Passivhaus Documentation
Single family house, The Green, Acomb, York, UK
(Passivhaus database 5319)

Junko Suetake, Passivhaus Designer www.suetake.co.uk

The project was commenced on site in the summer of 2014, completing and achieving Passivhaus certification in November 2015.

The design took a courtyard approach to fit in the pocket site. The site is in a conservation area so that the volume, material and window patters were decided within design requirements from the local context.

U-value external walls 0.099 W/ (m^2K)   U-value floor 0.057 W/ (m^2K)

U-value roof 0.070 W/ (m^2K)   U-value window 0.82 W/ (m^2K)

PHPP space heat demand 13 kWh/ (m^2a)
PHPP primary energy demand 107 kWh/ (m^2a)
Pressure test n50 0.4h-1
Heat Recovery 89.8 %

2. Brief project description

The Acomb Passivhaus is a 3 bed 124.7 sqm detached dwelling.This two storey house uses brick of clay dug out of the ground 9 miles away, to provide a textured and simple finish. Masonry wall wide-cavity construction uses details developed by the Green Building Store. Decorative brick fins to the North windows enliven the surface as well as responding to the design constraint of overlooking. The beauty and character of brick building is maintained while achieving high standards of thermal performance and comfort.

We decided to use the cavity wall construction, which had been tried and trusted with a wide full fill cavity 300mm with basalt wall ties, and which the airtightness can be achieved by the internal plaster finish. The external finish was decided as faced brick so that masonry structure was a straight forward decision. Due to large areas of the external heat loss, we tried to lower the U-values of roof and ground whilst the wall U-value had a limit with the 300mm insulation thickness.

Architect Anne Thorne Architects **Service Design** Alan Clarke **Structural Design** SGM **Airtightness test** ALDAS **Passivhaus certifier** WARM **PHPP Passivhaus Planning and design** Junko Suetake **Contract** Croft Farm Construction **Contract (foundation)** Tower Estate Ltd **Advice** Green Building Store

