient simulation).

3.2.7 Electrical devices and lighting

☐ Building services plans for electrical fittings: (in residential buildings only if planning or concept for efficient use of electricity exists, otherwise the standard values already entered in the PHPP will be used) representation and dimensioning of lighting (as well as concepts or simulations for the use of daylight, if applicable), elevators, kitchen equipment, computers, telecommunication systems and other specific uses of electricity (e.g. furnaces)

☐ Manufacturer, type, technical data sheets and verification of the electricity demand for all significant electricity uses such as elevators, lighting, security technology etc.

3.2.8 Renewable energy

☐ Solar thermal systems attached to the building: data sheets relating to the collectors and storage used, indicating the necessary input parameters. If the method implemented in the PHPP for assessing the solar fraction is not used, then additional evidence regarding the monthly contribution of the solar thermal system is required (e.g. simulation report).

☐ PV system attached to the building: data sheets of the collectors and inverters used, indicating the parameters necessary for input.

☐ Renewable energy generation plants which are not spatially connected to the building: Appropriate proof of ownership must be provided together with evidence of the forecasted yearly electricity production of the system (simulation) and if necessary, proof of the percentage of ownership of the system as a whole.

3.2.9 Airtightness of the building envelope

The airtightness measurement is carried out in accordance with EN 13829 (method A). A series of measurements is required for positive pressure and negative pressure, in deviation from the standard. The pressure test should only be carried out for the heated building envelope. Porches, conservatories etc. that are not integrated into the thermal envelope of the building should not be included in the pressure test. It is recommended that the test be carried out when the airtight layer is still accessible so that needed repairs can be carried out more easily. The pressure test report should also document the calculation of the indoor air volume.

In principle, the pressure test should be carried out by an institution or person independent of the client or contractor. A pressure test that has been carried out by the client will only be accepted if the test result is signed by someone taking personal responsibility for the accuracy of the information provided.

Only for EnerPHit: for values between 0.6 h^{-1} and 1.0 h^{-1}, extensive leakage detection must be carried out within the framework of the pressurisation test, during which individual leakages which may cause structural damage or impair comfort are sealed. This must be confirmed in writing and signed by the person in charge in accordance with Section 3.2.10.

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3.2.10 Confirmation of detection and sealing of leaks (only for EnerPHit)

(Only required for a pressure test result of 0.6 h^{-1} < n_{50} ≤ 1.0 h^{-1})

Standard text:

I hereby confirm that a search for leaks was carried out at negative pressure[7]. All rooms within the airtight building envelope were accessed for this purpose. All potential weak points were checked for leaks. This also applies in the case of areas which were difficult to access (e.g. large room heights). Any larger leaks that were found having a relevant share of the total leakage volumetric flow or affecting thermal comfort were sealed.

The following information is necessary:

- ☐ Name, address, company of the person signing
- ☐ Date and signature
- ☐ Description and address of the construction project
- ☐ Pressurisation test: date and name of the person carrying this out

3.2.11 Photographs

The progress of construction should be supported with photographs; it is not necessary to provide complete photographic documentation of all measures.

3.2.12 Exemptions (only for EnerPHit)

If applicable, necessary proof of the use of exemptions e.g. economic feasibility calculation (see 3.2.13), written confirmation by the historic building preservation authority, excerpts from laws and ordinances, extract of a plan are required.

Generally, in the event that a specific value that is required as standard is exceeded on the basis of an exemption, clear evidence should be provided that the prerequisites for the exemption exist by presenting the appropriate documents with the signature of the person in charge.

If a reduction of the heating demand or cooling demand is not achieved due to extremely extensive use of exemptions, it is at the discretion of the certifier to issue only written confirmation relating to the specific value achieved in place of an EnerPHit certification.

3.2.13 Economic feasibility calculation (only for EnerPHit)

If applicable, required as evidence for the use of an exemption (see Section 3.2.12).

Calculation of economic feasibility compared with a refurbishment without improvement of the energy efficiency, using the PHPP worksheet "Comparison". Use of the boundary conditions previously entered in the PHPP in case different national boundary conditions are not verified.

[7] In individual cases, leakage detection at excess pressure may be admissible particularly in the case of an airtight layer on the outside. Leakage detection can take place in the context of a pressurisation test. Alternatively, the pressure difference can also be generated by simple fans or the ventilation system.

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Alternatively: in agreement with the certifier, separate calculation using a dynamic valuation method (e.g. net present value method) over the lifecycle of the building component on the basis of all relevant costs minus the costs that are incurred anyway; more exact description e.g. in “Wirtschaftlichkeit von Wärmedämm-Maßnahmen im Gebäudebestand" (“Economic feasibility of thermal insulation measures in existing buildings 2005", in German), which can be downloaded from www.passivehouse.com.

3.2.14 Verification of general minimum requirements (according to Section 2.3)

☐ Protection against excessive moisture build-up
If the certifier has concerns regarding physical damage to the building due to moisture, these should be resolved through evidence of moisture protection provided in accordance with accepted technical standards.
For building components with interior insulation, evidence must be provided regarding careful detail planning, with which air flow behind the insulation layer can be safely and permanently prevented if the execution of these details is carried out in accordance with the planning.
For interior insulation, evidence must also be provided regarding the moisture-related technical suitability of the components for the specific application. In case of doubt, proof of suitability with regard to moisture protection, must be provided by means of a corresponding expert's report (with legally effective acceptance of responsibility) which is based on accepted methods. This usually takes place through a hygrothermal simulation.
As a rule, proof regarding the temperature factor f_{Rsi} or input of this value into the PHPP is not required for connection details in a quality typical for Passive Houses, but such proof may be requested by the certifier in case of uncertainty.

☐ Thermal comfort
If the maximum heat transfer coefficients mentioned in Table 6 "Criteria for minimum thermal protection" are exceeded, then evidence of the comfort conditions based on DIN EN ISO 7730 should be provided alternatively (does not apply for PHI Low Energy Buildings).

☐ Occupant satisfaction
If use is made of any of the exemptions mentioned in Section 2.4.4, then evidence of the prerequisites for these must be provided.

3.2.15 Construction manager's declaration

Execution according to the reviewed project plan must be documented and confirmed with the construction manager's declaration. Any variation in construction should be mentioned; if any of the products used deviate from those included in the project plan, corresponding evidence must be provided.

In some circumstances it may be necessary to provide additional test reports or data sheets for the components used in the building. If values that are more favourable than those in the standard PHPP calculation procedure are to be used, these should be supported by evidence.

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