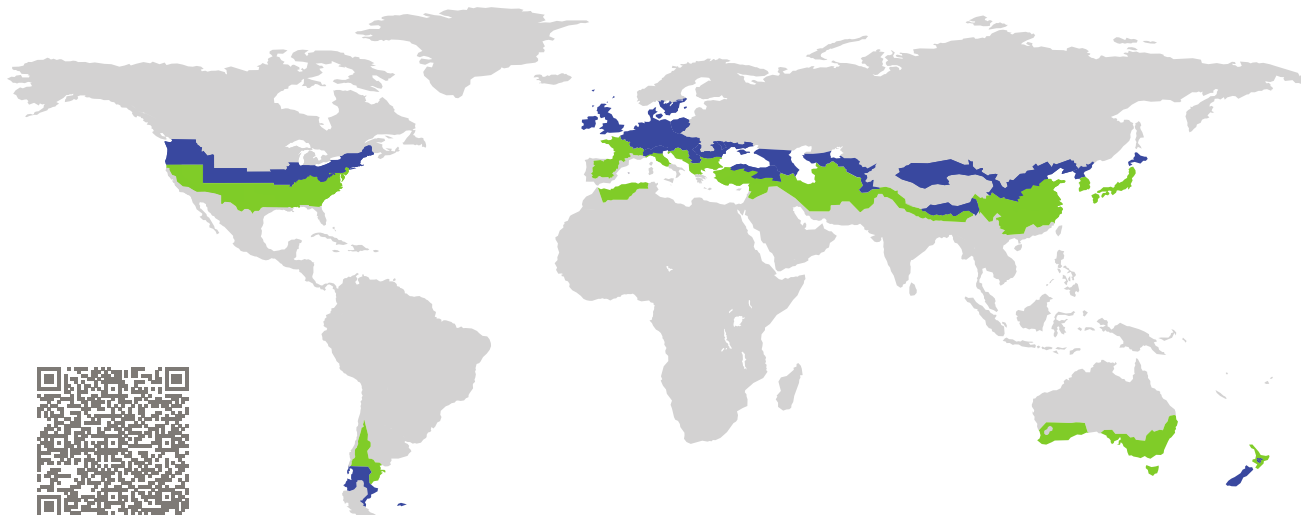


CERTIFICATE

Certified Passive House Component

Component-ID 2088vs03 valid until 31st December 2023

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany



Category: **Air handling unit with heat recovery**

Manufacturer: **2VV s.r.o.**
Czech Republic

Product name: **HRFL2-070HPCBE75-ES0S-0A0**

Specification: Airflow rate < 600 m³/h

Heat exchanger: Recuperative

This certificate was awarded based on the product meeting the following main criteria

Heat recovery rate $\eta_{HR} \geq 75\%$

Specific electric power $P_{el,spec} \leq 0.45 \text{ Wh/m}^3$

Leakage < 3%

Comfort Supply air temperature $\geq 16.5^\circ\text{C}$ at outdoor air temperature of -10°C

Airflow range

160–480 m³/h

Heat recovery rate

$\eta_{HR} = 78\%$

Specific electric power

$P_{el,spec} = 0.34 \text{ Wh/m}^3$

cool, temperate climate



**CERTIFIED
COMPONENT**

Passive House Institute

Passive House comfort criterion**Efficiency criterion (heat recovery rate)**

The effective heat recovery rate is measured at a test facility using balanced mass flows of the outdoor and exhaust air. The boundary conditions for the measurement are documented in the testing procedure.

$$\eta_{HR} = \frac{(\theta_{ETA} - \theta_{EHA}) + \frac{P_{el}}{\dot{m} \cdot c_p}}{(\theta_{ETA} - \theta_{ODA})}$$

With

η_{HR}	Heat recovery rate in %
θ_{ETA}	Extract air temperature in °C
θ_{EHA}	Exhaust air temperature in °C
θ_{ODA}	Outdoor air temperature in °C
P_{el}	Electric power in W
\dot{m}	Mass flow in kg/h
c_p	Specific heat capacity in W · h/(kg · K)

Heat recovery rate

$$\eta_{HR} = 78 \%$$

Efficiency criterion (electric power)

The overall electrical power consumption of the device is measured at the test facility at an external pressure of 100 Pa (50 Pa, respectively, for the intake and outlet). This includes the general electrical power consumption for operation and control but not for frost protection.

