Passive House Object Documentation

Passive House in the Woods, Konkol Residence - Town of Hudson, WI (USA)
(Passive House project database ID 1770)

http://www.passivhausprojekte.de/projekte.php?detail=1770
Technical drawings in this document are not drawn to scale.

2.1 PROJECT OVERVIEW

Project Designer Dipl.-Ing. Tim Delhey Eian - TE Studio, Ltd. (http://testudio.com)

The Passive House in the Woods is a single family home located in the Town of Hudson, Wisconsin (USA). The insulated concrete form substructure was built in the winter of 2009/10, and the home finished in September of 2010. The project is Wisconsin's first certified Passive House and at the time, one of only a handful of certified Passive House projects in the United States of America.

Special features

- Renewable systems to target carbon-neutral operation
- Rooftop terrace, exterior deck and stair structure
- Earth-friendly interior and exterior finishes throughout
- Automated ventilation system with earthloop preheating/ precooling system

U-value exterior wall	0,083 W/(m²K)
U-value basement slab	0,097 W/(m²K)
U-value roof	0,06 W/(m²K)
U-value window	0.82 W/(m²K)
Effective heat recovery	80.4%

PHPP annual heating demand 11 kWh/(m²a)

PHPP primary energy demand 106kWh/(m²a)*
Pressure test n_{50} 0.25h^{-1}
*) Verification mode; 66 kWh/(m²a) in design mode for 2-person household

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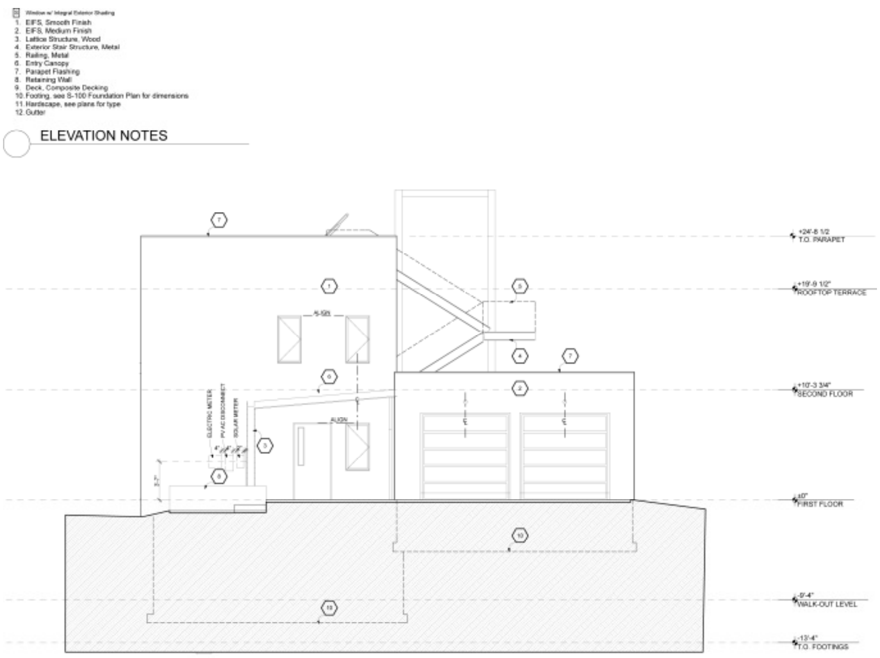
2.2 PROJECT DESCRIPTION

The Passive House in the Woods is a 3-bedroom, 180 square meter, two-story single-family home with walkout basement level, and a rooftop terrace. Commissioned by a private client, this home is the first certified Passive House in the state of Wisconsin. It sits on just over one acre in the Town of Hudson, WI—minutes from interstate 94. Located on the outer edge of a residential development, the home overlooks the St. Croix River valley. The building lot provides stunning views and prime passive solar exposure. With its renewable energy systems, it is projected to make more energy than it consumes and achieve carbon-neutral operation with two people. You may find more information about this project at passivehouseinthewoods.com.



East elevation (covered entry)

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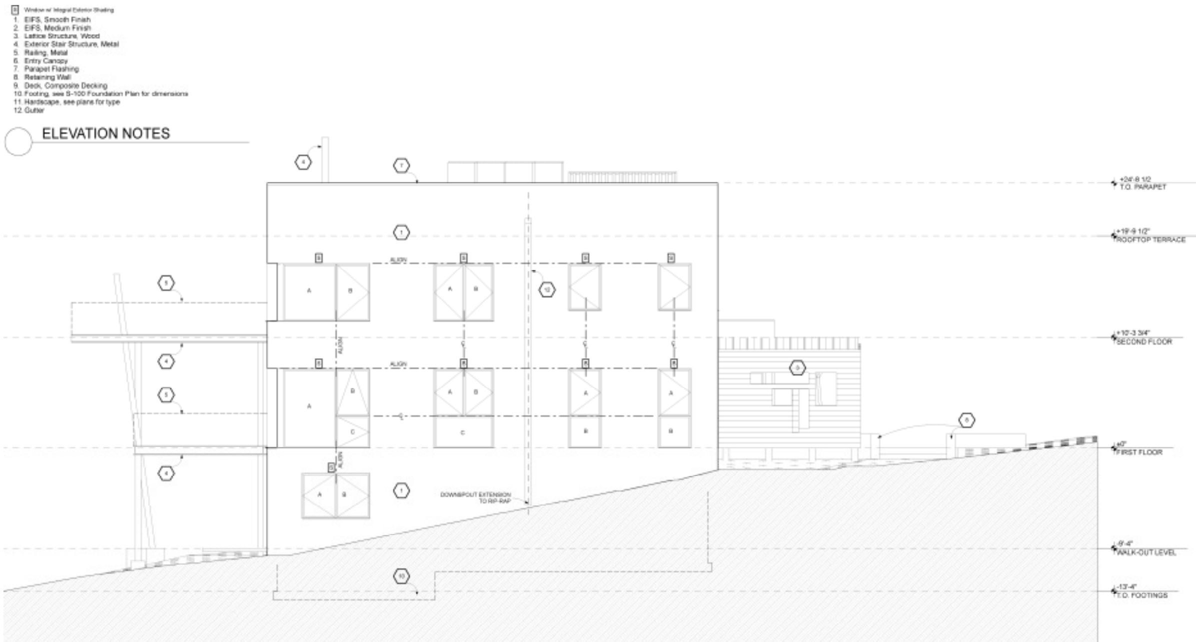
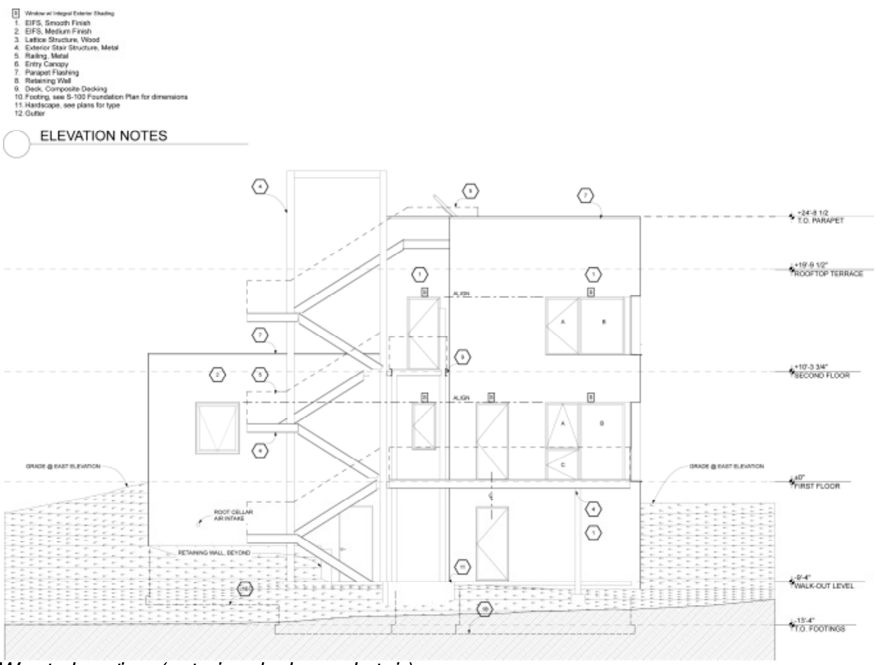