3. Elevation view of the building

South West

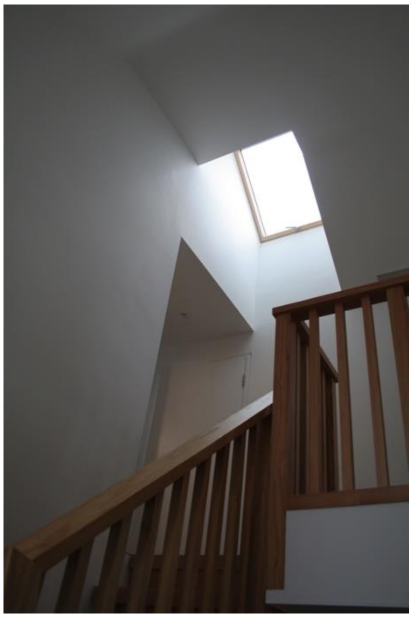
North West

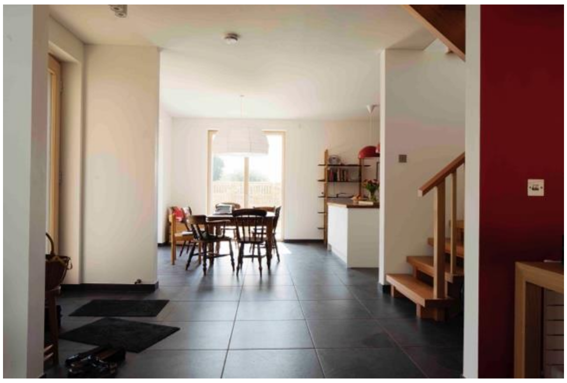
North

South East

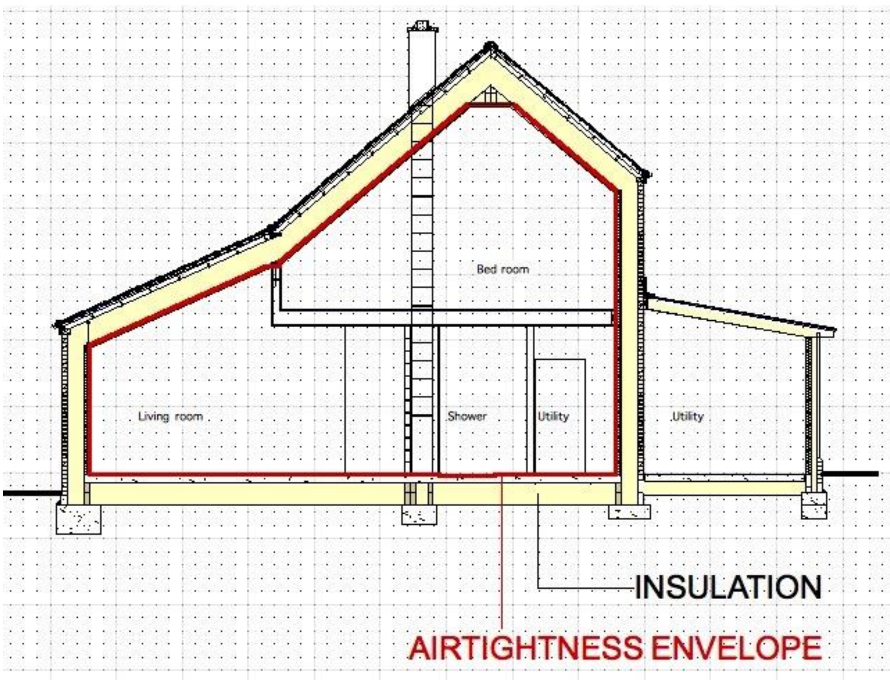
South

4. Internal views

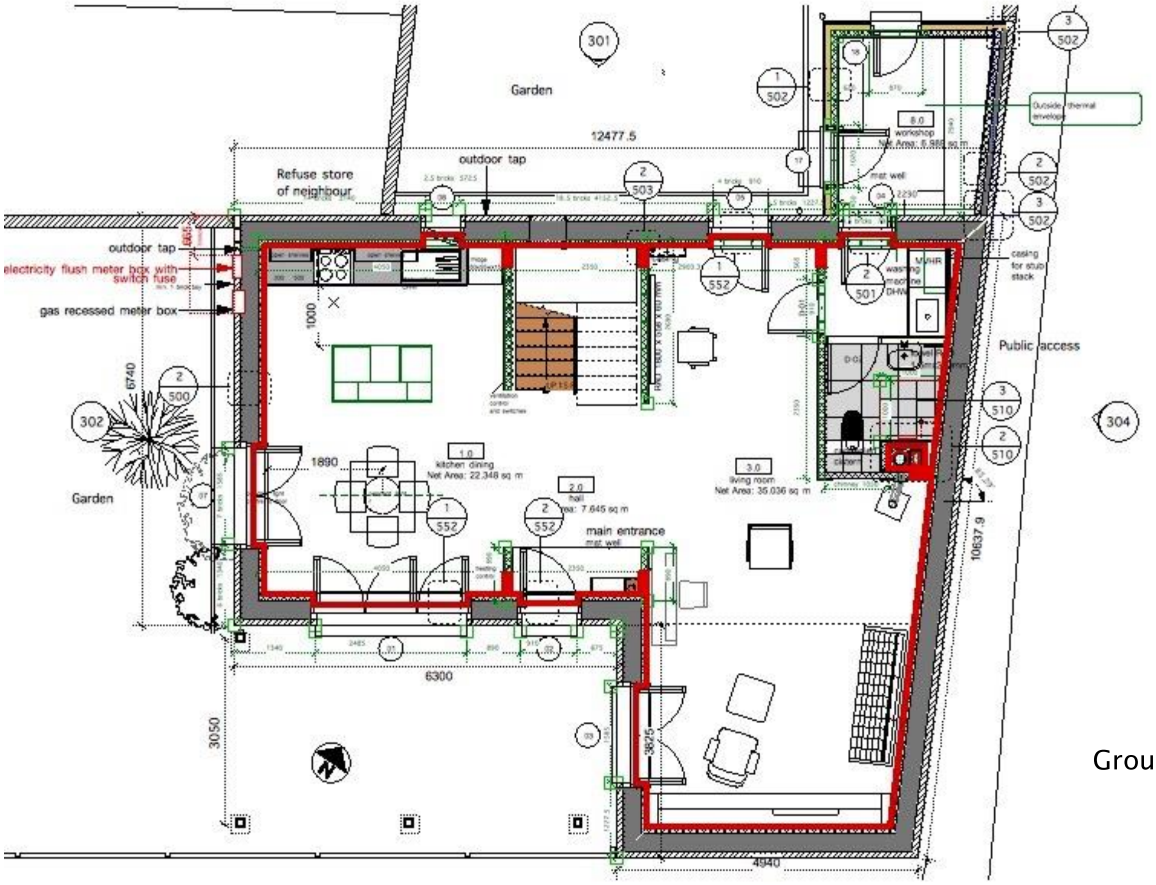




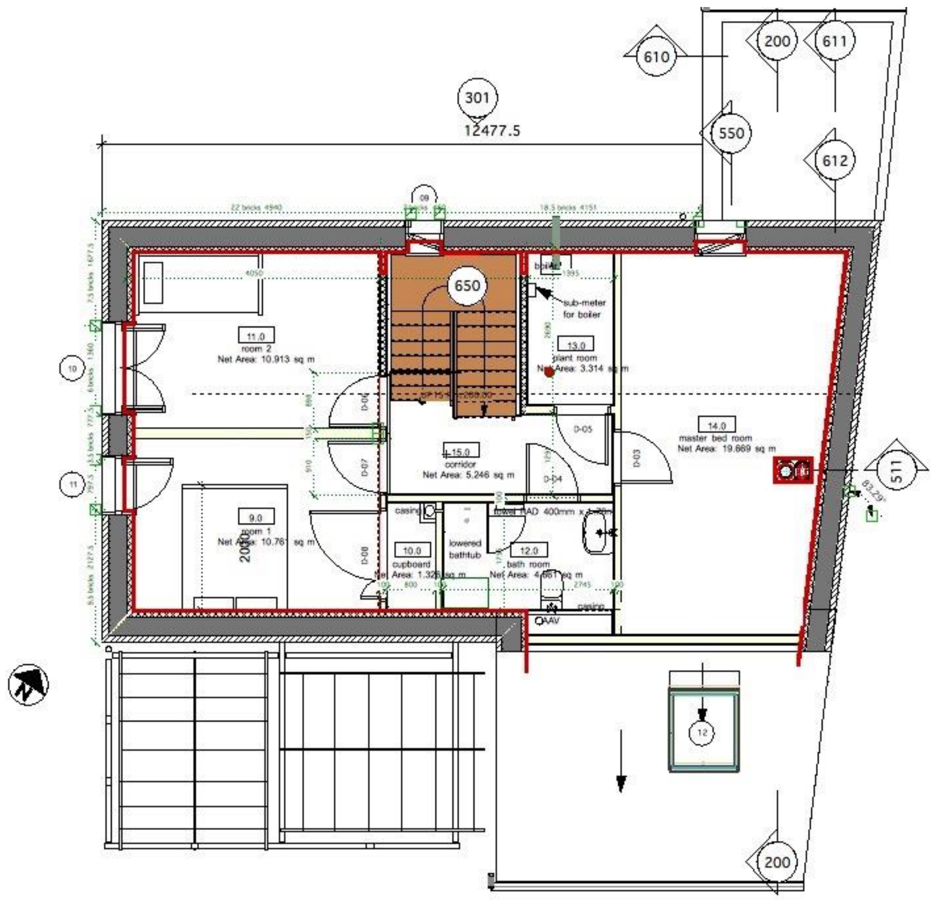
5. Section of the building



6. Floor Plans



Ground floor

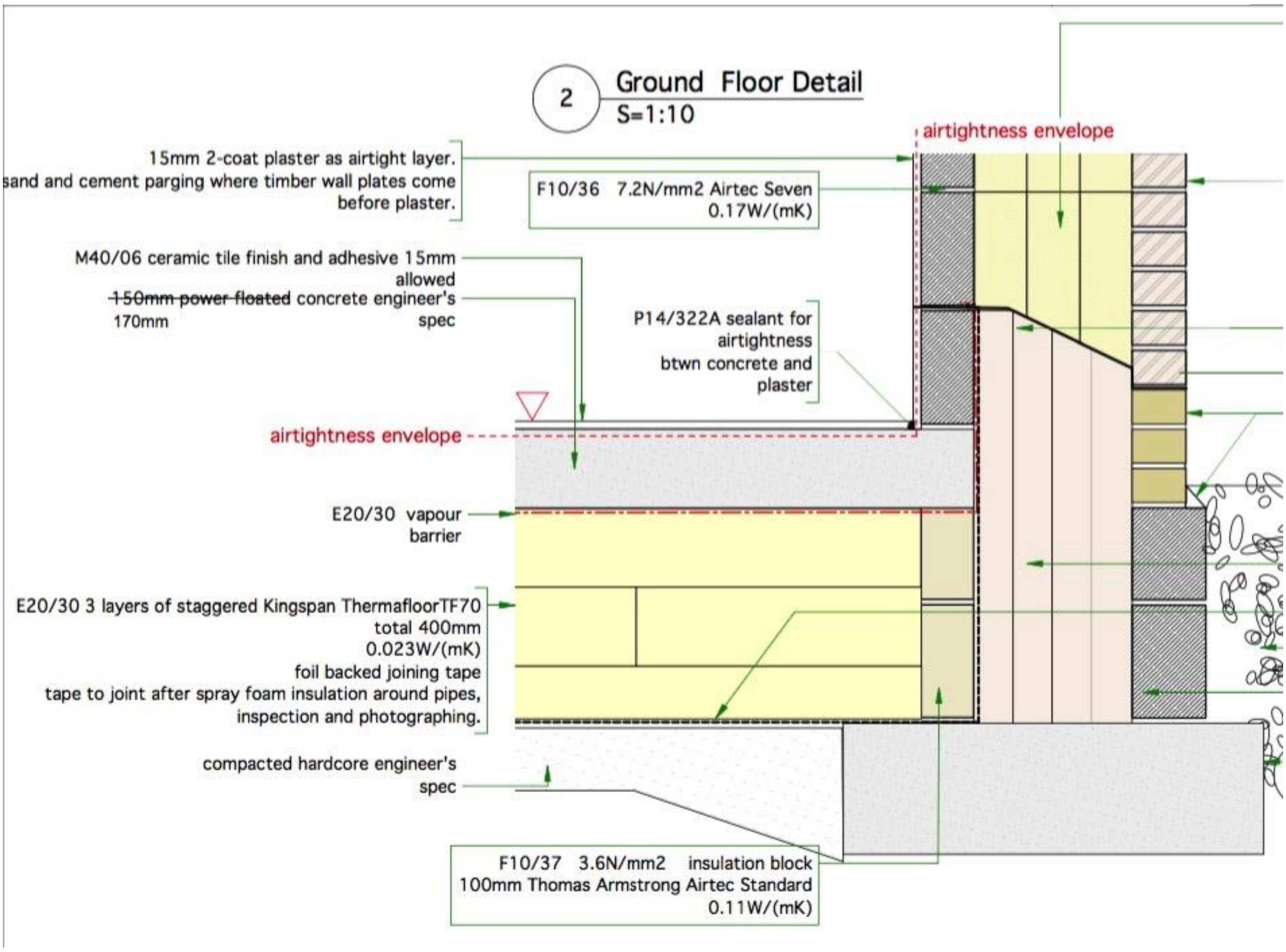


First floor

7. Construction of floor slab

U-Value=0.057 W/(m2K) Tile finish + 150mm concrete slab + 400mm Kingspan ThermafloorTF70 insulation