Specific electric power

$$P_{el,spec} = 0.34 \text{ Wh/m}^3$$

Efficiency ratio

The efficiency ratio provides information about the overall energy performance of the respective ventilation unit. It specifies the achieved reduction in ventilation heat losses by using a ventilation unit with heat recovery rather than without.

Efficiency ratio

$$\epsilon_L = 0.57$$

Leakage

The leakage airflow must not exceed 3 % of the average airflow of the unit's operating range.

Internal leakage

$$2.16 \%$$

External leakage

$$1.05 \%$$

Settings and airflow balance

It must be possible to adjust the balance of airflows at the unit itself (either between the exhaust and the outdoor airflows or between the supply and the extract airflows, if the unit is respectively placed inside or outside of the insulated thermal envelope of the building).

- This unit is certified for airflow rates of 160–480 m³/h.
- Balancing the airflow rates of the unit is possible.
- The user should have at least all the following setting options:
 - ✓ Switching the system on and off.
 - ✓ Synchronized adjustment of the supply and extract airflows to basic ventilation (70–80 %), standard ventilation (100 %) and increased ventilation (130 %) with a clear indication of the current setting.
- The device has a standby power consumption of 3.00 W. The target value of 1 W was exceeded. The device should be equipped with an additional external switch so that it can be disconnected from the mains, if required.
- After a power failure, the device will automatically resume operation.

Acoustical testing

The required limit for the sound power level of the device is 35 dB(A) in order to limit the sound pressure level in the installation room. The sound level target value of less than 25 dB(A) in living spaces and less than 30 dB(A) in functional spaces must be ensured by installing commercial silencers. The following sound power levels are met at an airflow rate of 480 m³/h:

Device	Duct			
	Outdoor	Supply air	Extract air	Exhaust air
52.8 dB(A)	53.1 dB(A)	66.8 dB(A)	53.8 dB(A)	66.7 dB(A)

- The unit does not fulfil the requirements for the sound power level. The unit must therefore be installed acoustically separated from living areas.
- One example of suitable silencers for supply and extract air ducts is mentioned in the detailed test report or can be obtained from the manufacturer. It is recommended to identify suitable silencers for each individual project.

Indoor air quality

This unit is to be equipped with the following filter qualities:

Outdoor air filter	Extract air filter
ISO ePM1 50%	ISO Coarse 60%

On the outdoor air side, the filter efficiency of ISO ePM1 50% (F7 according to EN 779) or better is recommended. For the extract air side, a filter efficiency of at least ISO Coarse 60% (G4 according to EN 779) is recommended. If not in standard configuration, the recommended filter is available as an accessory part.

Frost protection

Appropriate measures should be taken to prevent the heat exchanger and optional downstream hydraulic heater coil from getting damaged by frost during extreme winter temperatures ($-15\text{ }^{\circ}\text{C}$). It must be ensured that the unit's ventilation performance is not affected during frost protection cycles.

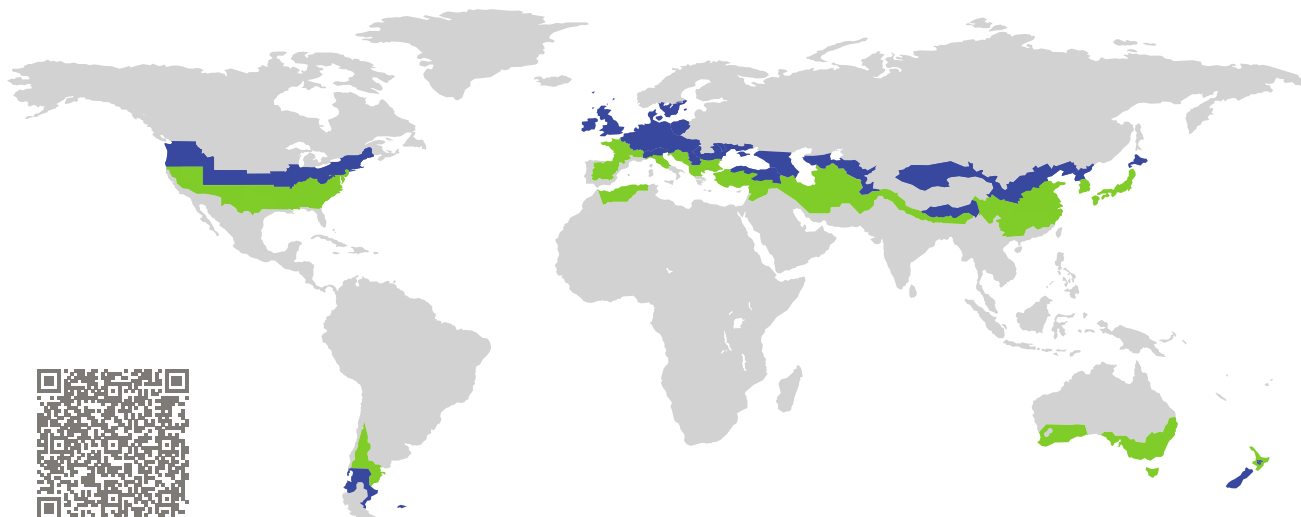
- Frost protection of the heat exchanger:
 - ✓ In order to protect the heat exchanger from freezing up, the unit is equipped with an internal electrical preheater with a maximum power of 2700 W. The operation of this frost protection is controlled depending on the exhaust air temperature.
- Frost protection of downstream hydraulic heater coils:
 - ✓ According to the manufacturer information both fans are switched off in case that the supply air temperature drops below $5\text{ }^{\circ}\text{C}$.