South elevation (solar facade)



West elevation (exterior decks and stair)

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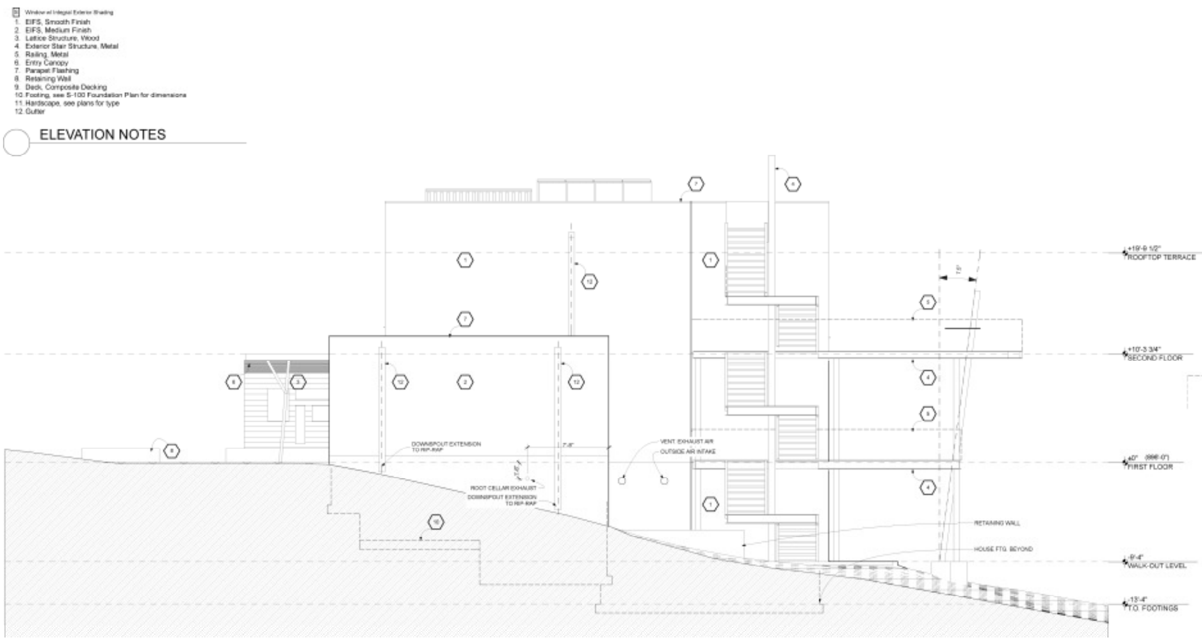
Southwest perspective



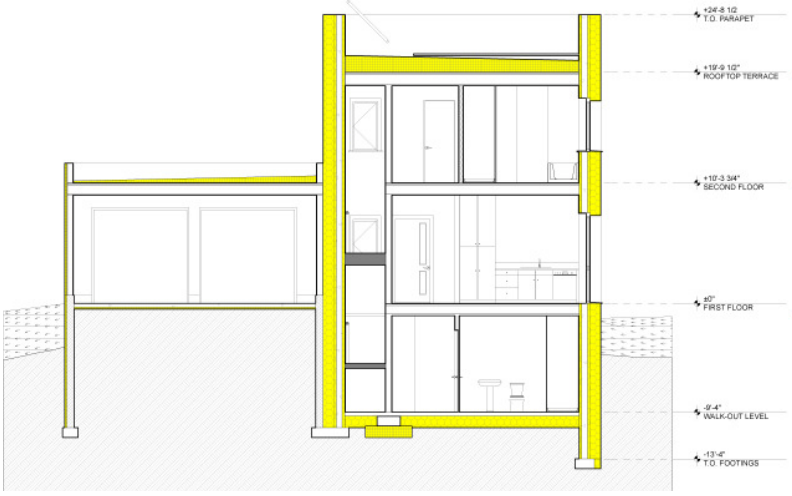
North elevation (garage and exterior stair)

