Passive House Object Documentation

Detached house with 4no. Bedrooms in Crawsfordsburn, Northern Ireland.

Project Designer	Mr Paul McAlister – Paul McAlister Architects Ltd
Year of construction	2012/2013
Cost of build	£192,000.00 GBP
Size of build	2340 sq/ft
Method of Construction	Timber Frame – SIP Panels

This Passivhaus design has been designed to achieve the Passivhaus Institute Standards. The main living spaces such as the kitchen and the double height living room have been designed to the south elevation to maximise heat gain from the southern sun. This modern Passivhaus is situated on a cluster of farmyard buildings and its simple design is integrated into the surrounding context.

Special Features: Solar collectors for hot water

U-Value Exterior Wall	0.115 W/(m^{2}k)	**PHPP Annual heating demand**	**14kWh/(m^{2}a)**
U-Value Roof	0.123 W/(m^{2}k)		
U-Value Window	0.87 W/(m^{2}k)	PHPP primary energy Demand	91kwh/(m^{2}a)
U-Value Floor	0.144 W/(m^{2}k)	Pressure Test n50	0.585h^{-1}
Heat Recovery	92%		

Project description

The design of a new sustainable family home in a rural context. The client requested that the dwelling be certified by the Passive House Institute in Germany. The project was achieved within a limited budget with low energy space heating and hot water systems achieving a SAP ‘A’ rating.

Design statement

The Passive house was allowed us to put into practice all of the sustainable credentials that we had been developing over the previous five years of practice. This Passivhaus focuses on ultra energy efficiency and internal comfort. Sustainable considerations influenced the palette of materials; timber was used as the primary structure with SIP (Structural Insulated Panel) as the method of envelope construction.

The quality of the design proposal was critical as the building was designed to reach Passivhaus standard. Great care had to be taken with junctions and openings as air-tightness is critical to Passivhaus certification. The PHPP software allowed the calculation of the heat-load and resulted in the primary heating being provided by a 5Kw wood burning stove which is only required for 4 months of the year. Hot water is achieved by solar panels in the summer with a thermal store with integrated heat pump economically providing hot water in cooler months.

The completed house and its commissioned systems are being monitored and early steady-state tests have shown that the house is performing as designed. Ventilation is achieved using mechanical ventilation with heat recovery and this allows the heat produced within the building to be ‘recovered’ and reused ‘Passively’ heating the dwelling. Thermal mass also plays a part in reducing heat load, with large south facing windows capturing the heat of the sun adding considerably to the dwellings heating efficiency.

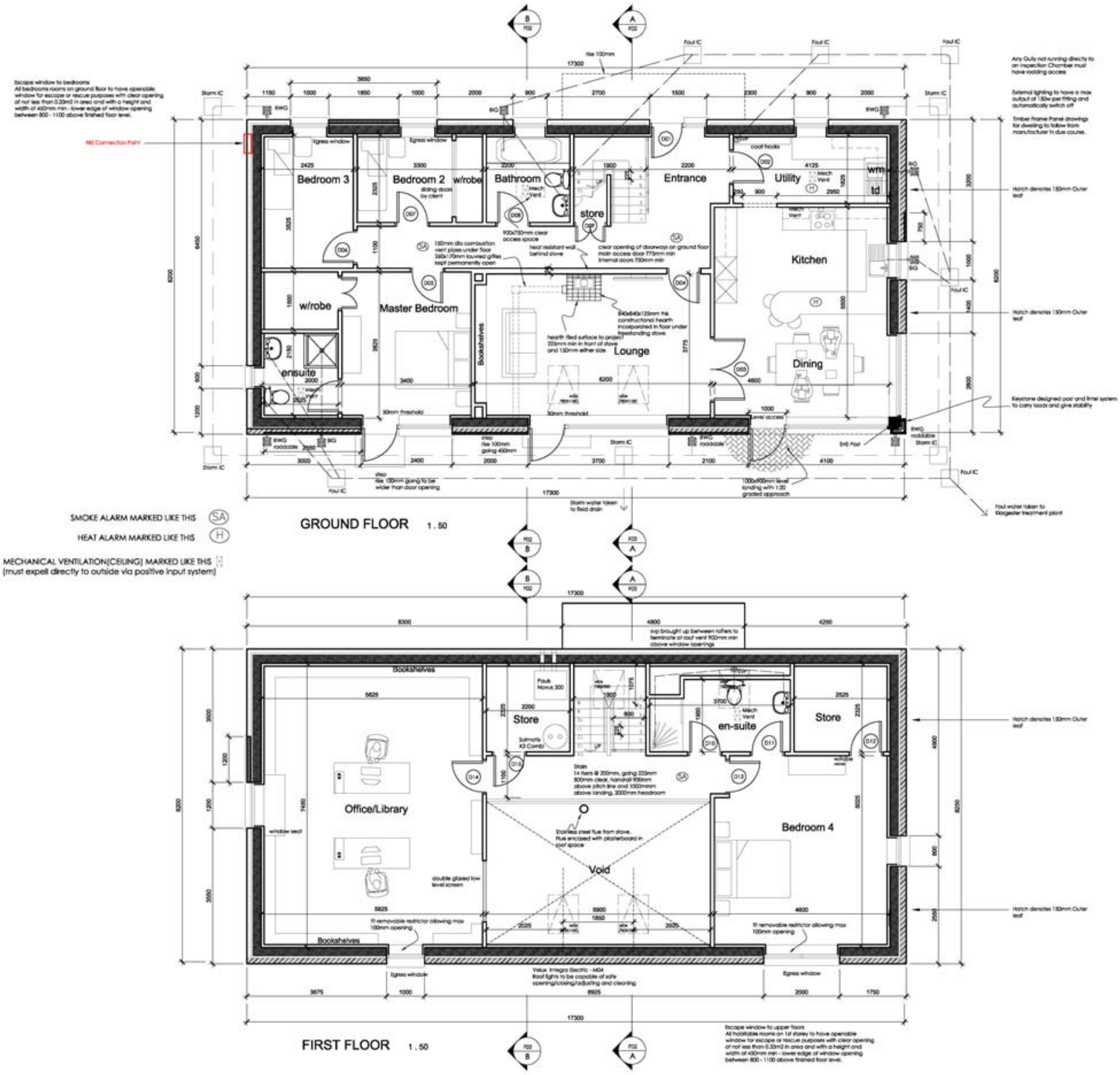
The project was procured using a standard contract agreement as a lump sum tender process. The project is now Northern Irelands second privately owned Certified Passive House it was constructed on time and with virtually no additional costs during the build. This building is an example of how a technically advanced building may be built within a modest budget and in the same manner as a conventional house.

