4 Ventilation concept

Each of the 32 Passive houses has its own independent ventilation system with built-in heat exchanger to recover heat, which can be operated by the occupants. The system is located in the building services room under the roof; supply and exhaust air are aspirated or blown out directly above the roof. The ventilator control is clearly located in the windscreen area of each house.

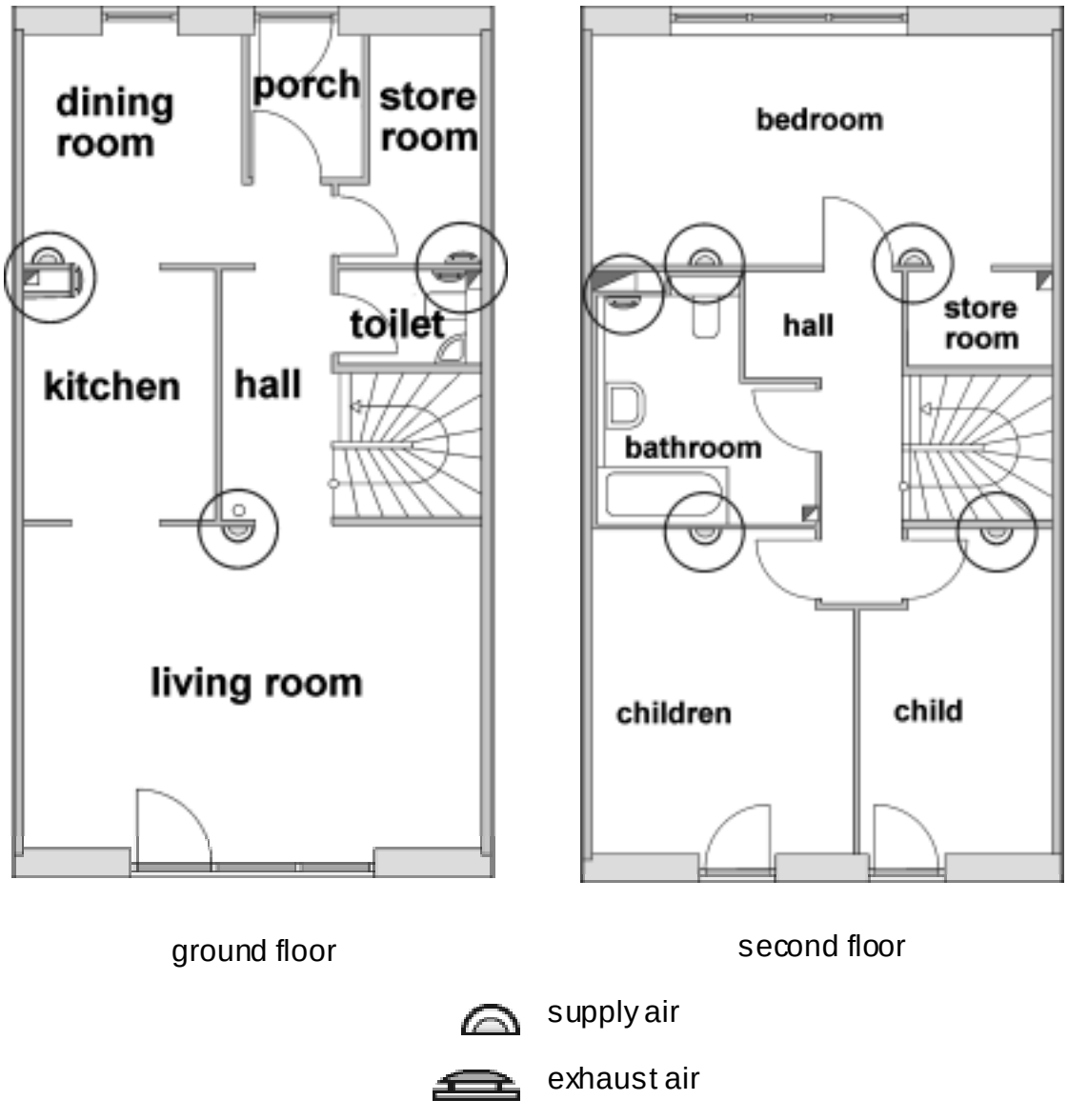

Figure 17: Position of the supply and exhaust air outlets and respective nozzles on both floors