CERTIFICATE

Certified Passive House Component

Component-ID 2089vI03 valid until 31st December 2023

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany



Category: **Air handling unit with heat recovery**

Manufacturer: **2VV s.r.o.**
Czech Republic

Product name: **HRFL2-150HPCBE75-ES0S-0A0**

Specification: **Airflow rate > 600 m³/h**

Heat exchanger: **Recuperative**

This certificate was awarded based on the product meeting the following main criteria

Heat recovery rate	η_{HR}	\geq	75 %
Specific electric power	$P_{el,spec}$	\leq	0.45 Wh/m ³
Leakage		$<$	3 %
Performance number		\geq	10
Comfort	Supply air temperature ≥ 16.5 °C at outdoor air temperature of -10 °C ²⁾		

Airflow range

450–830 m³/h

at an external pressure of
214 Pa ¹⁾

Requirements non-residential
buildings (Therefore also
applicable for residential building)

Heat recovery rate

$\eta_{HR} = 82$ %

Specific electric power

$P_{el,spec} = 0.44$ Wh/m³

Performance number

9.7 ³⁾

¹⁾ The real available external pressure difference with installed filters is 156 Pa. Additional components decrease the available pressure difference accordingly.

²⁾ Achieved by use of an internal electrical preheater.

³⁾ In the middle and lower operating range, the recommended performance number of 10 is not achieved.

cool, temperate climate



**CERTIFIED
COMPONENT**

Passive House Institute

Passive House comfort criterion

A supply air temperature of 16.5 °C is maintained at an outdoor air temperature of about -10.0 °C by use of an internal electrical preheater.

Efficiency criterion (heat recovery rate)

The effective heat recovery rate is measured at a test facility using balanced mass flows of the outdoor and exhaust air. The boundary conditions for the measurement are documented in the testing procedure.

$$\eta_{HR} = \frac{(\theta_{ETA} - \theta_{EHA}) + \frac{P_{el}}{\dot{m} \cdot c_p}}{(\theta_{ETA} - \theta_{ODA})}$$

With

η_{HR}	Heat recovery rate in %
θ_{ETA}	Extract air temperature in °C
θ_{EHA}	Exhaust air temperature in °C
θ_{ODA}	Outdoor air temperature in °C
P_{el}	Electric power in W
\dot{m}	Mass flow in kg/h
c_p	Specific heat capacity in W · h/(kg · K)

Heat recovery rate

$$\eta_{HR} = 82 \%$$

Airflow range and external pressure difference

The operational range of the device results from the efficiency criterion (see below). As per the certification criteria for ventilation units > 600 m³/h the applicable pressure differences vary with the nominal range of operation (as declared by the producer) and the application (residential or non - residential building).

The external pressure difference includes all pressure losses of the ventilation system caused by components apart from the tested unit (consisting of casing, heat exchanger and fans). If filters are installed inside of the unit, their pressure losses are to be reduced accordingly. The average filter pressure drop of an operational filter is assumed to be 30% higher than that of the clean filter.

- According to the certification requirements for non-residential buildings the airflow range achieves 450-830m³/h at an external pressure difference of 214 Pa. The available pressure difference with installed filters, internal electrical preheater and shut-off dampers is about 156 Pa.