Rear of dwelling

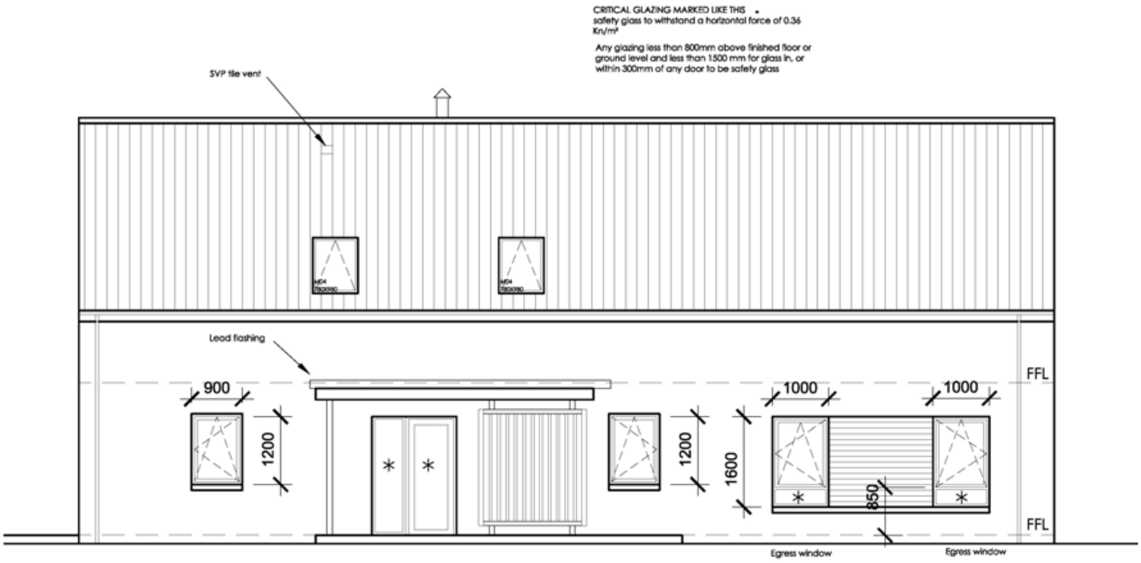
Front Entrance of dwelling

Dwelling on site

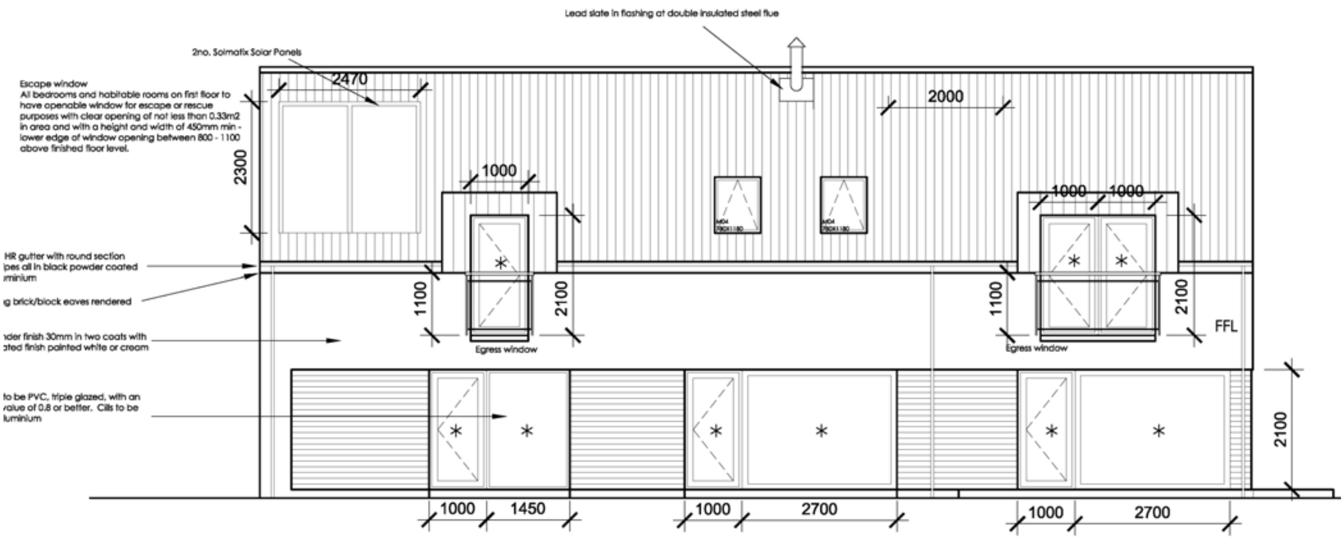
Interior of dwelling


Bedroom 3
Bedroom 2
w/robe
Bathroom
store
Entrance
Utility
Kitchen
Master Bedroom
Lounge
Dining
ensuite
GROUND FLOOR 1:50
SMOKE ALARM MARKED LIKE THIS
HEAT ALARM MARKED LIKE THIS
MECHANICAL VENTILATION(CEILING) MARKED LIKE THIS
(must expell directly to outside via positive input system)
Store
en-suite
Office/Library
Bedroom 4
Void
Bookshelves
FIRST FLOOR 1:50