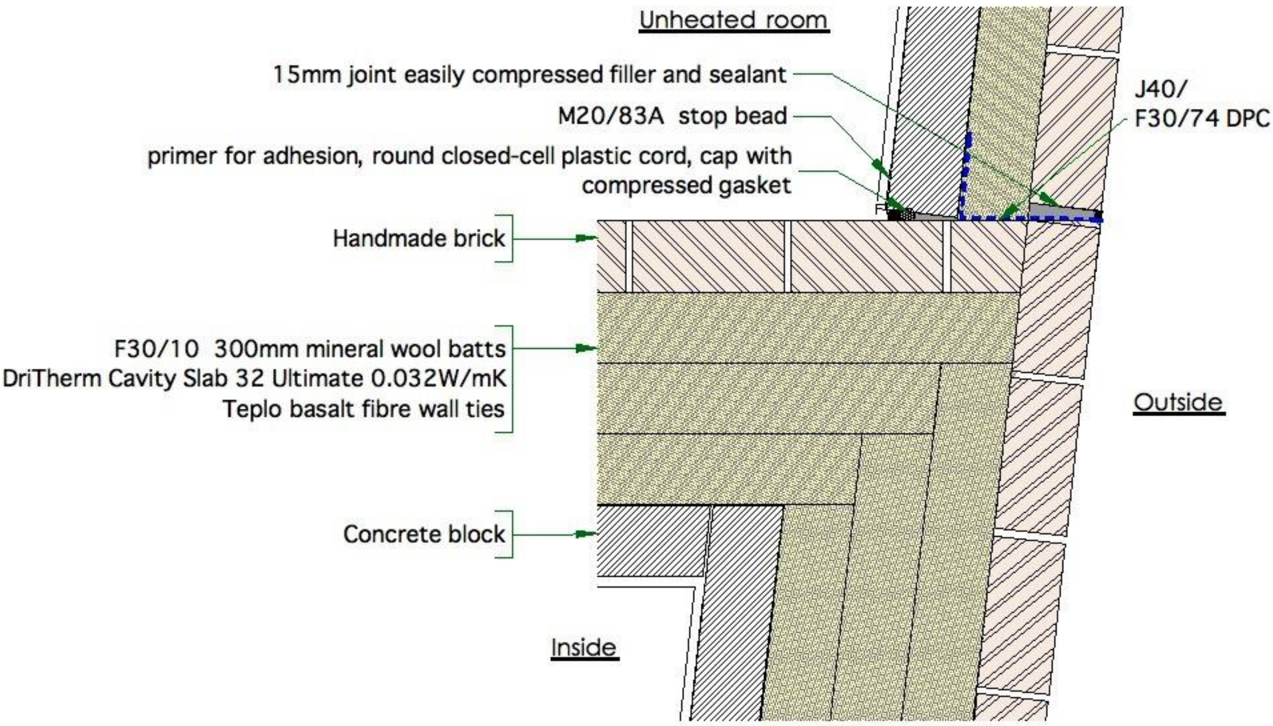
The strip foundation supports both leaves of the wall. This is detailed to minimize the thermal bridge at the ground - wall junction by using structural blocks with relatively lower conductivity and XPS insulation boards at the bottom of the walls, below the ground level and the cavity tray. The concrete slab had to be supported structurally by the block walls. The continuity of the insulations is maintained outside of concrete slab and blocks. The airtightness is continuous from the concrete slab to the plaster on the wall.



8. Construction of exterior walls

U-Value=0.099 W/(m2K) Inside 15mm two-coat plaster + 100mm concrete block Airtec Seven + 300mm water repellent glass mineral wool insulation DriTherm Cavity Slab 32 Ultimate + brick York Handmade Brick

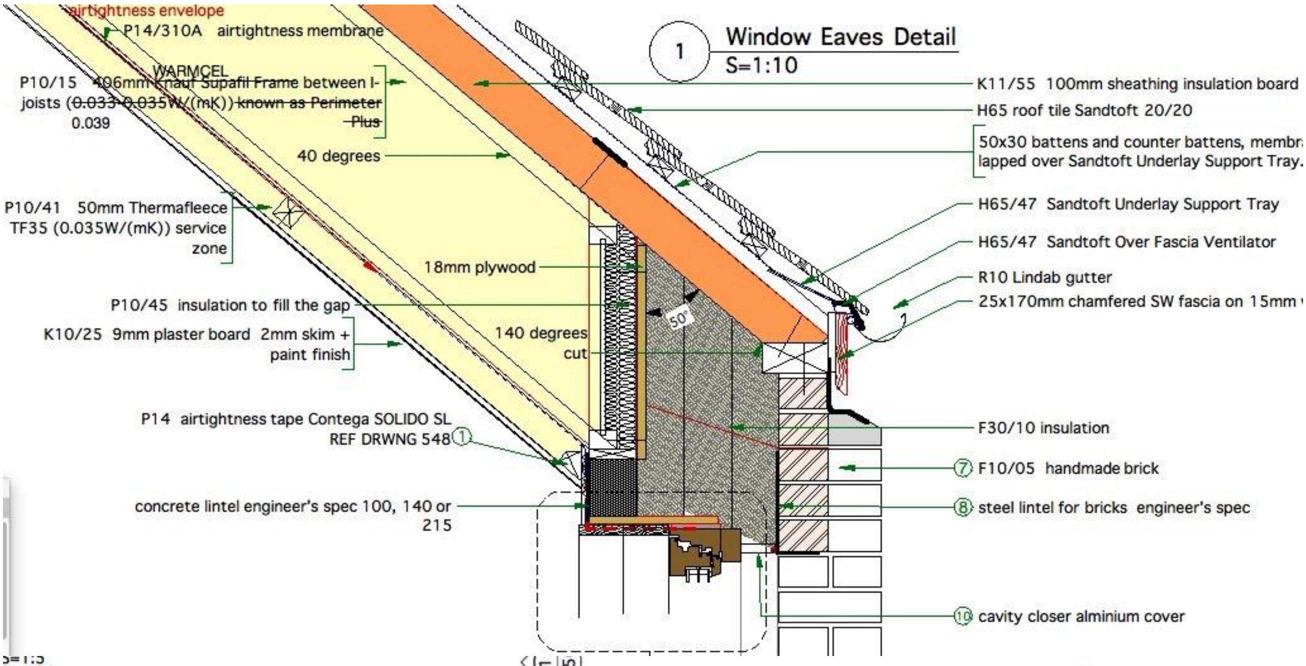
The insulation and airtightness layer is continuous at the corners. Where the wall meets the unheated room (workshop) the thermal envelope (the plaster, interior finish) is still continuous as the drawing below.

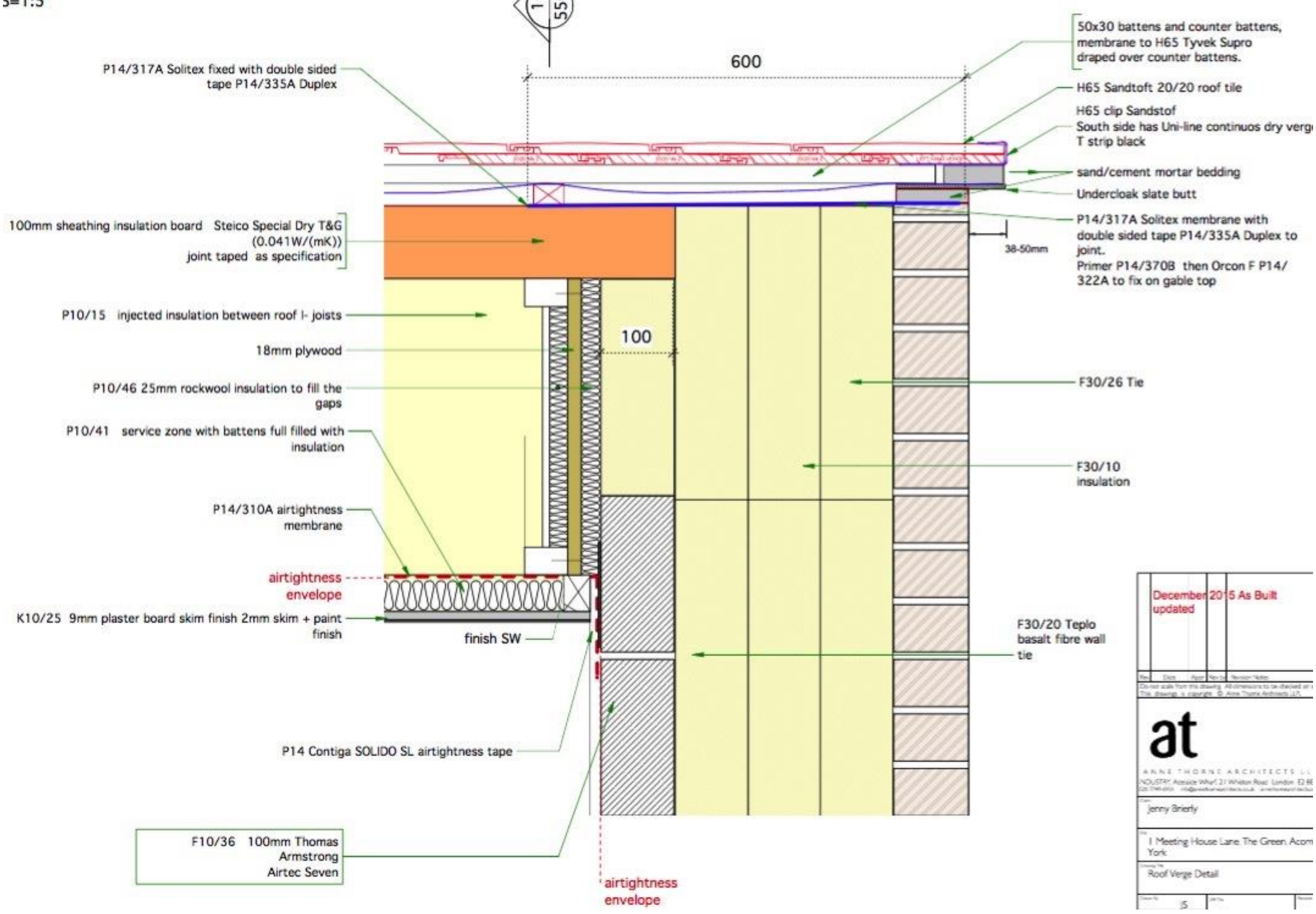


9. Construction of roof

U-Value=0.070 W/(m2K) Plasterboard+50mm sheep wool Thermafleece insulation + Airtightness membrane+ Cellulose fibre insulation Warmcel between 406mm I-joists +100mm Steico Special Dry woodfibre insulation board + Tybek membrane + Sandtoft roof tile

The insulation and airtightness layer is continuous at the gables and eaves.