4.1 Ventilation zones

There is no room, which is not clearly integrated into the ventilation concept. The supply air is shared and it is guaranteed that no „dead zones“ with stagnant air exist. Figure 17 shows the locations of the supply and exhaust air outlets in the „Jangster

de Lüx“ house type. All living and sleeping rooms are planned as supply air zones, the exhaust air rooms are the kitchen, storeroom, toilet and bathroom. The hallway and staircase act as overflow zones.

The duct network for air distribution is made up of folded spiral-seam pipe and sound absorbers, and was arranged as compactly as possible to minimise pressure losses. The physical distribution of air to the three vertical shafts takes place in the services floor. A shaft with the exhaust duct passes on the north side along the bathroom/partition wall corner to the kitchen on the ground floor. The second shaft goes down along the south side into the bathroom and leads the supply duct through the penetration into the living/dining room. The third shaft with a folded spiral-seam pipe goes through the north side of the first floor storage room along the partition wall and then aspirates the exhaust air in the ground floor from the toilet and storage room.

The supply nozzles in the sleeping and children’s rooms in the first floor are serviced directly from the services floor.

4.2 Technical parameters of housing ventilation

The complete building services technology was planned by the inPlan engineering office, the following technical parameter details were taken from [Stärz 1998].

4.2.1 Ventilation duct network

An optimum between large nominal diameters and justifiable investment costs was aimed at for the duct network. The air flow velocity is set at a maximum of 3 m/s. Due to the central location of the wet rooms (exhaust) and the use of wide casting nozzles, a duct network with very low pressure losses was realized.

The fresh air and exhaust ducts were built with very short extensions out of the thermal envelope and through the roof. A folded spiral-seam pipe with a 160 nominal diameter and 90mm aluminium-clad mineral wool insulation was used. Both pipelines have permanently installed differential pressure sensors from the Westaflex company („dynamic pressure measuring device“ model, Halton system, DN 160), so as to allow for system balance calibration. The fresh air duct also has an electrical frost protection heating system with temperature sensors, in order to avoid freezing of the heat exchanger. Both ducts are located on the north side of the roofs. In order to avoid a short-circuit of the airflows, the ducts are situated with the largest possible separation distance (ca. 3 m) on the roof. The ducts end in a 90-degree bend with weather protection and built-in coarse grid protector (bent outlet with grid, Lindab company).

Inside the thermal envelope and from the heat recovery system onwards, the supply and extract ducts are carried out in nominal diameters of 100 and 125 mm

respectively. The supply ducts are insulated with 30 mm aluminium-clad mineral wool from the air-heating-element (postheater) onwards. The extract ducts are carried out without insulation.

The duct network plan in Figure 18 shows the ventilation system for the house type „Jangster de Lüx“. The other house types are only slightly different.