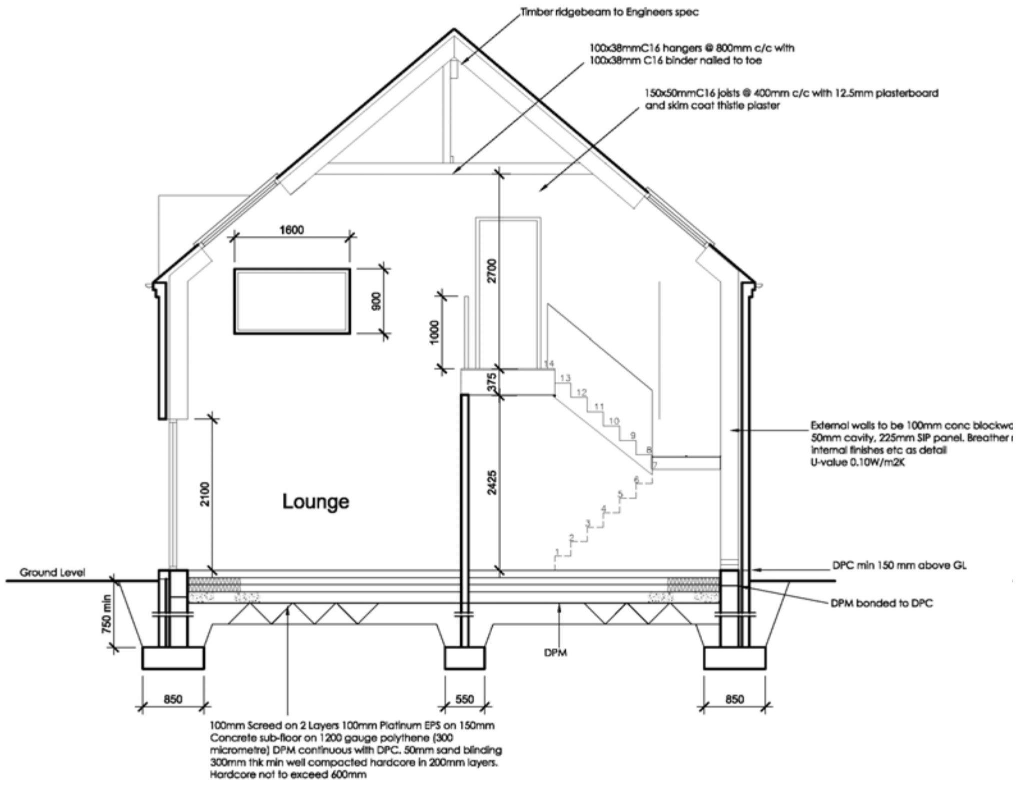
Floor Plans



Front Elevation

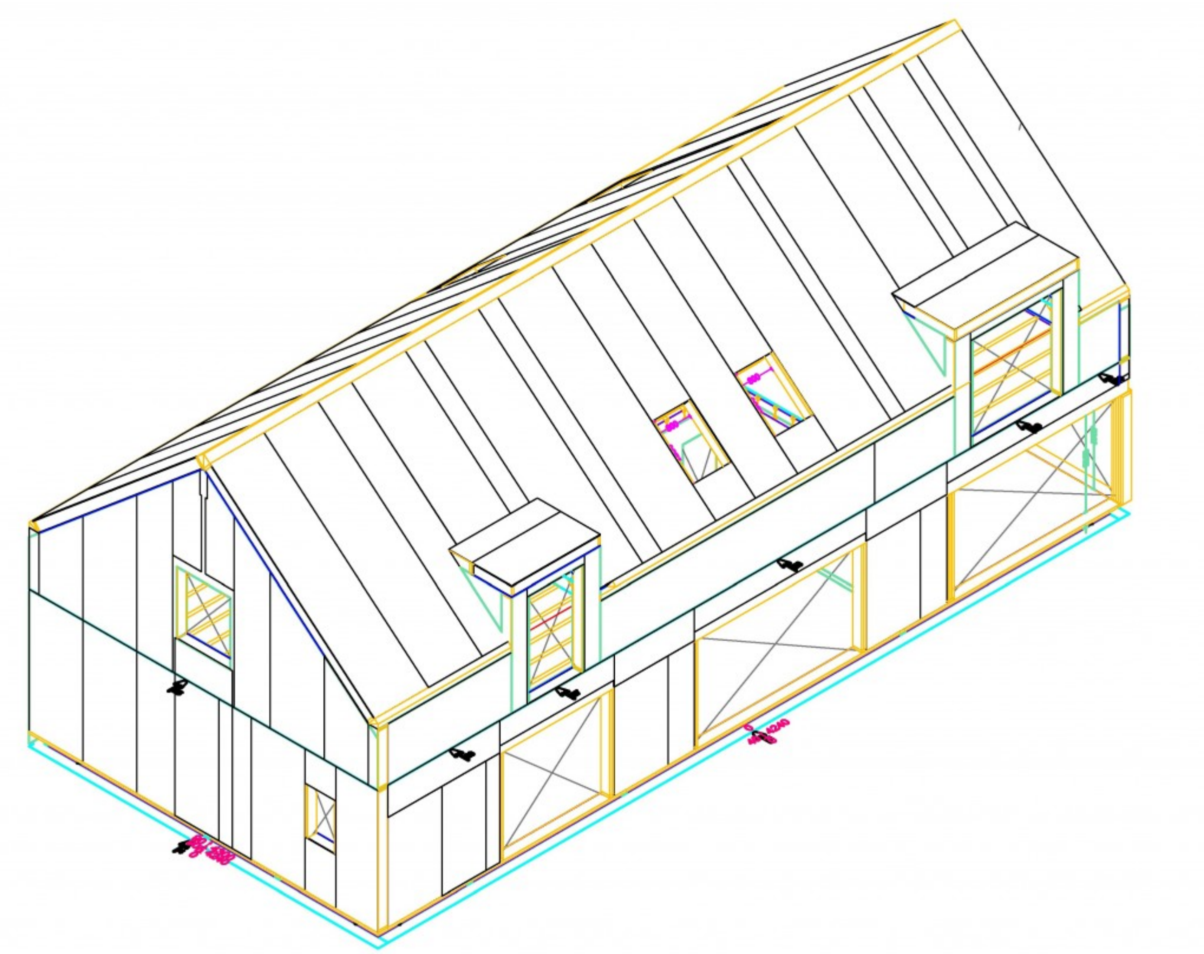


Rear Elevation



Typical Section

Timber Frame – SIP Panels



The drawing above was provided by SIPFIT which shows the manufacturing details and the panel layouts.

Insulation

Super insulation is obviously fundamental to Passivhaus construction. The passive house will have 225mm SIP panel walls and roof, and 200mm of high-performing Springvale Platinum Floorshield insulation in the floor. The junctions of these elements are of particular importance to prevent any heat loss.

Windows

All windows and doors utilised in Passivhaus certified buildings have to meet certain performance criteria. The wall openings have been discussed in the previous diary entry but here we will detail the exact capabilities of the window and doors units.

All the windows and doors were supplied by Munster Joinery/Baskil Window Systems. All the windows and doors have been certified by the Passivhaus Institut in Germany, assuring they meet the requirements necessary for Passivhaus certification and insuring their performance capabilities.

Again the windows and doors have been modelled using PHPP software to analyse their performance. All windows and doors must perform as part of the overall building envelope and must achieve a total U-value equal or below 0.8W/(m^2K). In our build the windows and doors achieve a U-value of 0.77 W/(m^2K). (g-Value of 0.61)

The glazing has a thickness of 52mm. The Glazing unit was made up of 4-20-4-20-4 Low-E 0.05 uncorrected emissivity (SGG Planitherm Total +) Internal and central panes, 90% Argon , 10% Air filled, Float Outerpane (SGG planilux) glazing unit with Technoform TGI spacer bar with Polyurethane Secondary Seal.

The frames are all grey finished PVC with easy clean friction hinges. All ironmongery is brushed satin finished aluminium.

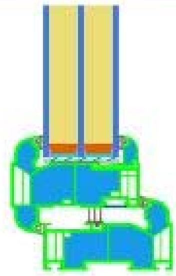
This photograph illustrates two of the windows in situ with the external timber cladding fitted.

Certificate

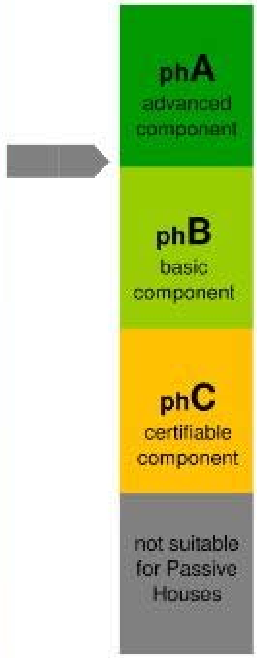
Passive House suitable component
for cool, temperate climate, valid until 31 December 2012

Passive House Institute
Dr. Wolfgang Feist
Rheinstraße 44/46
D-64283 Darmstadt

Category	**Window Frame**
Maunfacturer	**Munster Joinery**
	Ballydesmond, Mallow, Co.Cork IRELAND
Product name	**PassiV Future Proof**



Passive House Efficiency Class



The following comfort criteria were used in awarding this certificate:

Given a U_g value of 0.70 W/(m²K) and a window size of 1.23 m by 1.48 m,

U_w = 0,78 W/(m²K) ≤ 0.80 W/(m²K)

Taking into account the installation based thermal bridges, and provided that the installation is, with regard to the thermal bridges, equal or better than shown in the data sheet, the window meets the following criterion.

U_w ≤ 0.85 W/(m²K)

Thermal data of the window frame

	U_f-value [W/(m²K)]	Width [mm]	Ψ_g [W/(mK)]	$f_{Rsi=0.25}$ [-]
Spacer			SuperSp. Tri-Seal*	
Bottom	0,77	102	0,024	0,74
Side/top	0,77	102	0,024	

*Spacers of lower thermal quality, especially those made of aluminium, lead to significantly higher thermal losses and lower temperature factors. Used material for secondary seal: PU

Component suitable for Passive Houses
Dr. Wolfgang Feist

MVHR Unit

After much research we decided to use a Novus 300 unit, manufactured by Paul. This MVHR unit has an effective heat recovery rate of 93%. The system was installed at the Crawsfordsburn passive house, with the heat recovery unit being housed on the first floor, within its own purpose built store.