2.4 INTERIORS

Upper floor master bedroom

Lower floor family room

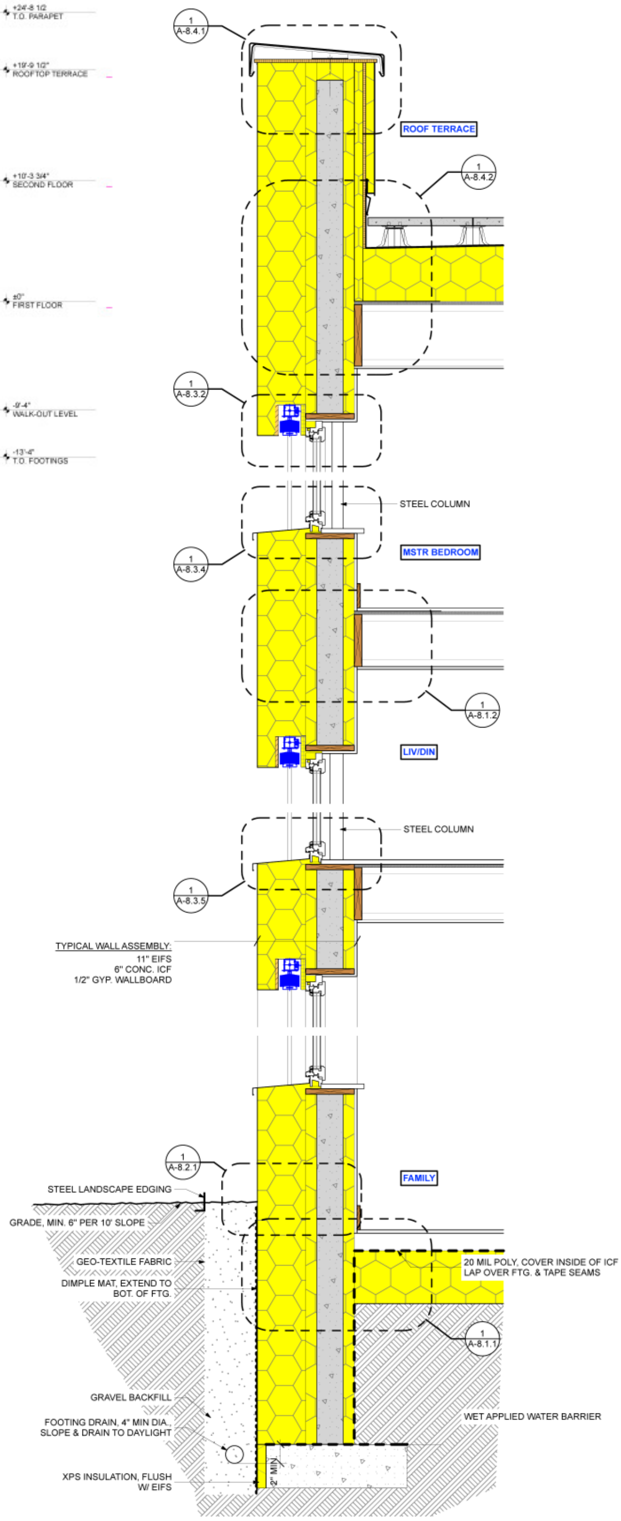
2.5 BUILDING SECTION



Typical North-South Building Section

The building envelope of the Konkol residence is very uniform. The below and above grade walls are made from the same insulated concrete form (ICF) assembly with exterior insulation and finish system. The basement slab rests on foam insulation—the roof deck is topped with foam insulation. The continuous concrete pour inside the ICF forms offers tremendous strength and helps with airtightness. R-values are very high and continuous. Both the garage as well as the exterior steel stair and deck structure are self-supporting and do not interrupt the building envelope.

The North side of the home is largely covered by the garage, which is essentially built up to the home but does not share any assemblies with it—making the house's envelope continuously the same. There aren't any windows on the North side at all. The south side opens up for maximum solar heat gains. The windows are shaded with an automated exterior shading system.

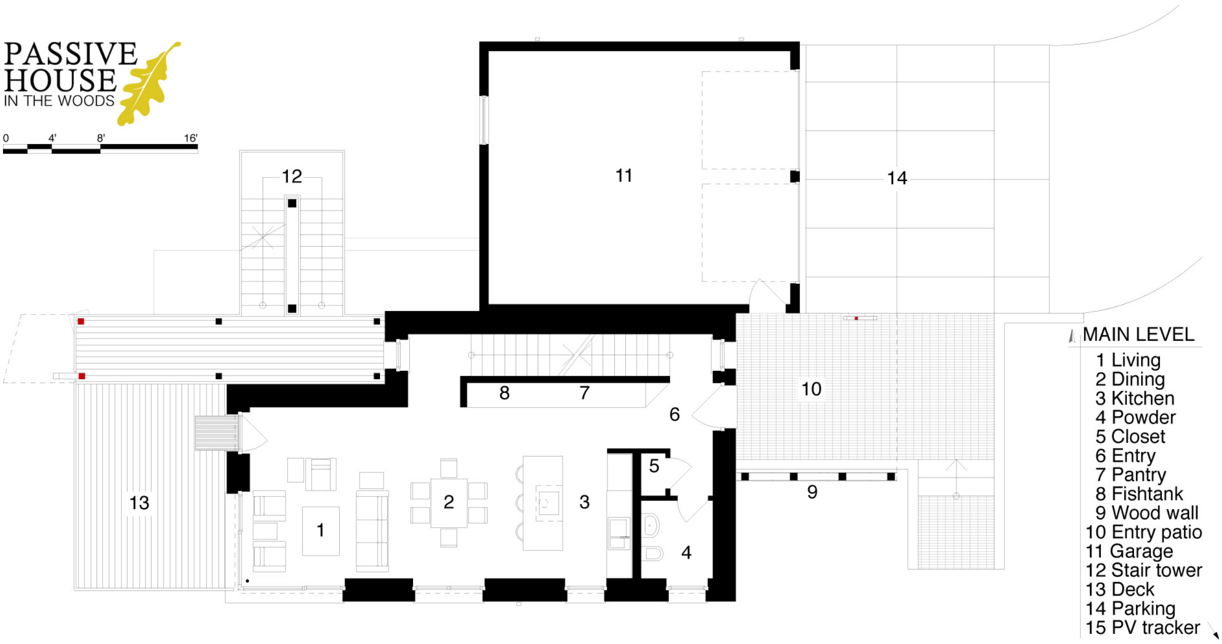


Typical assembly section

2.6 FLOOR PLANS

Lower level floor plan

The covered entry and garage access are located on the main level from the East. The main stair is located along the North wall with storage cabinets lining it on each floor. The main level holds the kitchen, dining, and living area, as well as a powder room. Storage, mechanicals, and a guest suite/ family room are located on the walkout level, which provides access to the backyard.



Main level floor plan

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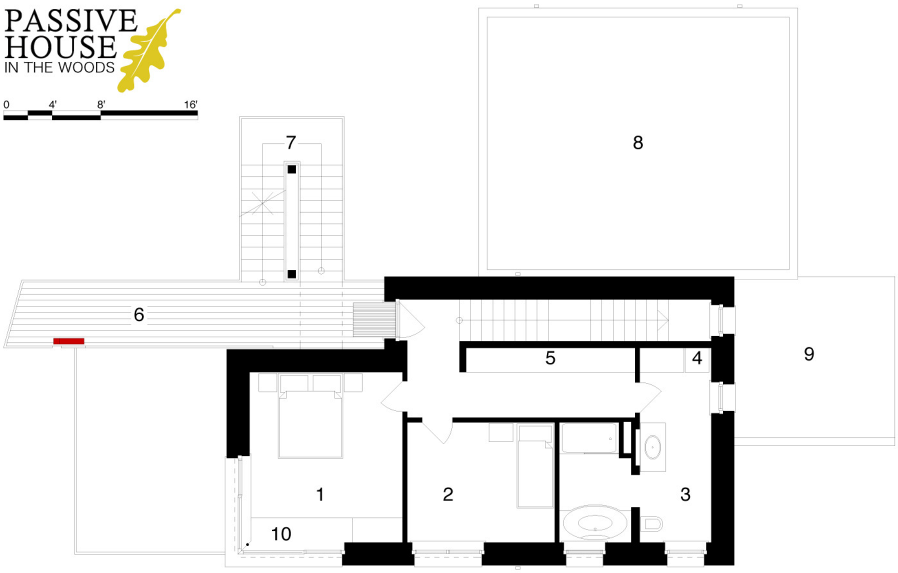
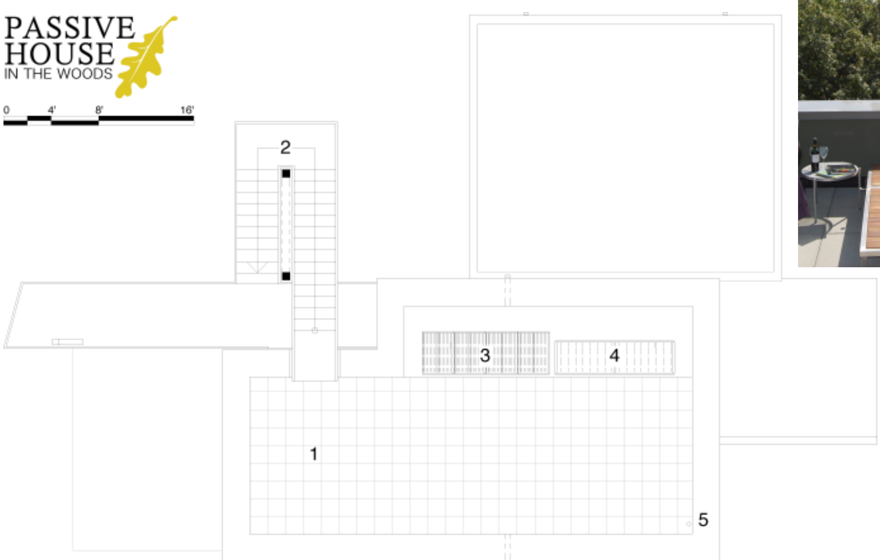