Efficiency criterion (electric power)

The overall electrical power consumption of the device including controllers was measured at the test facility as per the requirements for non-residential buildings at an external pressure difference of 214 Pa.

Specific electric power
$P_{el,spec} = 0.44 \text{ Wh/m}^3$

Performance number

Based on the measured values for the calculation of heat recovery efficiency and power consumption and on the climatic data of central Europe (Gt: 84 kWh, heating time: 5400 h/a), an average performance number at the airflow range was determined:

Performance number
9.7

In the middle and lower operating range, the recommended performance number of 10 is not achieved.

Leakage

The airtightness of the unit is tested for under pressure and over pressure before the thermodynamic test is conducted. As per the certification criteria the leakage airflows must not exceed 3 % of the average airflow of the device's operating range.

Internal leakage	External leakage
2.29 %	1.15 %

Settings and airflow balance

It must be possible to adjust the balance of airflows at the unit itself (either between the exhaust and the outdoor airflows or between the supply and the extract airflows, if the unit is respectively placed inside or outside of the insulated thermal envelope of the building). Available operation modes are explained in detail in the operation manual.

- Balancing the airflow rates of the unit is possible.
 - ✓ The airflow volumes can be held steady automatically (The airflow volumes can be held steady automatically (by measurement of pressure differences inside of the unit and adjusting of the fan speed).).
- The standby power consumption of this device makes 15.00 W. The target value of 1 W was exceeded. The device should be equipped with an additional external switch so that it can be disconnected from the mains, if required.
- After a power failure, the device will automatically resume operation.

Acoustical testing

A ventilation unit > 600 m³/h is assumed to be operated in an installation room, for which sound limits are defined in the applicable regulations. For this device, the following sound level values have been derived from the measurements at an airflow rate of **840 m³/h**:

Device	Duct			
	Outdoor	Supply air	Extract air	Exhaust air
60.8 dB(A)	62.0 dB(A)	77.3 dB(A)	62.1 dB(A)	77.4 dB(A)

- For complying with the required sound level in the supply and extract air rooms, dimensioning of a suitable silencer is required for the specific project on the basis of the measured sound level.

Indoor air quality

Instructions for changing of the air filters are documented in the operation manual. This device is equipped with following filter qualities:

Outdoor air filter	Extract air filter
ISO16890 ePM1 55\% (F7)	ISO16890 ePM10 70\% (M5)

If the device is not operated during summer, the filter should be replaced before the next operation. The producer of the device has to ensure that based on the latest findings, room air hygiene can be maintained by means of integrated or obligatory components.

For the operation of ventilation systems a strategy for avoiding permanent moisture penetration of the outdoor air filter needs to be considered. The strategies are mentioned in the full report and can be implemented through installation of either an additional component of the ventilation device in the factory, or retrofitted to the system on-site.

Frost protection

Appropriate measures should be taken to prevent the heat exchanger and optional downstream hydraulic heater coil from getting damaged by frost during extreme winter temperatures (-15°C). It must be ensured that the unit's ventilation performance is not affected during frost protection cycles.

■ Frost protection of the heat exchanger:

- ✓ In order to ensure a frost protection of the heat exchanger, the unit is equipped with an internal electrical preheater with a maximum power of 5.3 kW. In case that the internal preheater is not used, another sufficient frost protection strategy has to be additionally adopted in order to protect the heat exchanger from freezing.

■ Frost protection of downstream hydraulic heater coils:

- ✓ In order to prevent damage to a hydraulic supply air heater coil, an internal control algorithm ensures switching off the fans in case that specific boundary conditions occur.

It should be noted that, due to free circulation, cold air can also lead to freezing - even when the fans are stationary. This can only be ruled out if the air duct is closed (by means of a shut-off flap).