Certificate

Passive House suitable component
For cool, temperate climates, valid until 31 December 2012

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
GERMANY

Category: **Heat recovery unit**
Manufacturer: **Paul Wärmerückgewinnung GmbH**
08141 Reinsdorf, GERMANY
Product name: **novus 300**

This certificate was awarded based on the following criteria:

Thermal comfort	$\Theta_{supply\ air} \geq 16.5$ °C at $\theta_{outdoor\ air} = -10$ °C
Effective heat recovery rate	$\eta_{HR,eff} \geq 75\%$
Electric power consumption	$P_{el} \leq 0.45$ Wh/m³
Airtightness	Interior and exterior air leakage rates less than 3% of nominal air flow rate
Balancing and adjustability	Air flow balancing possible: yes Automated air flow balancing: yes
Sound insulation	Sound pressure level $L_p \leq 35$ dB(A) based on a 4 m² equivalent absorption area not met Here $L_p = 43.0$ dB(A) Unit must be installed in a separate building services room.
Indoor air quality	Outdoor air filter F7 Extract air filter G4
Frostprotection	Frost protection for the heat exchanger with continuous fresh air supply down to $\Theta_{Outdoor\ air} = -15$ °C

Certified for air flow rates of

121 - 231 m³/h

$\eta_{HR,eff}$

93%
(94% bei 144 m³/h)

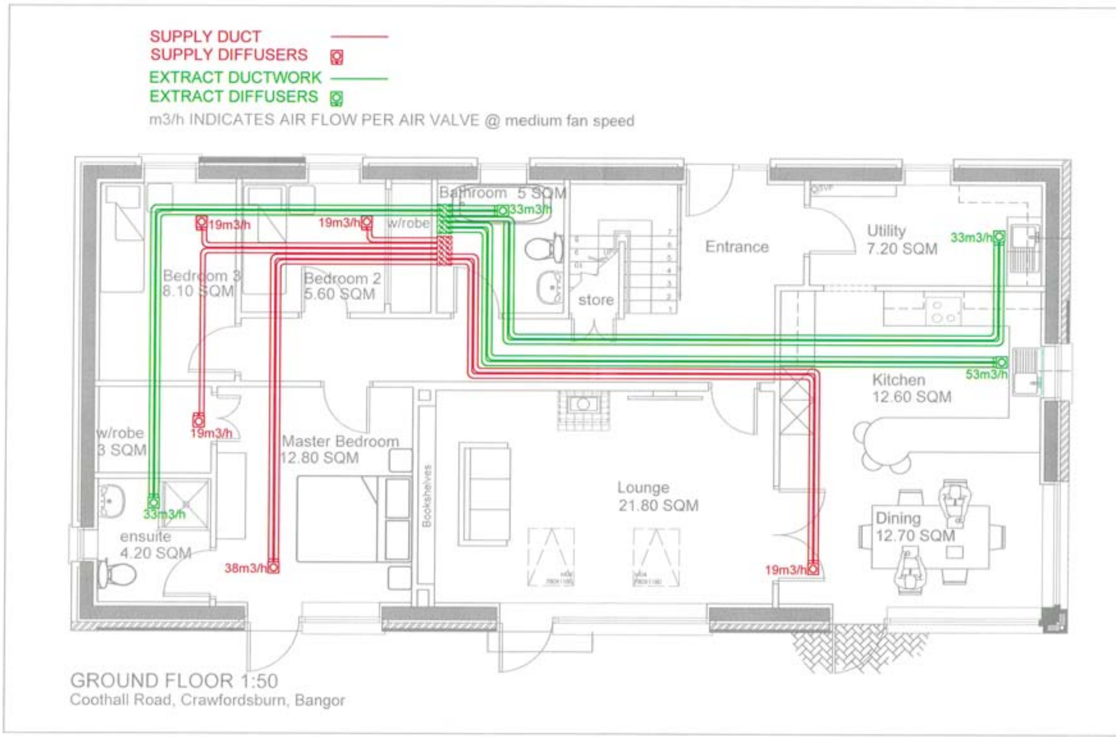
Electric power consumption

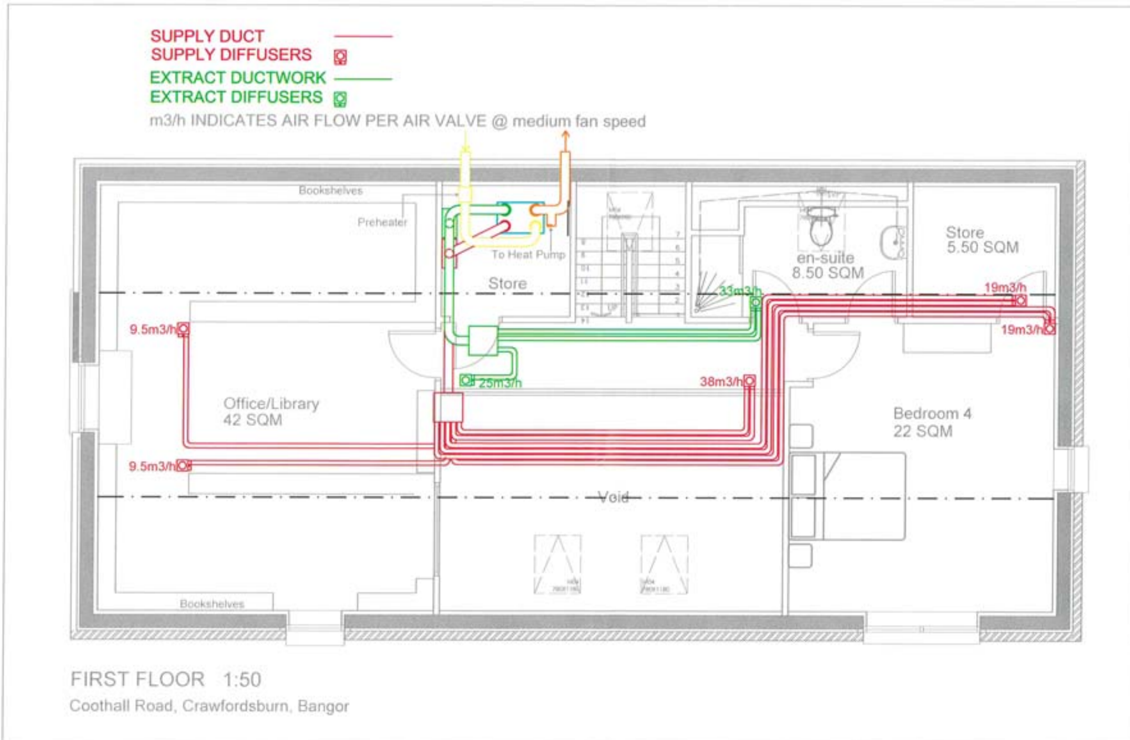
0.24 Wh/m³

Passive House suitable component
Dr. Wolfgang Feist

Further information can be found in the appendix of this certificate.