UPPER LEVEL
1 Master
2 Bed room
3 Bath
4 Laundry
5 Built-ins
6 "Plank"
7 Stair tower
8 Green roof
9 Canopy roof
10 Window seat

Upper level floor plan

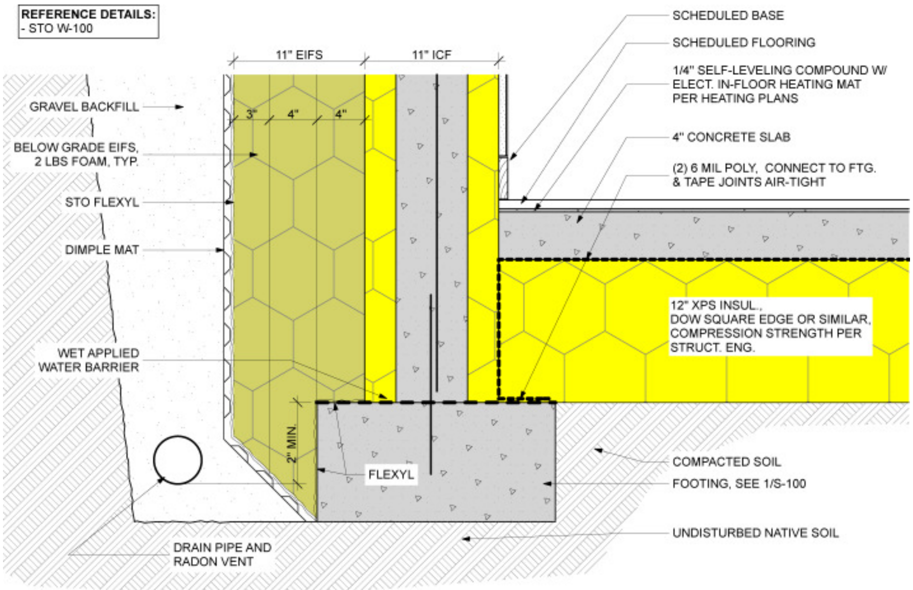
The upper floor contains the more private bedrooms and a joint bath/ laundry room. Both the main and upper floor offer access to the exterior decks on the West side, as well as the exterior stair structure on the North side, which connects all levels from the ground all the way to the roof top terrace. The rooftop terrace holds part of the photovoltaic system and the solar thermal panel. It offers spectacular views over the St. Croix River valley.



ROOF
1 Rooftop terrace
2 Stair tower
3 Photovoltaic
4 Solar thermal
5 Weather station