10. Windows

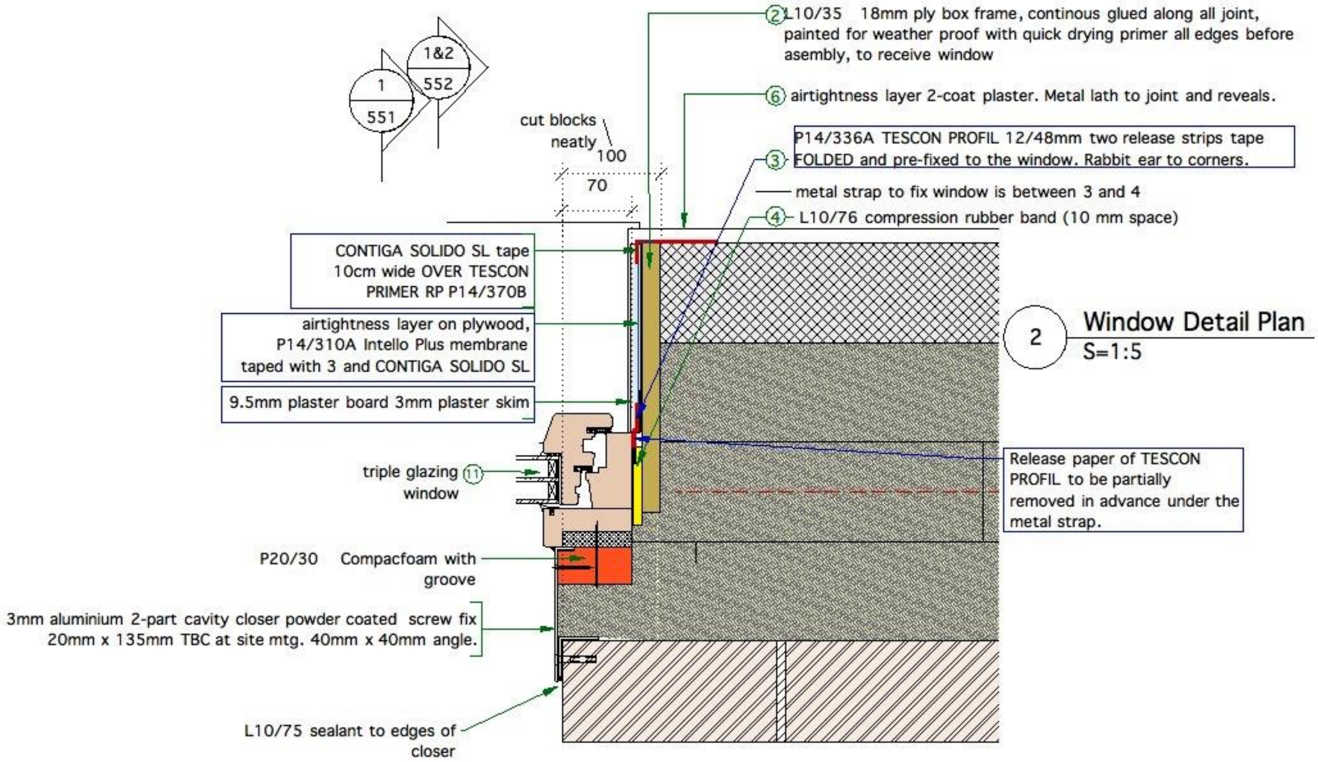
Passivhaus certified component, Progression, inward opening Tilt & turn Green Building Store, triple glazed timber & cork frame windows. Uf value 0.83 W/(m2K) (Bottom 0.81 W/(m2K))

Glazing Planitherm Lux g value 0.62 Ug value 0.618 W/(m2K)

Saint Gobain Planitherm Ultra N g value 0.50 Ug value 0.530 W/(m2K)

Rooflight FAKRO FTT U6 Uf value 1.2 W/(m2K) g value 0.45 Ug value 0.75 W/(m2K)

The windows are positioned almost at the centre of the insulation to the wall. Plywood boxes are installed to the structural opening in order to support the window and airtightness lining. At the threshold and the external reveal, insulating material Compacfoam was used as the block to mitigate the cold bridge.



11. Airtight building envelope

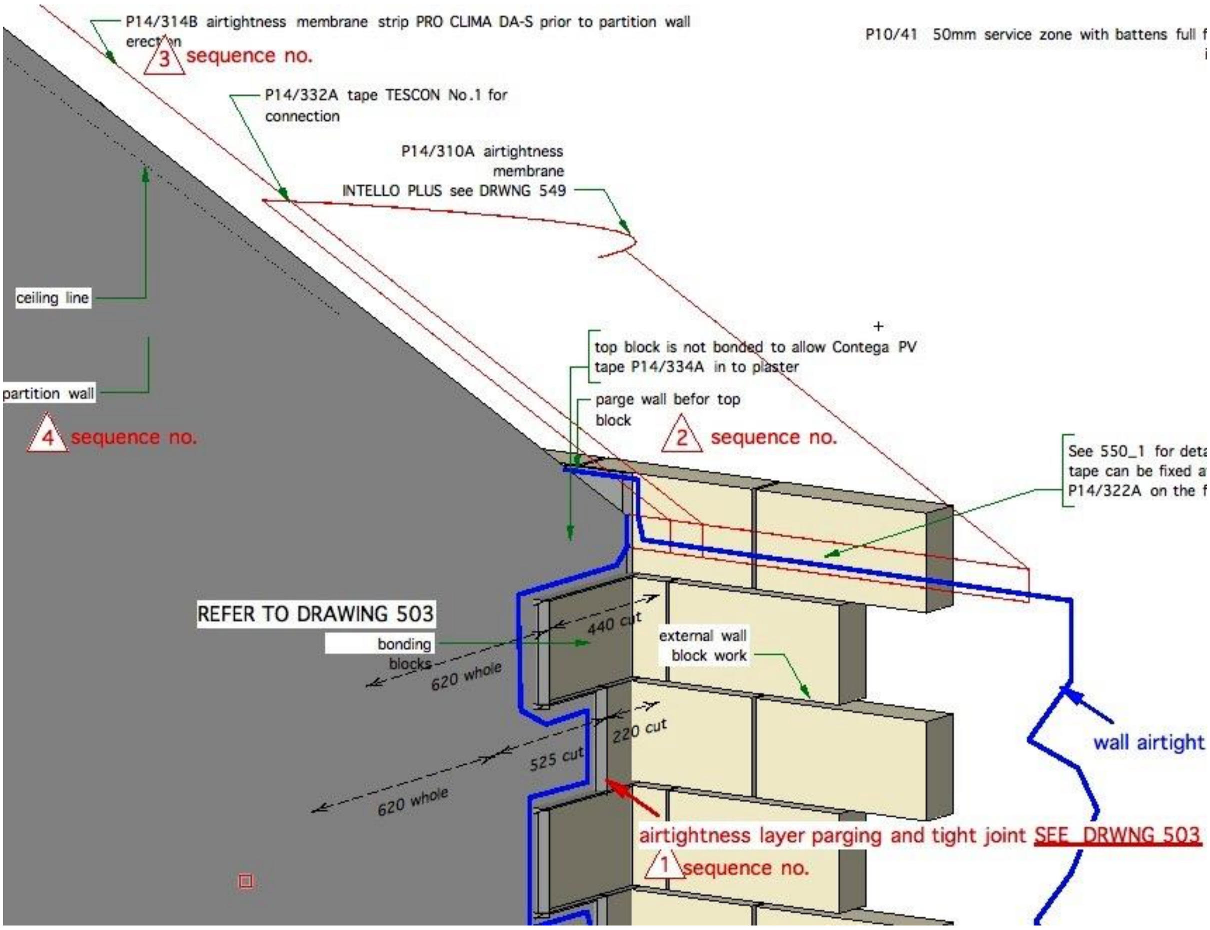
Pressure test result: air changes: 0.4 ACH-1 @50pa