www.passivehouse.com


SUPPLY DUCT
SUPPLY DIFFUSERS
EXTRACT DUCTWORK
EXTRACT DIFFUSERS
m3/h INDICATES AIR FLOW PER AIR VALVE @ medium fan speed
Bathroom 5 SQM
33m3/h
19m3/h
19m3/h
w/robe
Entrance
Utility
7.20 SQM
33m3/h
Bedroom 3
8.10 SQM
Bedroom 2
5.60 SQM
store
Kitchen
12.60 SQM
53m3/h
19m3/h
w/robe
3 SQM
Master Bedroom
12.80 SQM
Lounge
21.80 SQM
Dining
12.70 SQM
33m3/h
ensuite
4.20 SQM
38m3/h
19m3/h
Bookshelves
GROUND FLOOR 1:50
Coothall Road, Crawfordsburn, Bangor


SUPPLY DUCT
SUPPLY DIFFUSERS
EXTRACT DUCTWORK
EXTRACT DIFFUSERS
m3/h INDICATES AIR FLOW PER AIR VALVE @ medium fan speed
Bookshelves
Preheater
To Heat Pump
Store
en-suite
8.50 SQM
Store
5.50 SQM
33m3/h
19m3/h
19m3/h
9.5m3/h
25m3/h
38m3/h
Office/Library
42 SQM
Bedroom 4
22 SQM
9.5m3/h
Void
Bookshelves
FIRST FLOOR 1:50
Coothall Road, Crawfordsburn, Bangor

Ventilation Worksheet

Passive House Planning

VENTILATION DATA

Building: Detached House

Treated Floor Area A_{TFA}	m²	185	*(Areas worksheet)*
Room Height h	m	2.5	*(Annual Heating Demand worksheet)*
Room Ventilation Volume (A_{TFA}*h) = V_V	m³	463	*(Annual Heating Demand worksheet)*

Ventilation System Design - Standard Operation

Occupancy	m²/P	35				
Number of occupants	P	5.3				
Supply air per person	m³/(P*h)	30				
Supply air demand	m³/h	159				
Extract air rooms		Kitchen	Bathroom	Shower	WC	utility
Quantity		1	1	2	0	1
Extract air demand per room	m³/h	60	40	20	20	40
Total extract air demand	m³/h	180				

Design Air Flow Rate (Maximum) m³/h 180

Average Air Change Rate Calculation

Type of Operation	Daily Operation Duration h/d	Factors Referenced to Maximum	Air Flow Rate m³/h	Air Change Rate 1/h
Maximum		1.00	180	0.39
Standard	24.0	0.77	139	0.30
Basic		0.54	97	0.21
Minimum		0.40	72	0.16
	Average value	0.77	Average Air Flow Rate (m³/h): 139	Average Air Change Rate (1/h): 0.30

Infiltration Air Change Rate

Wind Protection Coefficients e and f		
Coefficient e for Screening Class	Several Sides Exposed	One Side Exposed
No Screening	0.10	0.03
Moderate Screening	0.07	0.02
High Screening	0.04	0.01
Coefficient f	15	20

			for annual demand:	for heating load:		
Wind Protection Coefficient, e			0.10	0.25		
Wind Protection Coefficient, f			15	15	Net Air Volume for Press. Test V_{n50}	Air Permeability q_{50}
Air Change Rate at Press. Test	n_{50}	1/h	0.65	0.65	582 m³	0.65 m³/(hm²)

Type of Ventilation System

x	Balanced PH Ventilation	*Please Check*	for annual demand:	for heating load:
	Pure Extract Air			
	Excess Extract Air	1/h	0.00	0.00
	Infiltration Air Change Rate $n_{V,Res}$	1/h	0.082	0.204

Effective Heat Recovery Efficiency of the Ventilation System with Heat Recovery

x Heat recovery unit within the thermal envelope.

Heat recovery unit outside of the thermal envelope.

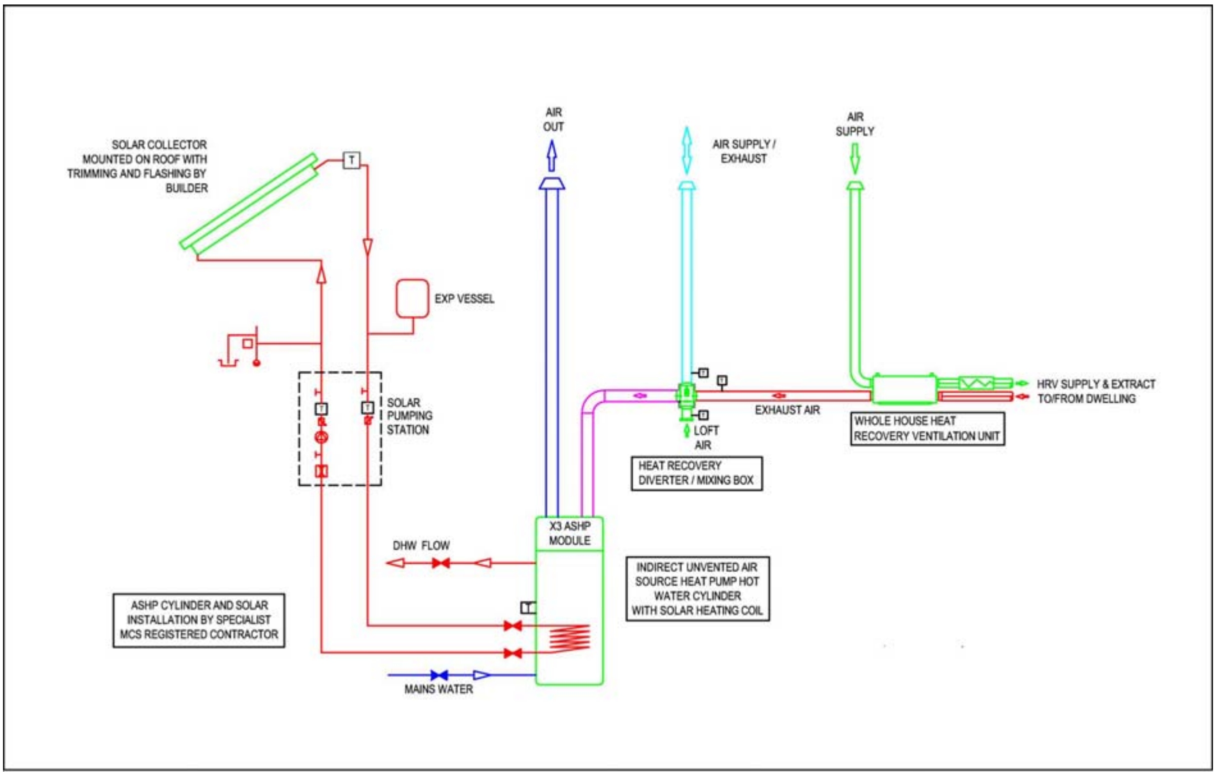
Efficiency of Heat Recovery	η_{HR}		0.93	Paul Novus 300
Conductance Ambient Air Duct	Ψ	W/(mK)	0.195	Calculation see Secondary Calculation
Length Ambient Air Duct		m	1	
Conductance Exhaust Air Duct	Ψ	W/(mK)	0.195	Calculation see Secondary Calculation
Length Exhaust Air Duct		m	1.5	Room Temperature (°C): 20
Temperature of Mechanical Services Room		°C		Av. Ambient Temp. Heating P. (°C): 6.4
(Enter only if the heat recovery unit is outside of the thermal envelope.)				Av. Ground Temp (°C): 10.4