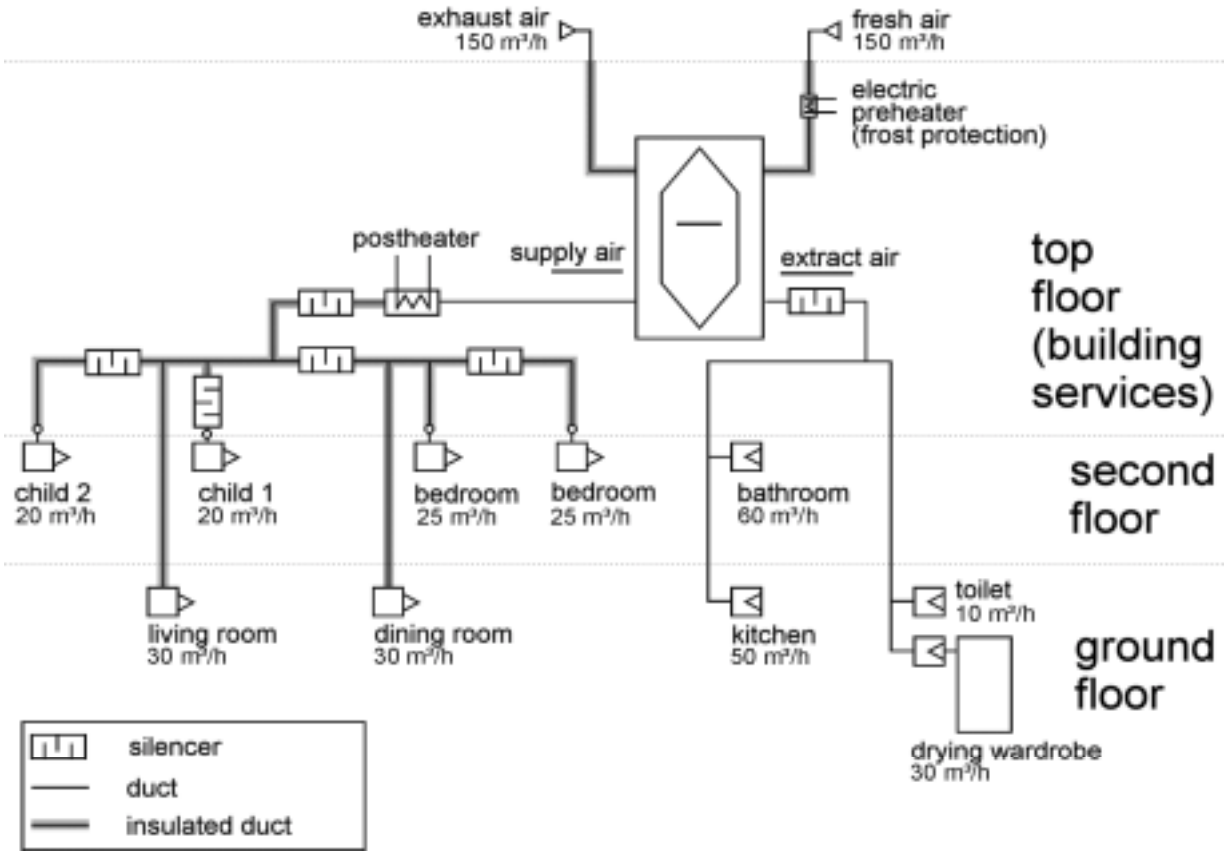

Figure 18: Ventilation system duct network plan for Passive House type „Jangster de Lüx“ with the design layout flow volumes

A noise pressure level of 25 dB(A) was aimed for, which is clearly below the limit of 30 dB(A) for so-called “rooms requiring protection”. The **silencers** are flexible pieces from the „Aerotechnik Sigwart“ company, made up of a perforated aluminium inner pipe, mineral fibre packaging and aluminium outer pipe. On the exhaust side, there is a common silencer (nominal diameter 160, packaging thickness 25 mm, length 1000 mm) before the ventilation system.

4.2.2 Design layout flow volumes

On the supply side, the per-person flow volumes are set at 30 m³/h. That means 90 m³/h for 3 people („123“), 120 m³/h for 4 people („Jangster“) and 150 m³/h for 5 people („Jangster de Lüx“). On the exhaust side, there are flow volumes set for the kitchen (40-50 m³/h), the ground floor toilet (10 m³/h) and the bathroom (40 m³/h). This set-up leads to the following flow volumes:

House type		„123“	„Jangster“	„Jangster de Lüx“
		[m³/h]	[m³/h]	[m³/h]
Supply air room	Dining room ground floor	20	30	40
	Living ground floor	25	30	40
	Sleeping first floor	25	30	40
	Child 1 first floor	20	15	15
	Child 2 first floor	-	15	15
Total		**90**	**120**	**150**
Exhaust air room	Dry storage cabinet	-	30	30
	Kitchen ground floor	50	40	50
	Toilet ground floor	-	10	10
	Bathroom first floor	40	40	60
Total		**90**	**120**	**150**

Table 3: Design layout flow volumes for the three house types (m³/h)

In order to be able to react to the different occupancy levels and uses of the houses, the ventilation system can be set at three levels. In addition to normal ventilation, the occupants can choose „basic ventilation“ for a reduced airflow (75%) or “maximum ventilation” for an increased airflow if necessary (150%).

4.2.3 Pressure losses

An overview of the magnitude of the pressure losses of the entire system under the different operation levels is shown in the following Table:

	Post-heater	In- & outflow elements	Filter	duct network	**Total**
	[Pa]	[Pa]	[Pa]	[Pa]	**[Pa]**
Basic ventilation 90 m³/h	10	10	15	25	**60**
Normal ventilation 120 m³/h	15	30	20	40	**105**
Max ventilation 180 m³/h	35	50	30	60	**175**

Table 4: Projected ventilation system pressure losses for the three different operational levels

4.2.4 Inflow vents

The inflow elements used in living and sleeping rooms are solely of the wide-casting nozzle type (ceiling and wall versions) from the manufacturer ABB („CTVB“ and „CTVK“ models).

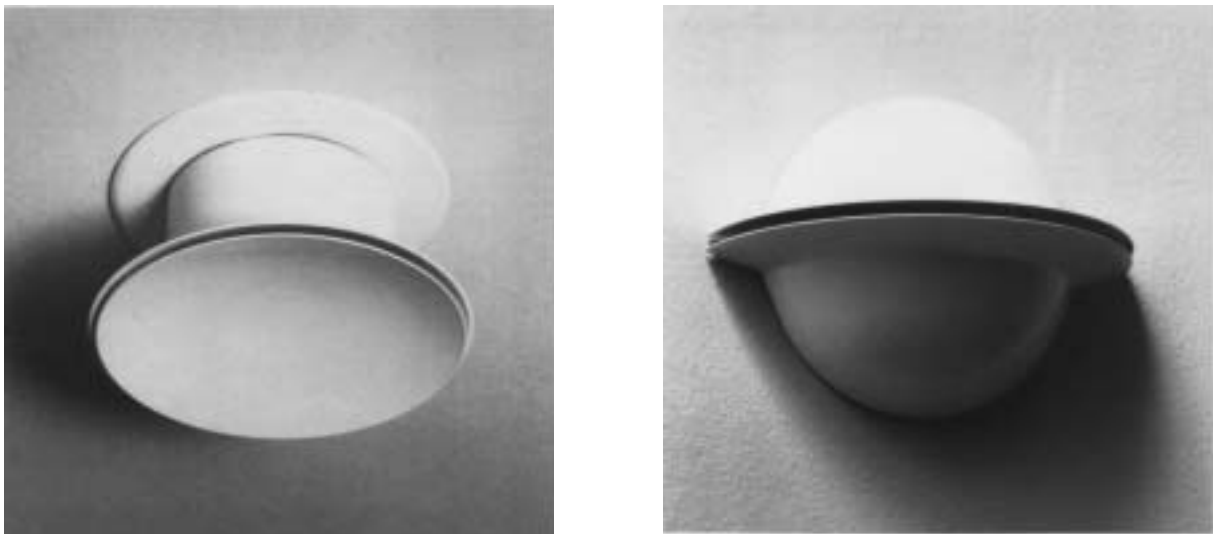

Figure 19: Inflow elements as wide-casting nozzles, both ceiling and wall versions (Photos: Manufacturer)

4.2.5 Outflow vents

The outflow rooms are equipped with exhaust elements from the manufacturer Exhausto. Plate vents (VTU model) are used in the bathroom, toilet and ground floor storage room, whereas the kitchen has a filter brace (FA 100 PB model) with removable aluminium filter (EU3 / G85) and an exhaust vent (URH model) behind it.