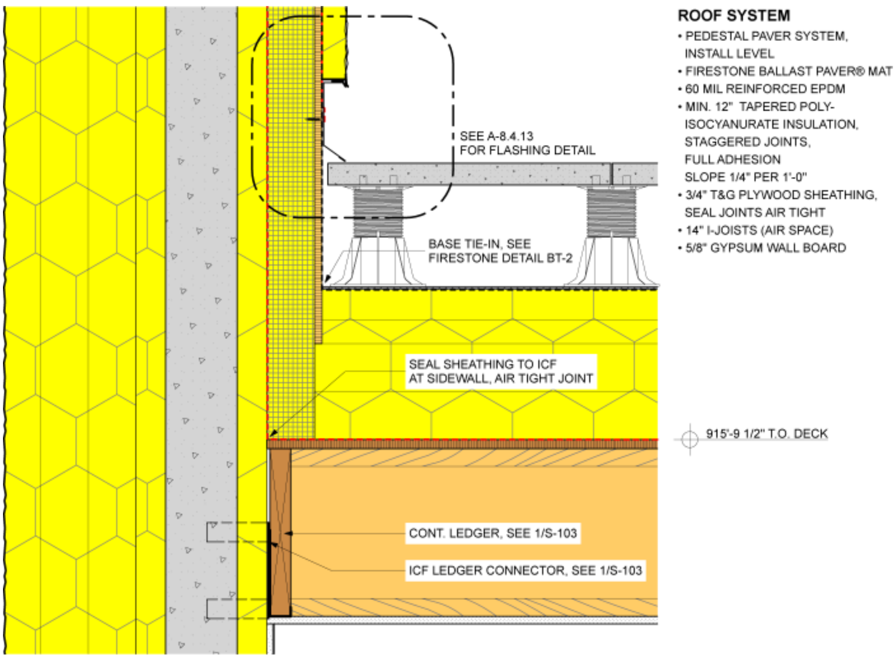
Rooftop terrace floor plan

2.7 CONSTRUCTION DETAILS



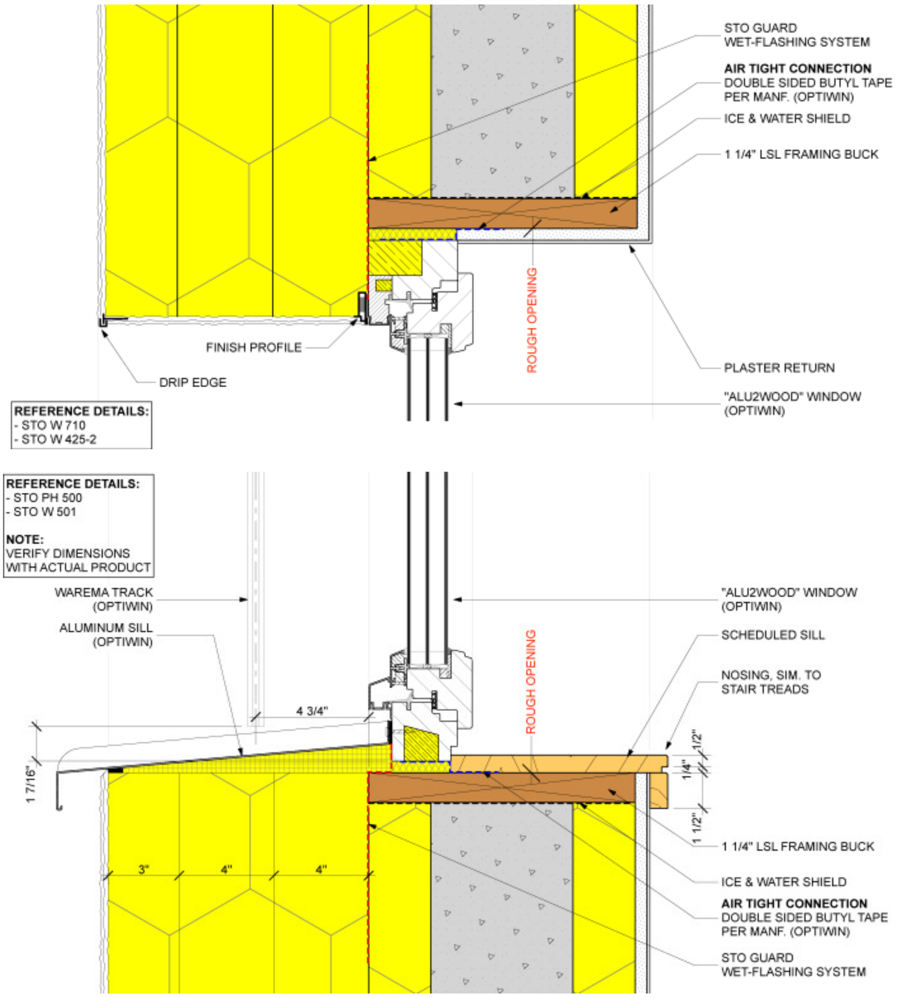
2.7.1 Slab to basement wall detail

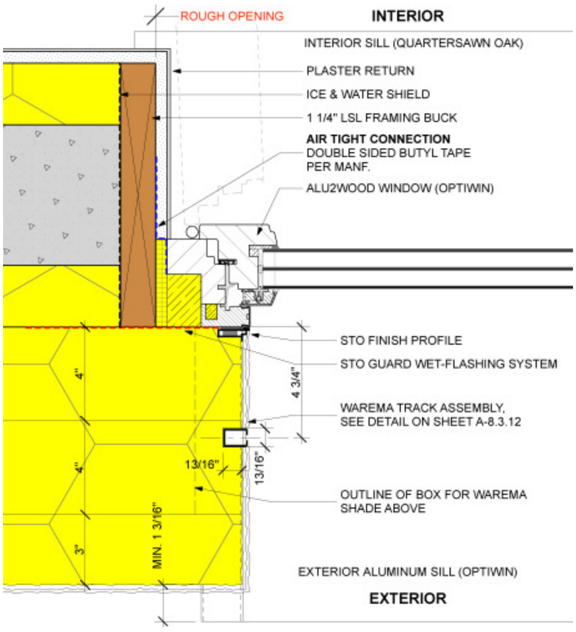
The building envelope (exterior walls) is homogenous, i.e. continuous ICF construction with Exterior Insulation Finish System (EIFS). Connection details at interior walls and floors do not present a protrusion of the airtightness or insulation layers.



2.7.3 Exterior wall to roof connection

The building envelope (roof system) is homogenous. The insulation is located on the exterior of the structure. The EPDM roof is covered with a concrete paver system.





2.7.4 Window details

We used German-made Optiwin windows that are built into the insulation layer of the walls and significantly reduce thermal bridges.

Frame: Optiwin Alu2Wood
(PH certified installation)
Glazing: GlasTrösch Silverstar TRIII E - EW

The windows deliver an installed overall U_W-value of 0.82 W/(m^{2}K).

The glazing offers an U_g-value of 0.64 W/(m^{2}K) and a solar heat gain coefficient of 64%.

A Warema exterior shade system is used to control the amount of passive solar heat gains.

2.7.5 DESCRIPTION OF THE AIRTIGHT ENVELOPE

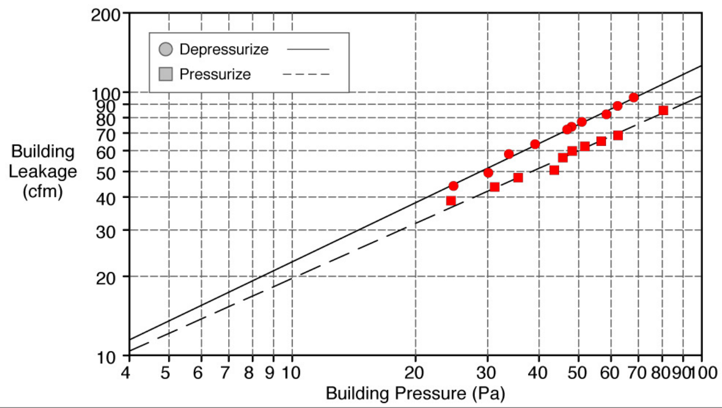
Two layers of polyethylene membrane, which are sealed and taped at connections and protrusions, provide the airtightness of the basement slab. The exterior walls are made from Insulated Concrete Forms (ICF), which provide the airtightness. A liquid-applied membrane is used as the airtightness layer on top of the roof sheathing. Windows and doors are sealed with tape. Protrusions are caulked and foamed.

BUILDING LEAKAGE TEST

Date of Test: 9/4/2010 | Technician: Gary Nelson
Test File: PHinTheWoods | Project Number:
Customer: Tim Eian | Building Address: PH in the woods

Phone:
Fax:

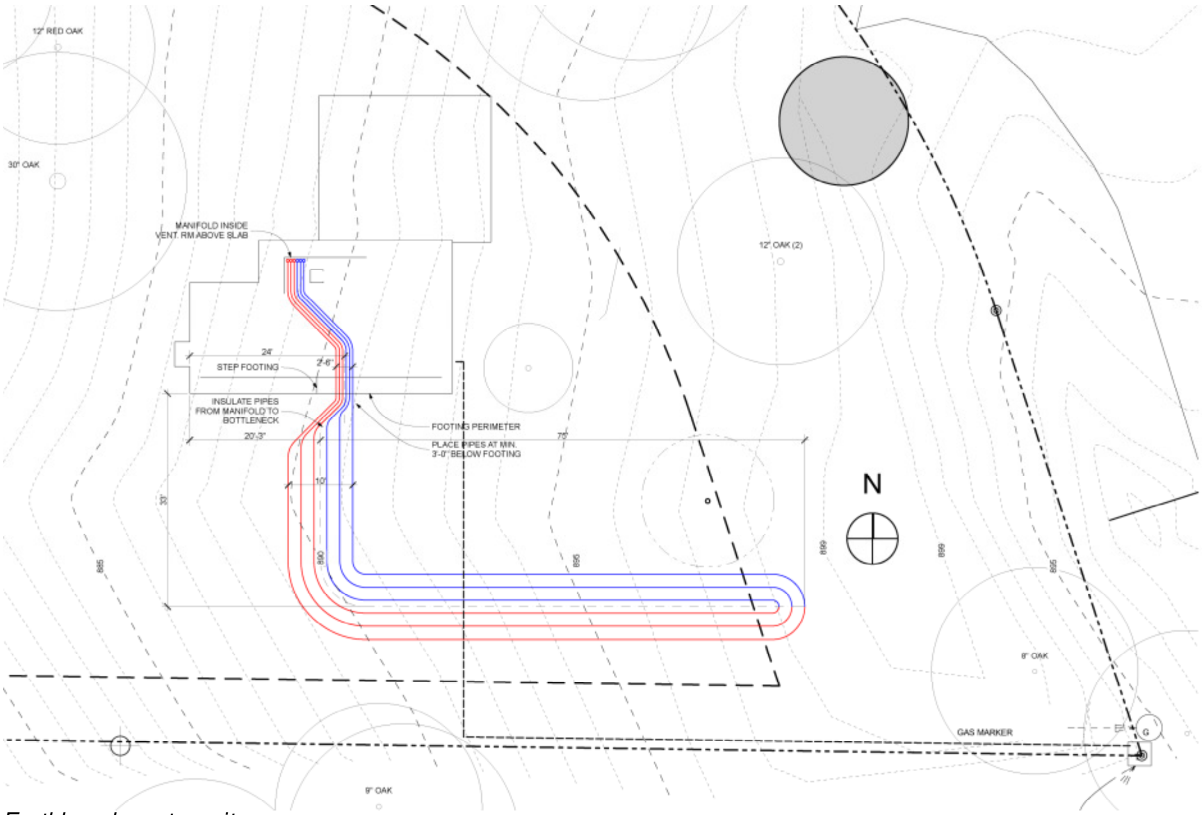
	Depressurization	Pressurization	Average
Test Results at 50 Pascals:			
V50: cfm Airflow	75 (+/- 1.4 %)	60 (+/- 2.3 %)	68
n50: 1/h Air Change Rate	0.28	0.22	0.25
w50:			
q50:			
Leakage Areas:			
Canadian EqLA @ 10 Pa (in²)	6.7 (+/- 8.7 %)	5.8 (+/- 12.4 %)	6.2
LBL ELA @ 4 Pa (in²)	3.3 (+/- 13.5 %)	2.9 (+/- 19.1 %)	3.1
Building Leakage Curve:			
Air Flow Coefficient (Cenv)	3.9 (+/- 20.8 %)	3.8 (+/- 29.3 %)	
Air Leakage Coefficient (CL)	4.1 (+/- 20.8 %)	4.0 (+/- 29.3 %)	
Exponent (n)	0.746 (+/- 0.053)	0.694 (+/- 0.074)	
Correlation Coefficient	0.99624	0.99163	
Test Standard:	EN 13829		
Test Mode:	Depressurization and Pressurization		
Type of Test Method:	A		
Regulation complied with:	PHIUS		