Effective Heat Recovery Efficiency $\eta_{HR,eff}$ **92.0%**

Effective Heat Recovery Efficiency Subsoil Heat Exchanger

SHX Efficiency	η^*_{SHX}	
Heat Recovery Efficiency SHX	η_{SHX}	0%

Hot Water Heating



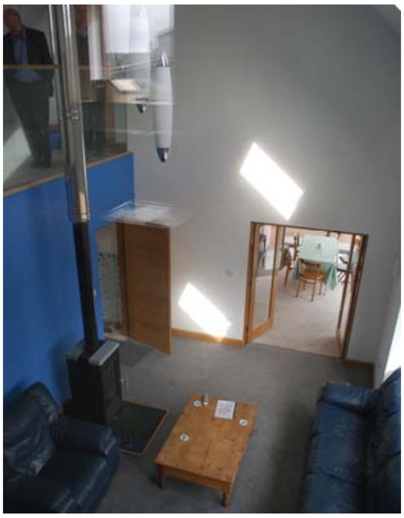
SOLMATIX X3 COMBI PLUS (HEAT PUMP CYLINDER WITH INTELIGENT AIR CONTROL) WITH SOLAR & INDEPENDENT SPACE HEATING

The hot water is heated by means of two Solmatix solar panels installed on the south facing roof in the summer; these connect to a 300 litre thermal store. The ESP Ecocent indirect unvented air source heat pump will economically provide a back up for hot water production during the winter months. Solmatix provided and installed both the solar panels and the heat pump, alongside offering us vital advice and helping to produce an economic, low energy heating strategy for the passive house. The photo illustrates the solar panels when there were being installed, which occurred as the roof was being slated to prevent any retrofitting issues.

Space Heating

The dwelling will be heated passively, utilising solar gains, energy given off by the day to day activities and recycled using the ventilation system. This system will transfer a calculated amount of heat throughout the house with smaller rooms needing no additional heat source due to the delivered temperature of the warm air. These 'passive' heat gains go a long way towards maintaining a comfortable temperature within the dwelling. The small amount of additional heat required in the winter months must be provided from an external source.

In this case we have provided the additional heating in the living room by means of a 5kW wood burning stove. This is a RIKA Vitra passive house wood burning stove which is located in the double height living space. It is unique in that it is independent to the air in the room as it has its own ducted air source direct from outside. It has the capacity to provide active warmth to a space of 50-110m^3 using very low amounts of energy, whilst releasing minimal emissions. The photo illustrates the RIKA Vitra passive house wood burning stove.



In additional to the wood burning stove, three Fondital towel radiators have also been installed in the bathrooms and ensuite to eliminate the problem of how to dry towels and perhaps clothes as there are no conventional radiators located within the passive house. These radiators are supplied from the 300 litre thermal store and are an efficient way of utilising the additional heat generated by the solar panels and heat pump.

Woodburning Stove Worksheet

06/02/2012 RIKA Innovative Ofentechnik GmbH - Product overview with technical data - Vitra Passivhaus

Product overview with technical data
Vitra Passivhaus

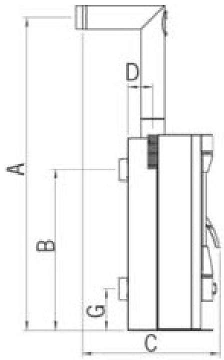
RIKA®

Dimensions / Weight

Dimensions HxBxT	1000 x 440 x 440 mm
Weight without shell	0 kg
Weight with natural stone	0 kg
Weight with thermostone	0 kg
Weight with steel shell	158 kg
Weight with ceramic shell	0 kg
Storage capacity	0 kg
Flue pipe outlet diameter	130 mm
Combustion chamber dimensions HxBxT	26x26x22 cm

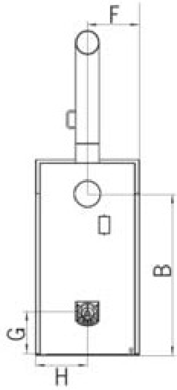
Power

Nominal heating power	4,00 kW
Minimum heating power	2,00 kW
Room heating capacity	50 - 110 m³



Features

Baking compartment	-
Holding compartment	-
Ceramic stove top	-
Rikatronic³ ®	-
RLS-System	1
Independent of room air ¹	1
Electrical connection	-
Rotatable	-
Corner installation possible	-



Installation Dimensions

A: Connection height with original angled pipe	153 cm
B: Connection height with rear flue pipe connection	84 cm
C: Depth with original angled pipe	67 cm
D: Depth at the back	22 cm
F: Flue pipe connection from right	22 cm
G: Connection height fresh air	7 cm
H: Fresh air connection from left	22 cm
Fresh air connection diameter	125 mm

Important Data

Exhaust gas temperature	214 °C
Minimum feed pressure	12.0 Pa
CO value	737 mg/MJ
CO value (full load)	1095 mg/Nm³
Exhaust gas mass flow	5,30 g/sec

¹ WICHTIGER HINWEIS: Bitte beachten Sie die unterschiedlichen Ländervorschriften beim Thema Raumluftunabhängigkeit.
Technische und optische Änderungen sowie Satz- und Druckfehler vorbehalten. Stand: Monday, 06.02.2012

www.rika.at/datasheet.php?IDofen=10 1/1

Achieving Airtghtness

The passive house was tested by Gareth Chambers from Airtightness Ireland Ltd. We prioritised airtightness from the very beginning of design detailing and throughout construction of the passive house. While our continual calculations allowed us to be quietly confident, we were nervous of the unknown and also intrigued to witness the testing process.

The aim was to achieve the required Passivhaus airtightness standard of 0.6 air changes per hour at an air pressure difference of 50 Pascals. This requirement is about 16 times more airtight than the current Building Regulations.

Airtightness is tested by closing all apertures such as windows, doors, mechanical ventilation and heat recovery ducting. A fan is then fitted to an external door opening to lower the air pressure within the building, making the difference between the internal and the external atmospheres 50 Pascals.

We are delighted to report that the passive house exceeded our goals and achieved a result of 0.585 air changes per hour at an air pressure difference of 50 Pascals!

The first photograph illustrates the temporary airtight door screen and mounted fan used to gain the difference of 50 Pascals between internal and external air pressure.

Roof/wall interfaces were addressed using pro clima air-tight membranes and tapes with plaster reinforcement e.g. CONTEGA PV. A layer of plaster formed the air-tight seal. Specialist pro clima tapes (e.g. CONTEGA PV) were used to seal the floor perimeter.

Air test results

Depressurize Test Results

	Results		
Correlation, r^2	0.9857	95% confidence limits	
Intercept, C_{env} [m³/h.Paⁿ]	11.25	7.101	11.25
Slope, n	0.8546	0.7239	0.8546

	Results	Uncertainty
Air flow at 50 Pa, Q_{50} [m³/h]	320.5	+/-0.0648
Air changes, n_{50}	0.5435	
Equivalent leakage area at 50 Pa [m²]	0.01601	+/-0.0648

Combined Test Data

	Results	Uncertainty
Air flow at 50 Pa, V_{50} [m³/h]	345.0	+/-0.0515
Air changes, n_{50} [m³/h/m³]	0.585	+/-0.0876
Equivalent leakage area at 50 Pa [m²]	0.01725	+/-0.0515

Openings and Temporary Sealing

Mechanical Ventilation was sealed for the duration of the test. External Windows & Doors Closed but not sealed. Internal Doors Open. Stove not installed at time of test.