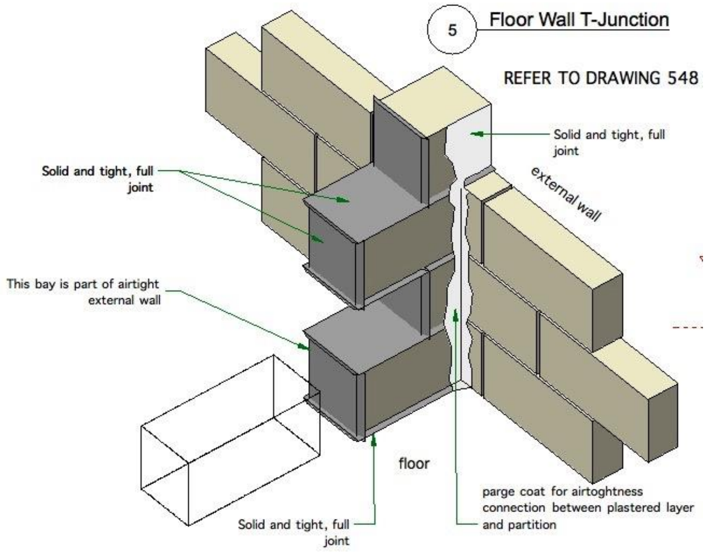
Wall: I5mm two-coat plaster

Roof: Airtightness membrane

Floor: 150mm concrete slab

Wood burning stove: RIKA Vitra Passive House with Passivhaus certified chimney system Schiedel Absolut Xpert





The airtightness envelope is completed by connecting between the reinforced concrete slab and 2-coat plaster on the wall with Orcon F sealant, and connecting between the wall and Intello Plus intelligent airtight membrane under the rafters of the roof with Contega SOLIDO SL tape, which is a fleece-faced sealing tape. Airtightness strip DA-S was used to bridge Intello Plus over the head of internal partitions. DA-S and Intello Plus was taped together with Tescon No1 tape.

Air Leakage Certificate

In accordance with BS EN 13829 and ATTMA TSL1 (2010)

Dwelling tested:		**1 Meeting House Lane, Acomb, York YO26**
Test Date:		**9th October 2015**
Test Engineer:		**Paul Jennings, Aldas**
Certificate No:		**JA5195/T03&4C**

This is to certify that the above named dwelling has been tested for air leakage in accordance with the BS EN 13829:2001 methodology and the requirements of the Passivhaus Institute. The average (pressurisation & depressurisation) Leakage Characteristics were recorded as follows:

Airflow @ 50 Pa:		146 m^3/hr
Air Permeability @ 50 Pa:		0.39 m^3/ ($hr.m^2$)
Air Change Rate @ 50 Pa:		0.40 ACH^{-1}
Correlation of Results, R^2:		1.000
Slope, n:		0.72
Intercept, C_{env}:		8.60 m^3/ ($hr.Pa^n$)
Test Parameters		
Envelope, A_E:		373.6 m^2
Volume, V:		367.0 m^3
Volume & Env. Calc. prepared by:		Junko Suetake & Paul Jennings

Initial Offset Pressure	-0.53 Pa	Final Offset Pressure:	0.00 Pa
Initial Inside Temperature:	16.4 °C	Final Inside Temperature:	16.9 °C
Average Outside Temperature:	9.7 °C	Barometric Pressure:	102.4 kPa

This certificate should be read in conjunction with the report JA5195 R3 and associated test method statement.

Signed: *Paul Jennings* **Name:** **Paul Jennings** **Date Issued: 28th October 2015**

Position: Air Leakage Specialist

Aldas, 54 Melville Road, Churchdown, Gloucester, GL3 2RG
Aldas is a trading name of Jennings Aldas Limited, Co. Reg 8409614

Director: Clare Corley
Air Leakage Specialist: Paul Jennings, BSc, MSc
doorfanman@hotmail.com 07866 948200

Depressurize Data Set

Date: **9th October 2015** Time: **09:37** to **10:19**

Environmental Conditions:

Barometric Pressure:		**102.4 KPa**	Wind speed:	**0.1 m/s**
Temperature: Initial:	indoors	**16.4°C**	outdoors	**9.2°C**
Final:	indoors	**16.9°C**	outdoors	**9.9°C**

Test Data:

At least **3** static pressures taken for **10** sec each.
A minimum of **10** induced pressures taken for **≥20** sec each.

Existing Pressure Differentials (Static pressure):

Baseline, initial [Pa]	-0.4	-0.5	-0.5	-0.6	-0.5	-0.7
Baseline, final[Pa]	-0.6	-0.7	-0.6	-0.7	-0.6	-0.7

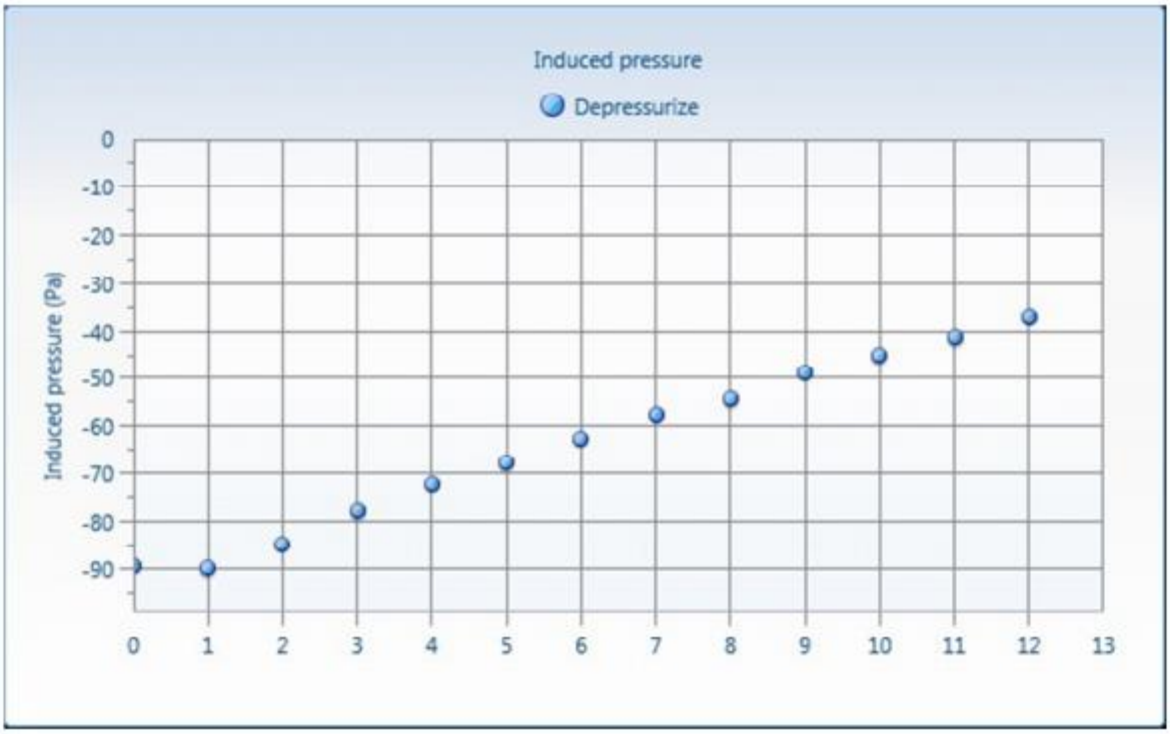
Static Pressure Averages:	**initial [Pa]**	ΔP_{01}	-0.53	ΔP_{01-ve}	-0.53	ΔP_{01+ve}	0.00
	final [Pa]	ΔP_{02}	-0.65	ΔP_{02-ve}	-0.65	ΔP_{02+ve}	0.00

Results:

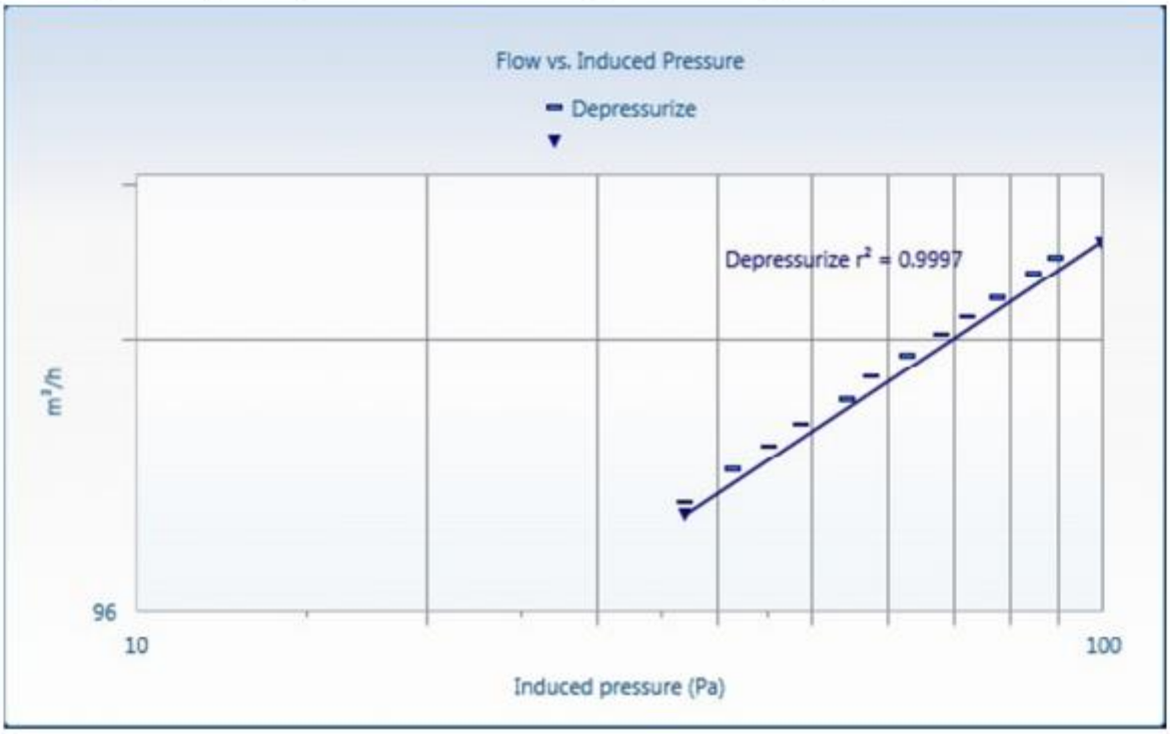
All results are compared to the standards set in Building Regulations 'Approved Document L1A – Conservation of fuel and power in new dwellings (2010)'. Results are calculated using the formulae set out in ATTMA TSL1 (Appendix A). Readings collected are detailed below:

Reading	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Induced Pressure [Pa]	-89.9	-85.3	-78.3	-72.8	-68.4	-63.1	-58.1	-55.0	-49.2	-45.6	-42.0	-37.5
Total flow, Q_r [m^3/h]	243.4	233.8	219.3	208.6	199.0	188.5	178.3	167.7	157.1	148.1	139.6	127.9
Corrected flow, Q_{env} [m^3/h]	231.8	222.6	208.9	198.6	189.5	179.5	169.7	159.6	149.6	141.0	132.9	121.8
Error [%]	0.1%	-0.1%	-0.2%	0.1%	-0.1%	0.4%	0.8%	-1.3%	0.4%	0.0%	0.2%	-0.2%

G1: Graph of imposed pressure differentials, Depressurize:



G2: Graph of imposed pressure differential against airflow, Depressurize:



Depressurize Test Results

	Results				Results	Uncertainty
Correlation, r^2	**1.000**	95% confidence limits		*Air flow at 50 Pa, Q_{50} [m^3/h]*	**154.2**	**+/-0.4%**
Intercept, C_{env} [$m^3/h.Pa^n$]	**8.94**	**8.49**	**9.40**	*Permeability at 50 Pa, AP_{50} [$m^3/h.m^2$]*	**0.41**	**+/-0.6%**
Slope, n	**0.73**	**0.71**	**0.74**	*Equivalent leakage area at 50 Pa [cm^2]*	**76.9**	**+/-0.4%**
				Air changes, n_{50}	**0.42**	**+/-0.6%**

Pressurize Data Set

After the depressurisation test a full multipoint pressurisation test was carried out.

Date: **9th October 2015** Time: **10:41** to **11:09**

Environmental Conditions:

Barometric Pressure:		**102.4 KPa**	Wind speed:	**0.1 m/s**
Temperature: Initial:	indoors	**16.9°C**	outdoors	**9.9°C**
Final:	indoors	**16.9°C**	outdoors	**9.9°C**

Test Data:

At least **3** static pressures taken for **10** sec each.
A minimum of **10** induced pressures taken for **≥20** sec each.

Existing Pressure Differentials (Static pressure):

Baseline, initial [Pa]	0.0	0.0	0.0	0.0	-0.1	0.1
Baseline, final[Pa]	0.0	-0.1	-0.2	0.1	0.1	0.1

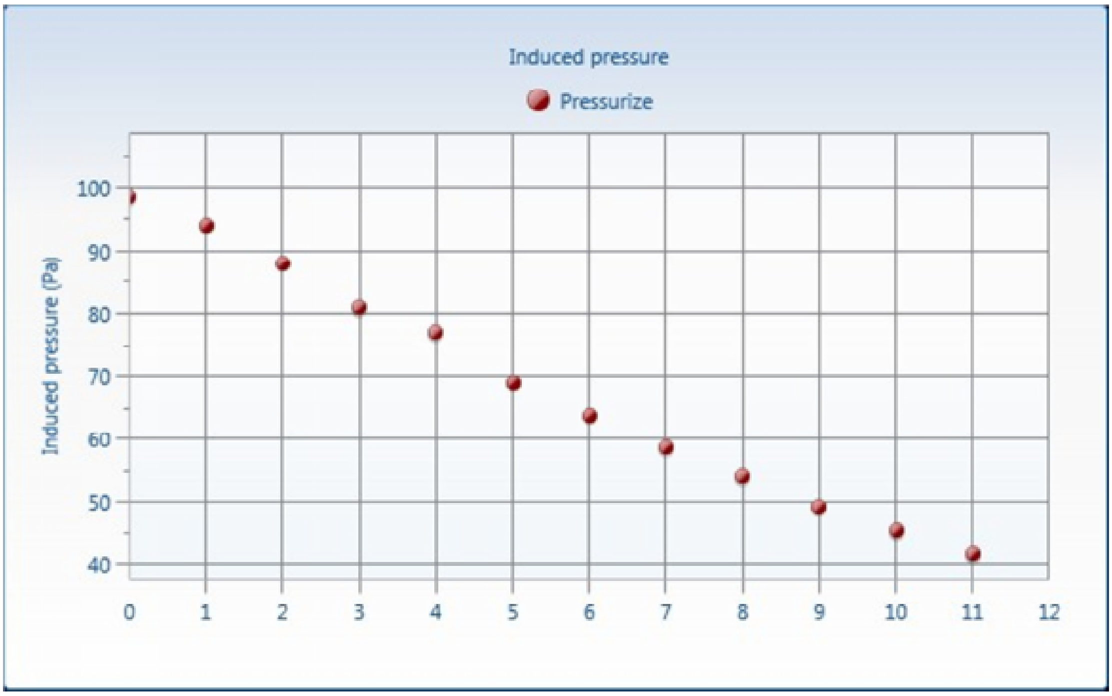
Static Pressure Averages:	**initial [Pa]**	ΔP_{01}	0.00	ΔP_{01-ve}	-0.10	ΔP_{01+ve}	0.02
	final [Pa]	ΔP_{02}	0.00	ΔP_{02-ve}	-0.15	ΔP_{02+ve}	0.08

Results:

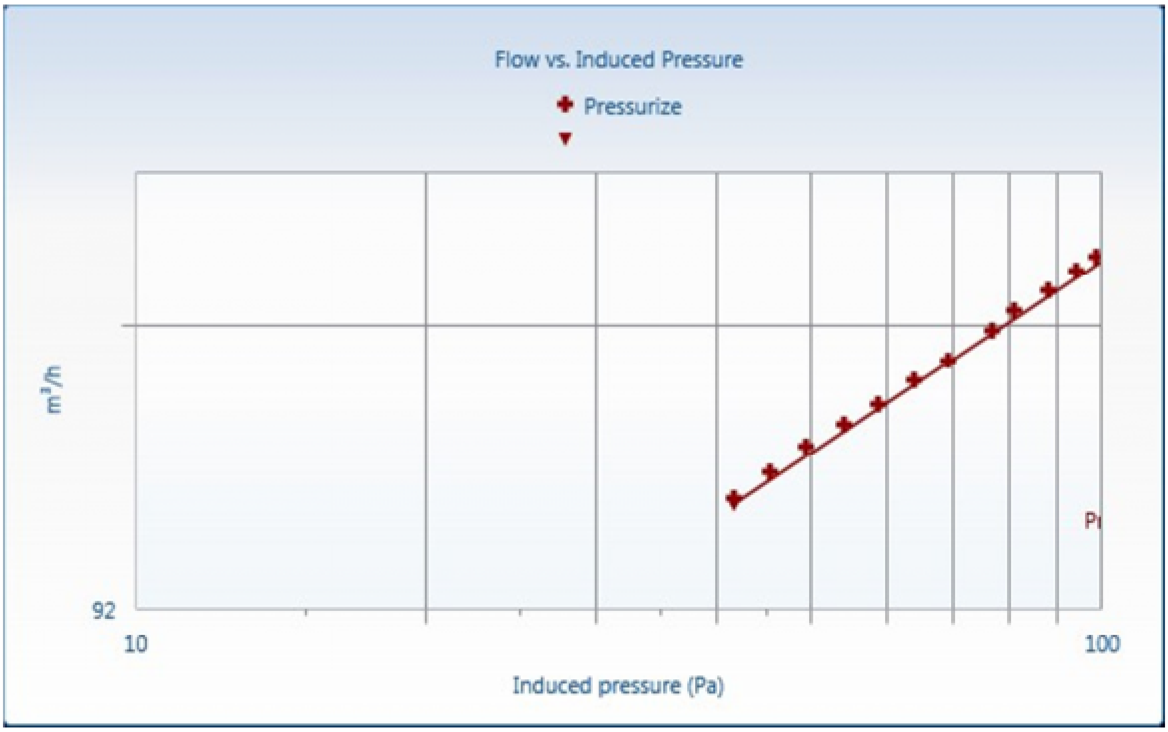
All results are compared to the standards set in Building Regulations 'Approved Document L1A – Conservation of fuel and power in new dwellings (2010)'. Results are calculated using the formulae set out in ATTMA TSL1 (Appendix A). Readings collected are detailed below:

Reading	1	2	3	4	5	6	7	8	9	10	11	12
Induced Pressure [Pa]	98.5	94.1	88.1	81.0	77.0	69.1	63.9	58.6	54.0	49.3	45.3	41.6
Total flow, Q_r [m^3/h]	228.9	220.9	210.1	199.6	189.7	175.5	166.1	156.3	148.3	139.9	130.9	122.4
Corrected flow, Q_{env} [m^3/h]	224.0	216.1	205.5	195.2	185.6	171.6	162.4	152.9	145.1	136.8	128.0	119.7
Error [%]	0.5%	0.2%	-0.1%	0.8%	-0.7%	-0.7%	-0.6%	-0.4%	0.2%	0.9%	0.3%	-0.3%

G3: Graph of imposed pressure differentials, Pressurize:



G4: Graph of imposed pressure differential against airflow, Pressurize:



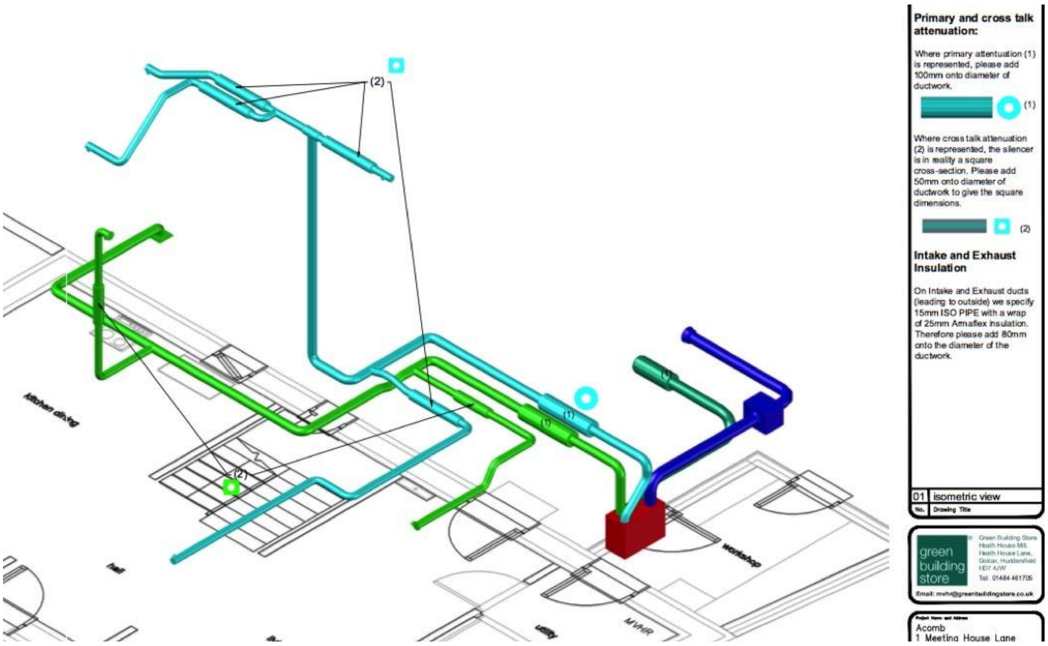
Pressurize Test Results						
	Results				**Results**	**Uncertainty**
Correlation, r^2	**1.000**	95% confidence limits		*Air flow at 50 Pa, Q_{50} [m^3/h]*	**137.9**	**+/-0.5%**
Intercept, C_{env} [$m^3/h.Pa^n$]	**8.25**	**7.81**	**8.72**	*Permeability at 50 Pa, AP_{50} [$m^3/h.m^2$]*	**0.37**	**+/-0.7%**
Slope, n	**0.72**	**0.71**	**0.73**	*Equivalent leakage area at 50 Pa [cm^2]*	**68.7**	**+/-0.5%**
				Air changes, n_{50}	**0.38**	**+/-0.7%**

12. Layout of the ventilation system

The unit was installed inside the thermal envelope (in the utility room). Ducts are Lindab steel ducts. The cooker hood in the kitchen is a circulating model with a filter.

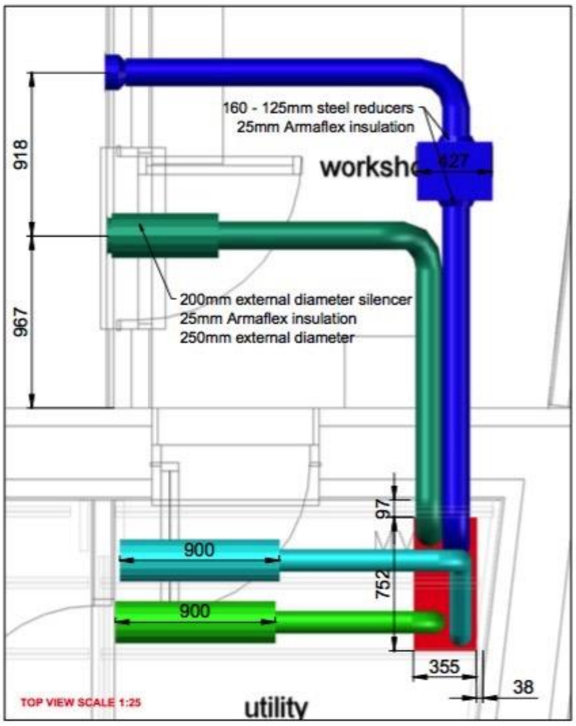
The wood burning stove is with the insulated chimney to supply the air as well as to extract in a closed area within the stove and chimney.

On a drawing by Green Building Store below, the green ducts are extract from the kitchen, bathroom and shower room. The blue ducts are supply to bedrooms and living room.



13. Ventilation unit

Heat recovery ventilation: Passivhaus certified MVHR Paul Focus 200 . Commissioned by Green Building Store. It has a separate frost heater. The frost heater is in the workshop to save space in the utility room enabling the MVHR to go close to the ceiling and leave some worktop space clear below.