The pressure test was done with the help of the Tactite software using the prescribed DIN EN 13829 protocol. The building averaged n_{50} of 0.25/h.

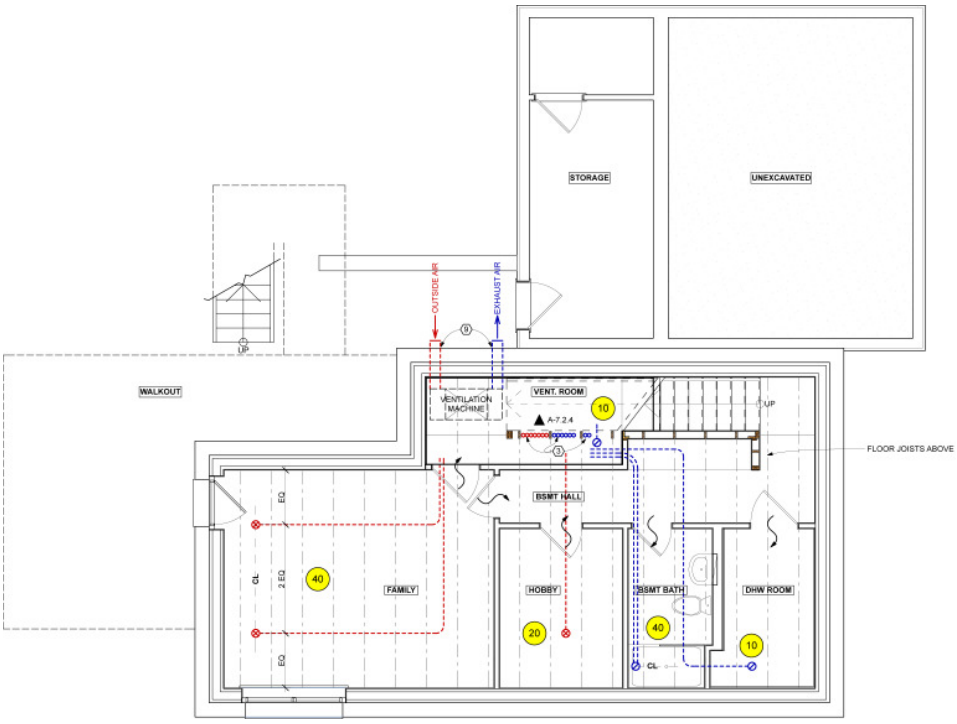
2.7.6 VENTILATION LAYOUT

The ventilation system in the Konkol house is augmented by a 180 m PEX tubing earthloop system that can prewarm the incoming ventilation air in the winter, and precool and dehumidify it in the summer. The earthloop was engineered with the help of Dipl.-Ing. Thomas Brandmeier at Lüfta. It is buried at a minimum depth of 1.8 m and individual pipes are spaced 50 cm apart to maximize thermal transfer. The earthloop is brought into the building through the floor and connects directly to a manifold and heat exchanger. It is designed to deliver approximately 1 kW of heating or cooling energy to the incoming airstream.