Test Method

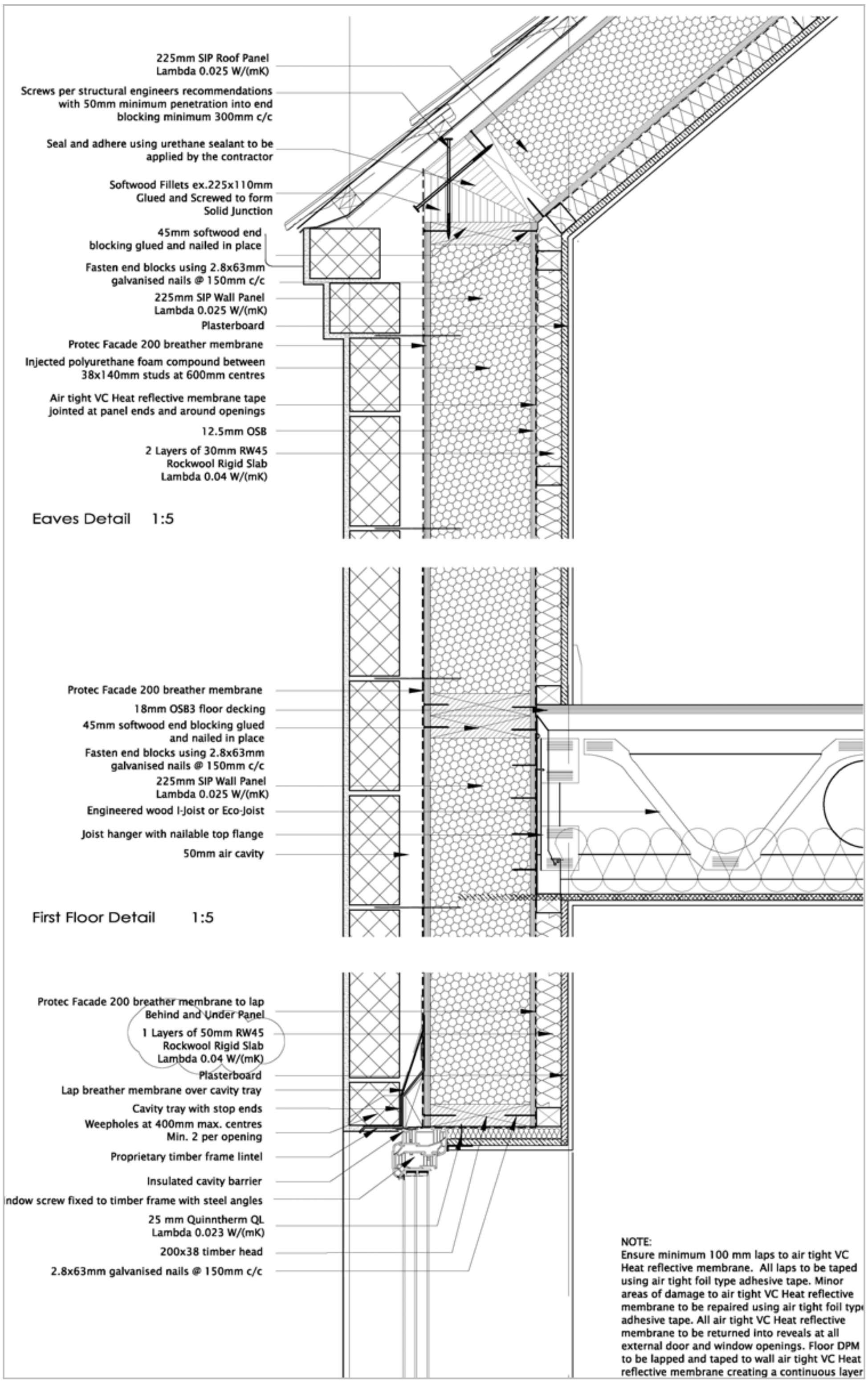
Carried out in accordance with the following standards:

- ATTMA TSL1 Issue 2 – Measuring Air Permeability of Building Envelopes
- BS EN13829:2001 Thermal Performance of Buildings
- BINDT – Quality Procedures and Explanatory Notes for Air Tightness Testing

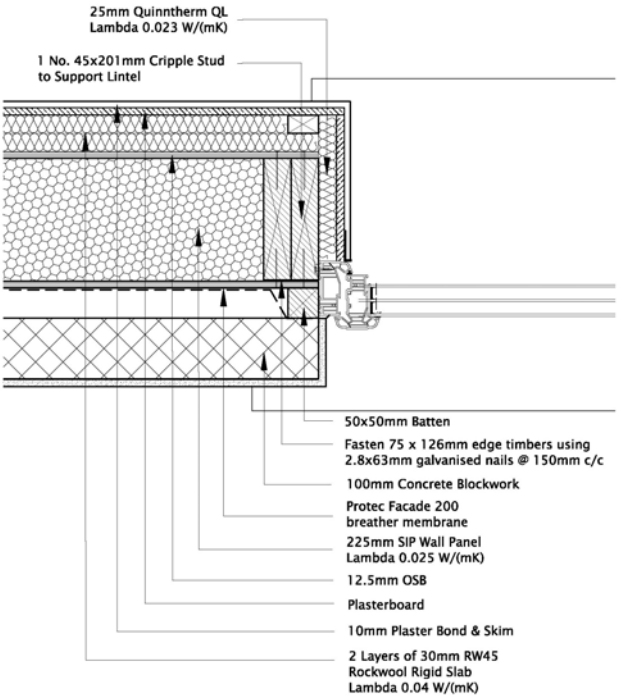
Test was carried out under **Method B** (method A, B or C)

The building was tested using a **Retrotec 3000** fan.