Bypass of the heat recovery

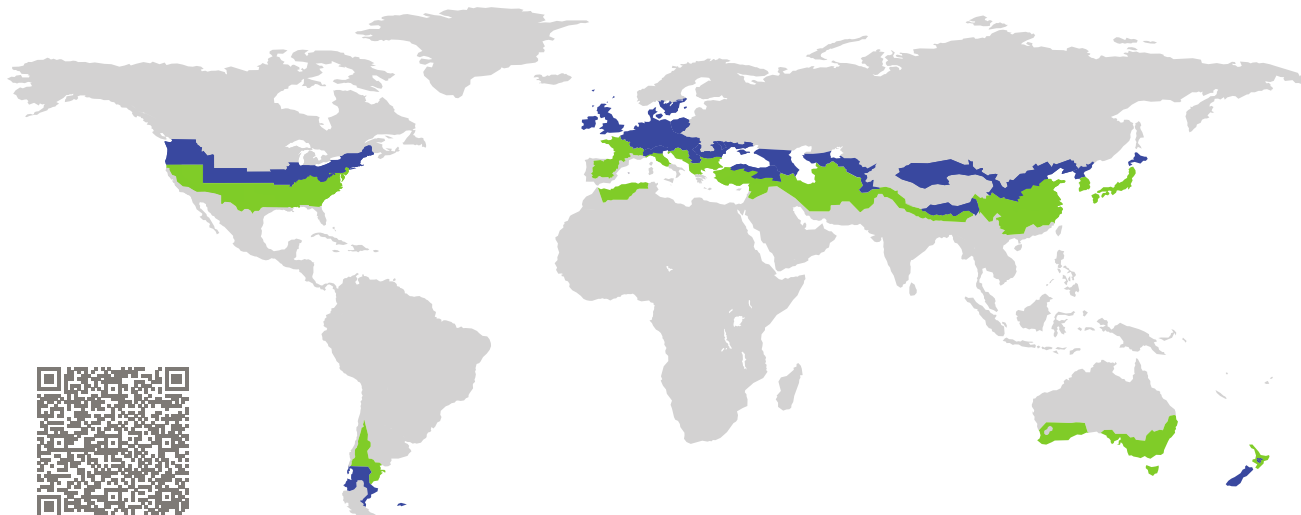
An automatically controlled summer bypass of the heat exchanger is part of this device. The effectiveness of bypass for night cooling of buildings has not been investigated within the scope of this testing.

CERTIFICATE

Certified Passive House Component

Component-ID 2090vI03 valid until 31st December 2023

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany



Category: **Air handling unit with heat recovery**

Manufacturer: **2VV s.r.o.**
Czech Republic

Product name: **HRFL2-200HPCBE75-ES0S-0A0**

Specification: Airflow rate > 600 m³/h

Heat exchanger: Recuperative

This certificate was awarded based on the product meeting the following main criteria

Heat recovery rate	η_{HR}	\geq	75 %
Specific electric power	$P_{el,spec}$	\leq	0.45 Wh/m ³
Leakage		$<$	3 %
Performance number		\geq	10
Comfort	Supply air temperature ≥ 16.5 °C at outdoor air temperature of -10 °C ²⁾		

Airflow range

530–1140 m³/h

at an external pressure of
232 Pa ¹⁾

Requirements non-residential
buildings (Therefore also
applicable for residential building)

Heat recovery rate

$\eta_{HR} = 81$ %

Specific electric power

$P_{el,spec} = 0.44$ Wh/m³

Performance number

9.9

¹⁾ The real available external pressure difference with installed filters is 175 Pa. Additional components decrease the available pressure difference accordingly.

²⁾ Achieved by use of an internal electrical preheater.

cool, temperate climate



**CERTIFIED
COMPONENT**

Passive House Institute

Passive House comfort criterion

A supply air temperature of 16.5 °C is maintained at an outdoor air temperature of about -10.0 °C by use of an internal electrical preheater.

Efficiency criterion (heat recovery rate)

The effective heat recovery rate is measured at a test facility using balanced mass flows of the outdoor and exhaust air. The boundary conditions for the measurement are documented in the testing procedure.

$$\eta_{HR} = \frac{(\theta_{ETA} - \theta_{EHA}) + \frac{P_{el}}{\dot{m} \cdot c_p}}{(\theta_{ETA} - \theta_{ODA})}$$

With

η_{HR}	Heat recovery rate in %
θ_{ETA}	Extract air temperature in °C
θ_{EHA}	Exhaust air temperature in °C
θ_{ODA}	Outdoor air temperature in °C
P_{el}	Electric power in W
\dot{m}	Mass flow in kg/h
c_p	Specific heat capacity in W · h/(kg · K)

Heat recovery rate

$\eta_{HR} = 81 \%$

Airflow range and external pressure difference

The operational range of the device results from the efficiency criterion (see below). As per the certification criteria for ventilation units > 600 m³/h the applicable pressure differences vary with the nominal range of operation (as declared by the producer) and the application (residential or non - residential building).