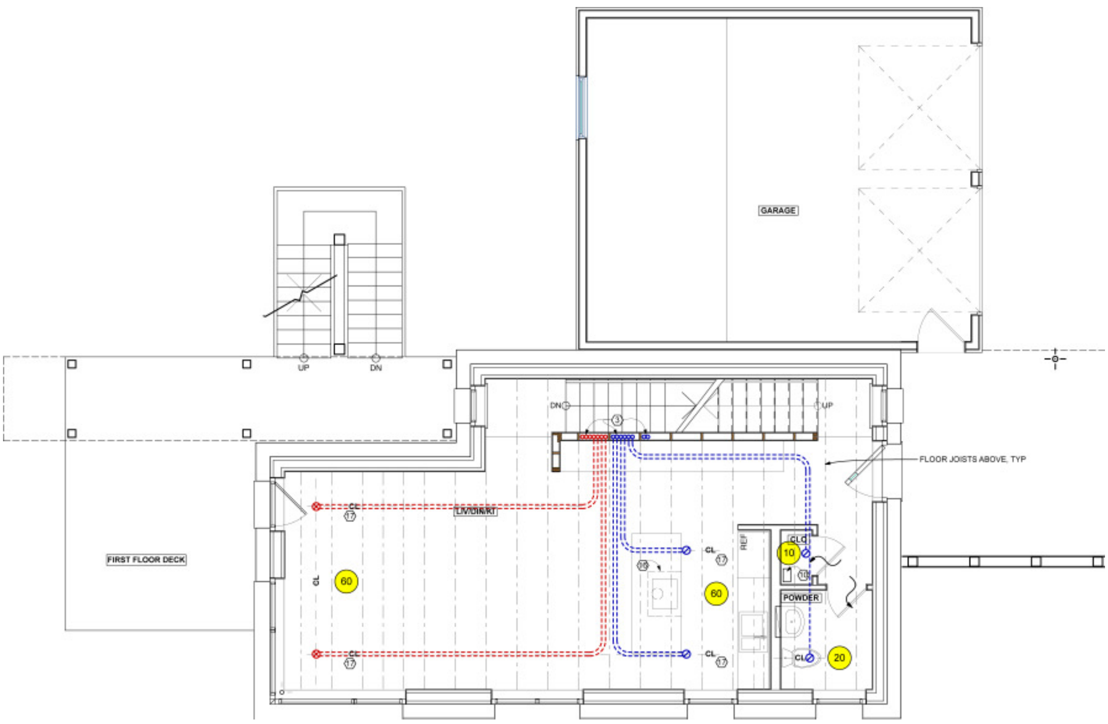


Earthloop layout on site

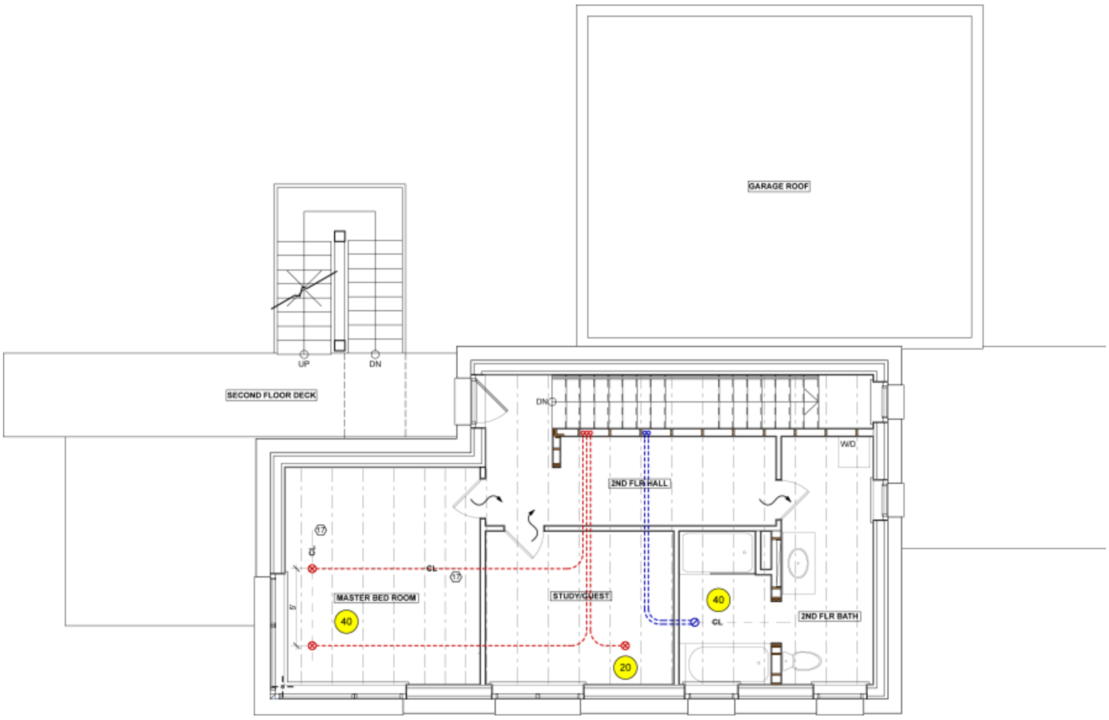
The duct system inside the home is home run. Outside air is supplied to living spaces and bedrooms, exhaust air returned from the kitchen, baths, and mechanical spaces. Adjustable diffusors were used to control air volumes. We identified a common wall alongside the main staircase for vertical runs—keeping overall duct lengths extremely short.



Walkout level ventilation plan

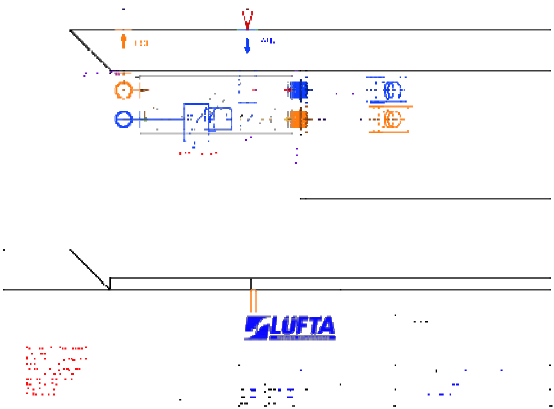


Main floor ventilation plan

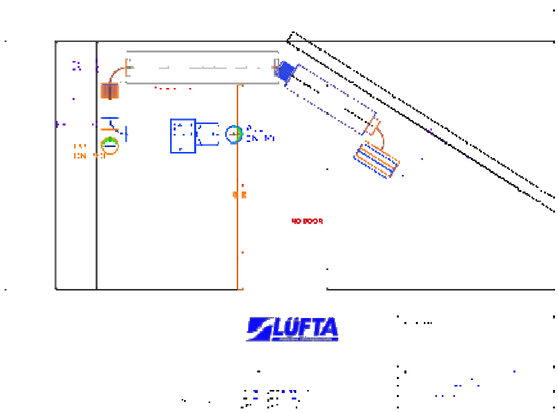


Upper level ventilation plan

The ventilation machine is installed in a space below the stair landing on the walkout level. Air intake and exhaust pipes connect straight through the wall—keeping them extremely short.

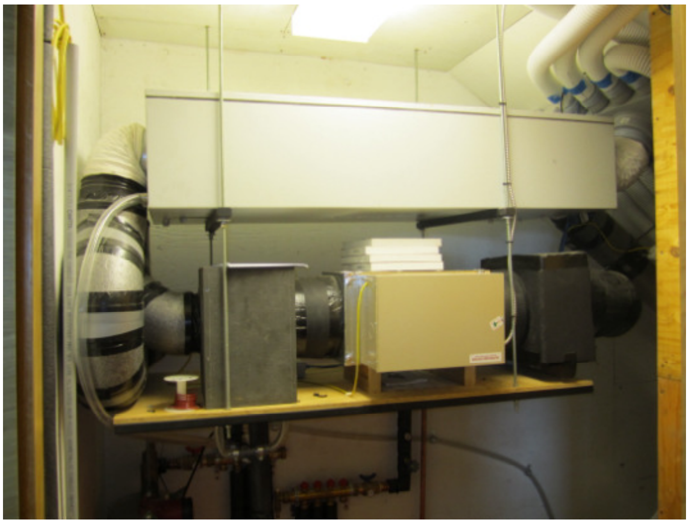


Schematic plan of ventilation machine install



Schematic elevation of ventilation machine install

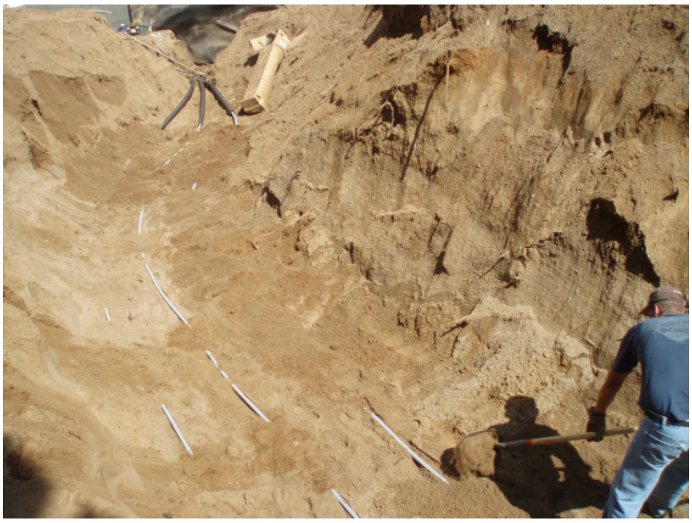
2.7.7 TYPE OF VENTILATION, INSULATION FOR DUCTS, COMMISSIONING



We used Lüfta's LS 300 DC-K ventilation machine with HRV core and combined it with Inno Products' Innoflex ductwork and diffusors for the interior distribution. Supply and exhaust runs to the exterior utilize Inno Products' Isoduct graphite-enhanced EPS insulated ductwork. The system was engineered with the help of Lüfta and installed, balanced, and commissioned by Peak Building Products.