Heat Recovery 89.8 %

Specific power input 0.31 Wh/m3

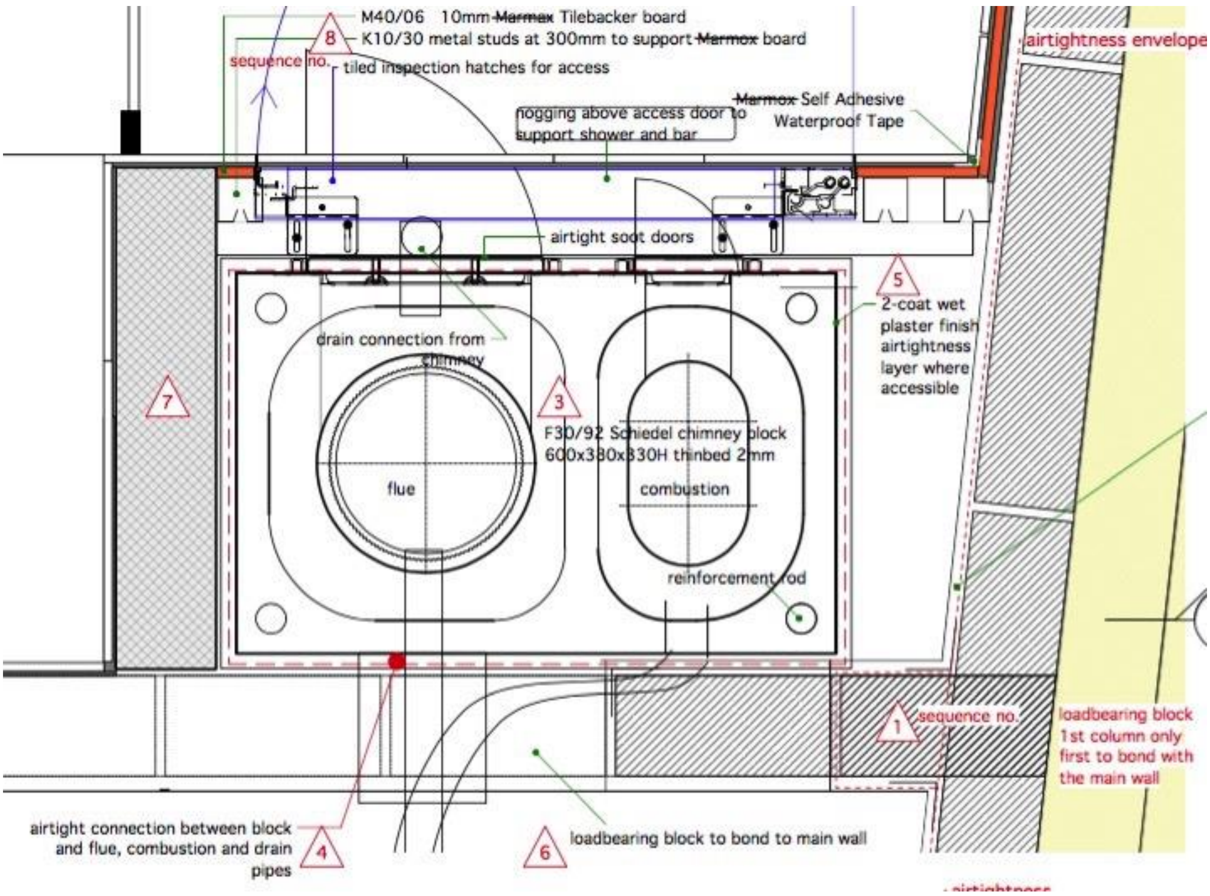
14. Heat supply

Gas combi boiler to radiators.
Wood burning stove RIKA Vitra Passive House with Passivhaus certified chimney system Schiedel Absolut Xpert (Drawing at the bottom this page.)
Location of the MVHR is away from the roof where it would draw in drifting smoke from the woodburner chimney.

A stove is planned for the living room. This is room-sealed with external air supply from the Shiedel air-supply chimney. A small output stove is selected, even though the open plan design of this house means that the stove can heat the whole building by natural convection provided bedroom doors are left open. The steady state heat load of the house is estimated at 1.4kW, and the average daily heating demand in December is 16kWh, so this requires a 2-4kW stove burning for 4-8 hours/day (if no gas backup is used).

A combi boiler is proposed for radiator heating and hot water. For the peak heating demand here (only 1.4kW) we wanted to choose a boiler with low output to heating.
The excess heat output needs to be buffered by the water volume and thermal mass of the radiators, in order to prevent the boiler temperature rising too high.

The boiler is in the plant cupboard between bedroom and stairs, and helps hot water performance by reducing the lengths of the hot water pipes and hence cold water draw-off volumes, especially to the kitchen.
(Service design by Alan Clarke)



15. PHPP

The verification sheet from PHPP for the project.

Passive House verification

Country:	UK						
Building type:	Detached House new build						
Climate:	[UK] - North East (Leeming)					Altitude of building site (in [m] above sea level):	25
Architecture:	Anne Thorne Architects LLP						
Street:	21 Whiston Road						
Postcode / City:	E2 8EX London						
Mechanical system:	Alan Clarke						
Street:	The Woodlands, Whitecroft						
Postcode / City:	GL15 4PL Lydney						
Year of construction:	2015		Interior temperature winter:	20.0	°C	Enclosed volume V_e m³:	640.0
No. of dwelling units:	1		Interior temperature summer:	25.0	°C	Mechanical cooling:	
No. of occupants:	3.6		Internal heat sources winter:	2.1	W/m²		
Spec. capacity:	132	Wh/K per m² TFA	Ditto summer:	2.2	W/m²		

Specific building demands with reference to the treated floor area

				Requirements	Fulfilled?*
	Treated floor area	124.7	m²		
Space heating	Heating demand	13	kWh/(m²a)	15 kWh/(m²a)	yes
	Heating load	10	W/m²	10 W/m²	yes
	Frequency of overheating (> 25 °C)	5.3	%	-	-
Primary energy	Heating, cooling, dehumidification, DHW, auxiliary electricity, lighting, electrical appliances	107	kWh/(m²a)	120 kWh/(m²a)	yes
	DHW, space heating and auxiliary electricity	58	kWh/(m²a)	-	-
Airtightness	Pressurization test result n_{50}	0.4	1/h	0.6 1/h	yes

* empty field: data missing; '-': no requirement

Passive House?	yes

We confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The PHPP calculations are attached to this application.

Name:	Peter	PHPP Version 8.5	
Surname:	Warm	Issued on:	27/11/2015
Company:	WARM	Signature:	Peter Warm

16. Building Costs n/a

17. Construction Costs n/a

18. Year of construction 2014- 2015

19. Information about designer / architect

The client had approached Anne Thorne Architects LLP wanting to build an energy efficient new home. Suetake Studio 2 was the lead designer as the Passivhaus Designer from the detailed design stage to the completion under Anne Thorne Architects LLP.

20. Information about service designer

Alan Clarke for heating, ventilation, plumbing, electrical design as a Passivhaus specialist.

21. Information about building physics

WARM advised and calculated thermal bridges.

22. Information about structural design

SGM structural engineers

23. User's experiences

Feedback from the occupant has been very positive. Comfortable with air temperature and full of lights. Shading to the rooflights is essential for summer. (External awnings.) Quote:

'In my mind's eye, I saw a house that was simple and beautiful, plain but not austere, low energy and low tech, built with sustainable materials wherever affordable, with high ceilings and ooded with light from every direction. Tucked away between old and new houses, bounded by an old Quaker meeting house and a well-used ginnel, the site was just the urban location I was looking for...and conveniently faced south/southwest.

Six months after moving in, I am still delighted every day by how well the spaces work, how I can feel the sun circling the house, how the garden (garden-to-be) and the sky feel part of the house, by the solid thickness of the walls and roof, the detailing of the simple wooden staircase, the calmness and comfort.

Little heating has been needed since the start of April so a full year estimate of combined energy use is £500-550, with usage well within predictions in the PHPP calculations.

Friends staying comment on how evenly comfortable and un-stuffy the house feels. The second most common comment is disbelief that this can be achieved without a full central heating system, even when it's freezing outside. I admit I was skeptical too...but this house has proved it convincingly for me, not just that Passivhaus design can reduce energy use but that it can contribute to a simple, low tech, well designed house that is a delight to live in.'

Measured energy performance

Energy consumption in the winter (5 months, Nov 2015 - Mar 2016) has totaled 3338kWh, at a cost of £316 for gas and electricity combined.

Predicted running costs for heating

The electricity demand was predicted as 2440kWh/a (quarteris610)

It was predicted the space heating (A) would be about 1,092 kWh in this period.

For gas cooking,(B) it was predicted 114 kWh in this period.

Domestic hot water (C) was predicted as 726 kWh

Energy consumption data

Electricity;-The quarter mid December 15 - mid march 16, 807 kWh was used. This is slightly higher than the expected monthly average in this house but it will be balanced out during spring/ summer.

Gas for space heating, cooking and domestic hot water: used 1,975 kWh this quarter.
(A)+(B)+(C)=1932 was predicted. This is lose to the used energy 1975. The wood burning stove was used occasionally, which can't be metered.

Internal environment data

Humidity has stayed in the range 45-60% so far. CO_2 is also monitored and has ranged from 400 to 650ppm to date.

Occupant additional feedback

'Once the MVHR controller and heating programmer had been set, and I had resisted the urge to keep adjusting these, the temperature settled and has been remarkably steady throughout the house, hovering between 19 and 21 in the day, dropping to 17-18 at night. I have used the wood burner very occasionally, but only on the coldest days or simply for coziness.

All is perfect in the home here. '