4.2.6 Overflow elements

Overflow openings are necessary to guarantee directional airflows in the building when doors are closed between the zones. The overflow openings in the 32 houses are integrated above the door frames (see Figure 20). The bathroom door is an exception, being equipped with a traditional grid in the upper part of the door; here as well, the PHI recommends the solution shown in Figure 20, which has proven itself very effective.

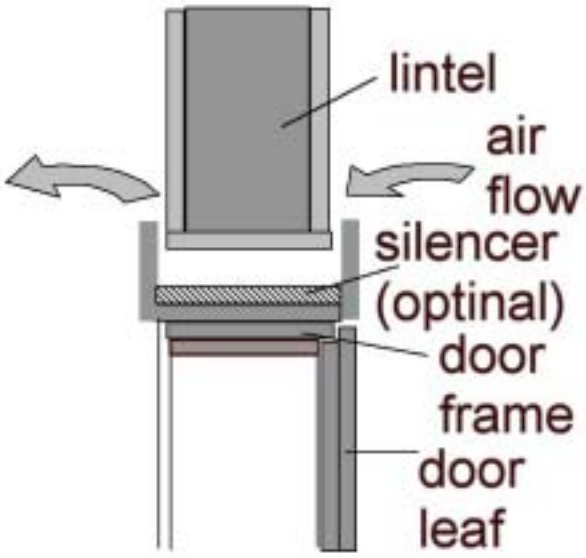

Figure 20: Overflow openings between the lintel and the door frame (source ebök)

4.3 Central ventilation system with heat exchanger

The ventilation units are made up of a counterflow heat exchanger, the supply-, and exhaust ventilators, two integrated filters and a control to set the flow volumes. The installed central ventilation units with counterflow heat exchangers are from the Paul Company („Thermos 201 DC“ model). The system's two ventilators are maintenance-free 24 V direct current (ecm) ventilators (radial ventilators with reverse bend blades). Each ventilation system is equipped with an electrical „defrost heater“ in the fresh air flow, which prevents the heat exchanger from freezing.

Technical details of the ventilation system (manufacturer's specifications):

Dimensions:	1010x1300x450mm (WxHxD)
Duct material:	plastic
Duct connectors:	DN 160
Ventilators:	2 radial ventilators, 24 V
Volume airflow:	75 to 230 m³/h
Power consumption (entire system):	36 to 88 W
Filter form (In- & outflow filter):	Z-Filter
Filter class (In- & outflow filter):	G4

Figure 21: Ventilation unit with heat exchanger in the building services floor of a Hannover-Kronsberg Passive House. In the background is the fresh air duct with defrost heater and in the foreground is the exhaust air pipe (both insulated with mineral wool, aluminium laminated)

The units are all equipped with a by-pass slide, which can be manually operated. If the heat exchanger is no longer needed in the transition season, this part of the system can be by-passed by pulling the slide. On the reverse side of the unit is a condensation drainpipe to drain the condensed water, which forms in the heat exchanger.

4.4 Control possibilities

Through the use of an operating unit clearly positioned in the windscreen area, the ventilation system can be switched to the different operation levels. The choice can be made between basic ventilation (75%), normal ventilation (100%) and maximum ventilation (150%). In addition, the „summer ventilation“ button can be pushed, so that only the exhaust ventilator is used when the outdoor air comes through opened windows and the inlying bathroom needs to be vented. The fifth button, „off“, shuts the ventilation system down. The respective operating level is indicated on the display. Furthermore, the „filter change“ display appears each time after an operating period of three months. The chosen operating level remain in operation until another setting is chosen (also maximum ventilation). Automatic timing is not available with this design.