The ventilation machine offers a summer bypass to maximize passive cooling when available. The controls respond to air-quality measurements and can automatically adjust the rate of ventilation accordingly.

Central Unit:	Lüfta LS 300 DC-K
Type:	HRV
Specific Values:	82% heat recovery/ 0.38 Wh/m^3 electric efficiency



2.7.8 HEATING STRATEGY

The heat load for the home (approx. 3 kW) is delivered with the help of electric in-floor heating mats in 7 zones throughout the home. Individual thermostats control each zone, and can be programmed for comfort. The heating system is twice oversized (approx. 6 kW) to provide reasonable recovery time should the building ever be below design temperature in the winter.

Electric in floor heating mats during installation

Concrete over-pour on top of electric in floor heating mats

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2.8 PHPP VERIFICATION PAGE

Building:	Passive House in the Woods		
Location and Climate:	Town of Hudson, WI	Minneapolis TMY3	
Street:	908 Kirkwood Way North		
Postcode/City:	Town of Hudson, WI 54016		
820	USA		
Building Type:	Single Family Detached		
Home Owner(s) / Client(s):	Gary Konkol		
Street:	T Kinsman		
Postcode/City:	Hudson, WI 54016		
Architect:	Tim Delhey Eian TE Studio, Ltd.		
Street:	3429 Benjamin St. NE		
Postcode/City:	Minneapolis, MN 55418		
Mechanical System:	TE Studio, Ltd. & Luefta GmbH		
Street:	3429 Benjamin St. NE		
Postcode/City:	Minneapolis, MN 55418		

Year of Construction:	2010		A/V Ratio:	0.20	
Number of Dwelling Units:	1		Interior Temperature:	20.0	°C
Enclosed Volume V_e:	820.5	m^3	Internal Heat Gains:	2.1	W/m^2
Number of Occupants:	4.7				

Specific Demands with Reference to the Treated Floor Area

	Applied:	Annual Method	PH Certificate:	Fulfilled?
Treated Floor Area:	164.5	m^2		
Specific Space Heat Demand:	**11**	**kWh/(m²a)**	**15 kWh/(m²a)**	**Yes**
Annual Heat Demand QH	**1819**	**kWh/a**		
Pressurization Test Result:	**0.3**	**h^{-1}**	0.6 h^{-1}	**Yes**
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):	**105**	**kWh/(m²a)**	120 kWh/(m²a)	**Yes**
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	55	kWh/(m²a)		
Specific Primary Energy Demand Energy Conservation by Solar Electricity:	82	kWh/(m²a)		
Heating Load:	18	W/m²		
Heating Load PH	2990	W		
Frequency of Overheating:	2	%	over 25 °C	
Specific Useful Cooling Energy Demand:	1	kWh/(m²a)	15 kWh/(m²a)	Yes
Cooling Load:	7	W/m²		

2.9 CONSTRUCTION COST

Withheld per owner request.

2.10 COST FOR THE BUILDING

Withheld per owner request.

2.11 YEAR OF CONSTRUCTION

2009/ 2010

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2.12 DESIGN OVERVIEW

The building was designed from the outset to become a Passive House. The first PHPP was completed during schematics, and subsequently kept current with design evolutions. The construction methods were selected specifically with airtightness in mind, as the local building industry does not have a lot of experience with airtight buildings. Fenestration and glazing were fine-tuned using the PHPP.

In an effort to deliver a holistic and sustainable design, the building was also designed to meet the Minnesota GreenStar Gold level of certification. Minnesota GreenStar is a checklist approach. It focuses on energy efficiency, resource efficiency, water conservation, indoor environmental quality, and site and community impact.

The home was designed by Dipl.-Ing. Tim Delhey Eian of TE Studio, Ltd. with the help of Christine Frisk of InUnison, Inc. (interior design) and Laurie McRostie (landscape architecture).

2.13 TECHNICAL DESIGN OVERVIEW

The technical systems were designed by Dipl.-Ing. Tim Delhey Eian of TE Studio, Ltd. in collaboration with Dipl.-Ing. Thomas Brandmeier, Lüfta GmbH (ventilation and earthloop system), Craig Tarr of Energy Concepts, Inc. (renewable energy systems) and Carol Chaffee (lighting design and control system).

2.14 PHPP MODELING & CERTIFICATION

The PHPP modeling was done by Dipl.-Ing. Tim Delhey Eian of TE Studio, Ltd. Ryan Abendroth of the Passive House Institute U.S certified the building. Katrin Klingenberg of the Passive House Institute U.S. issued the Passive House certificate on September 19, 2010.

2.15 STRUCTURAL ENGINEERING

Eric Bunkers, P.E. of Mattson Macdonald Young provided structural engineering for the project.

2.16 EXPERIENCES

The house has been occupied now for about one year. We learned a lot during that time, and continue to learn from it now. To give an example: The high solar heat gain potential of the window glazing requires proper shading at all times. Being that the building is of medium mass, there is not a lot of storage capacity for passive solar heat gains, which results in temperature swings. We learned that in our climate zone, more mass, and slightly lower solar heat gain coefficients will likely yield less temperature swings and more comfort.

At the end of the day however, we are most pleased with the building, and the owner feedback corroborates our efforts to deliver a high-performance building.

Owner feedback summer:

“Yesterday, my house was nice and cool without humidity when I arrived home at 9:30 pm. It's working!”

“The interior temperature of the house Tuesday was 78 degrees (25.5 C) with 35% relative humidity, outside it was 103 degrees (39.5 C) and very humid. The interior was comfortable with an overhead fan, a bit warm without it. With the outdoor cooling, the house ventilates very well, cooling down nicely.”

Owner feedback winter:

“For instance, yesterday it was 5 degrees (-15 C) for a high temperature outside. My house was 76 degrees (24.4 C) air temperature inside at 5:00 pm, while the granite counters were at least 80 to 90 degrees. It was down right near tropical. What a performance the house is providing.”

2.17 MONITORING

The building’s energy consumption and production is being monitored with the help of Powerhouse Dynamics’ e-Monitor system. The owner as well as the architect can access the information.

2.18 REFERENCES

• Project website: http://passivehouseinthewoods.com
• Project on architect website: http://testudio.com/passive-house-in-the-woods/
• Publications: http://www.passivehouseinthewoods.com/category/publicity/