The external pressure difference includes all pressure losses of the ventilation system caused by components apart from the tested unit (consisting of casing, heat exchanger and fans). If filters are installed inside of the unit, their pressure losses are to be reduced accordingly. The average filter pressure drop of an operational filter is assumed to be 30% higher than that of the clean filter.

- According to the certification requirements for non-residential buildings the airflow range achieves 530-1140m³/h at an external pressure difference of 232 Pa. The available pressure difference with installed filters, internal electrical preheater and shut-off dampers is about 175 Pa.

Efficiency criterion (electric power)

The overall electrical power consumption of the device including controllers was measured at the test facility as per the requirements for non-residential buildings at an external pressure difference of 232 Pa.

Specific electric power
$P_{el,spec} = 0.44 \text{ Wh/m}^3$

Performance number

Based on the measured values for the calculation of heat recovery efficiency and power consumption and on the climatic data of central Europe (Gt: 84 kWh, heating time: 5400 h/a), an average performance number at the airflow range was determined:

Performance number
9.9

Leakage

The airtightness of the unit is tested for under pressure and over pressure before the thermodynamic test is conducted. As per the certification criteria the leakage airflows must not exceed 3 % of the average airflow of the device's operating range.

Internal leakage	External leakage
1.94 %	1.07 %

Settings and airflow balance

It must be possible to adjust the balance of airflows at the unit itself (either between the exhaust and the outdoor airflows or between the supply and the extract airflows, if the unit is respectively placed inside or outside of the insulated thermal envelope of the building). Available operation modes are explained in detail in the operation manual.

- Balancing the airflow rates of the unit is possible.
 - ✓ The airflow volumes can be held steady automatically (The airflow volumes can be held steady automatically (by measurement of pressure differences inside of the unit and adjusting of the fan speed).).
- The standby power consumption of this device makes 15.00 W. The target value of 1 W was exceeded. The device should be equipped with an additional external switch so that it can be disconnected from the mains, if required.
- After a power failure, the device will automatically resume operation.

Acoustical testing

A ventilation unit $> 600 \text{ m}^3/\text{h}$ is assumed to be operated in an installation room, for which sound limits are defined in the applicable regulations. For this device, the following sound level values have been derived from the measurements at an airflow rate of **1130 m³/h**:

Device	Duct			
	Outdoor	Supply air	Extract air	Exhaust air
62.6 dB(A)	61.2 dB(A)	75.2 dB(A)	62.0 dB(A)	76.5 dB(A)

- For complying with the required sound level in the supply and extract air rooms, dimensioning of a suitable silencer is required for the specific project on the basis of the measured sound level.

Indoor air quality

Instructions for changing of the air filters are documented in the operation manual. This device is equipped with following filter qualities:

Outdoor air filter	Extract air filter
ISO16890 ePM1 55\% (F7)	ISO16890 ePM10 70\% (M5)

If the device is not operated during summer, the filter should be replaced before the next operation. The producer of the device has to ensure that based on the latest findings, room air hygiene can be maintained by means of integrated or obligatory components.

For the operation of ventilation systems a strategy for avoiding permanent moisture penetration of the outdoor air filter needs to be considered. The strategies are mentioned in the full report and can be implemented through installation of either an additional component of the ventilation device in the factory, or retrofitted to the system on-site.

Frost protection

Appropriate measures should be taken to prevent the heat exchanger and optional downstream hydraulic heater coil from getting damaged by frost during extreme winter temperatures (-15°C). It must be ensured that the unit's ventilation performance is not affected during frost protection cycles.

■ Frost protection of the heat exchanger:

- ✓ In order to ensure a frost protection of the heat exchanger, the unit is equipped with an internal electrical preheater with a maximum power of 7.2 kW. In case that the internal preheater is not used, another sufficient frost protection strategy has to be additionally adopted in order to protect the heat exchanger from freezing.

■ Frost protection of downstream hydraulic heater coils:

- ✓ In order to prevent damage to a hydraulic supply air heater coil, an internal control algorithm ensures switching off the fans in case that specific boundary conditions occur.

It should be noted that, due to free circulation, cold air can also lead to freezing - even when the fans are stationary. This can only be ruled out if the air duct is closed (by means of a shut-off flap).

Bypass of the heat recovery

An automatically controlled summer bypass of the heat exchanger is part of this device. The effectiveness of bypass for night cooling of buildings has not been investigated within the scope of this testing.