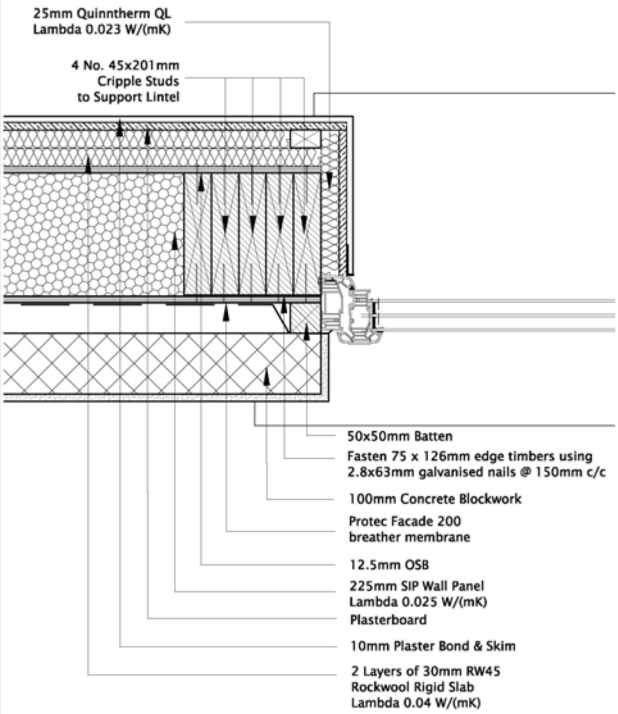
Construction Details



Construction Details

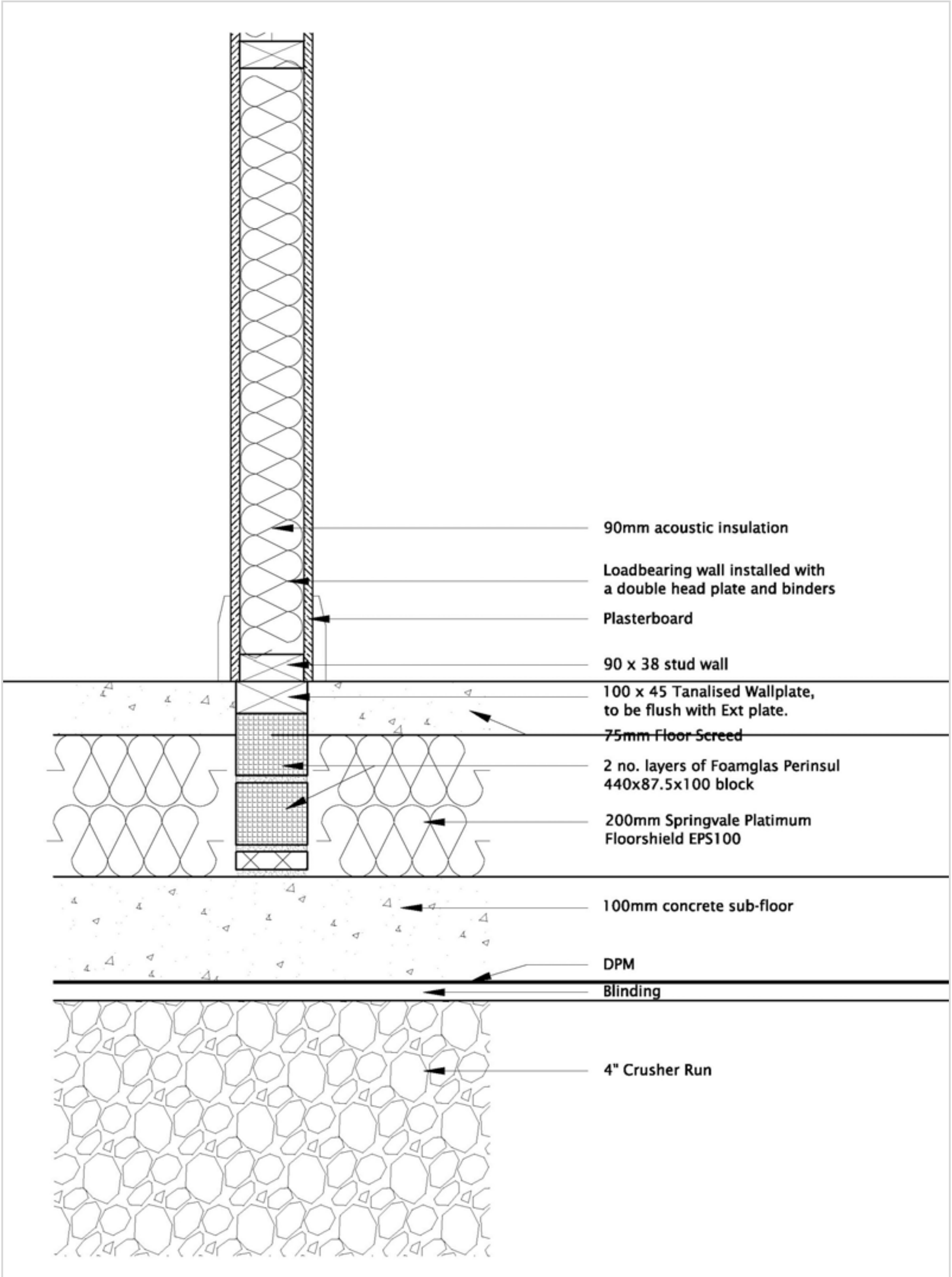


Window Jamb 1:5
1 No. Cripple Studs

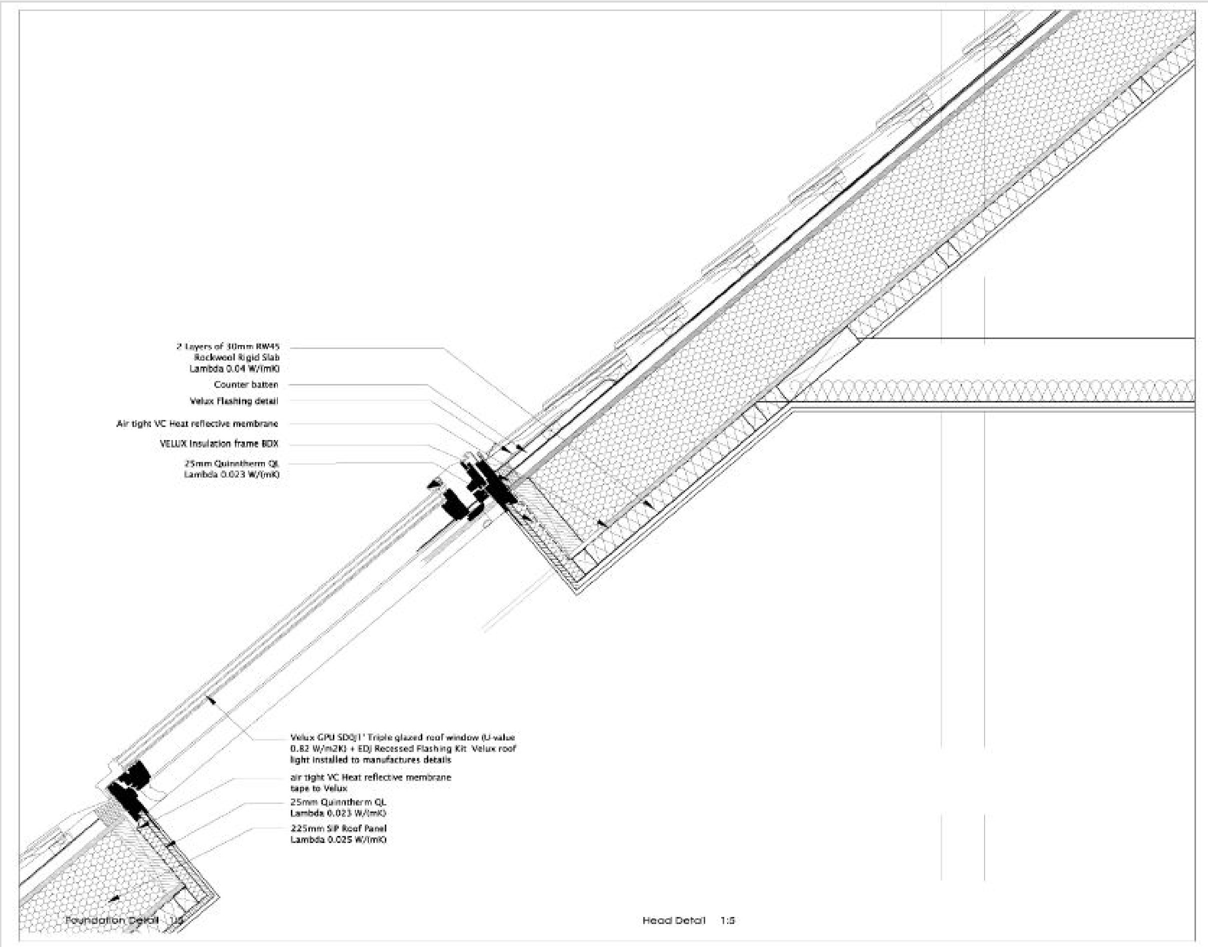


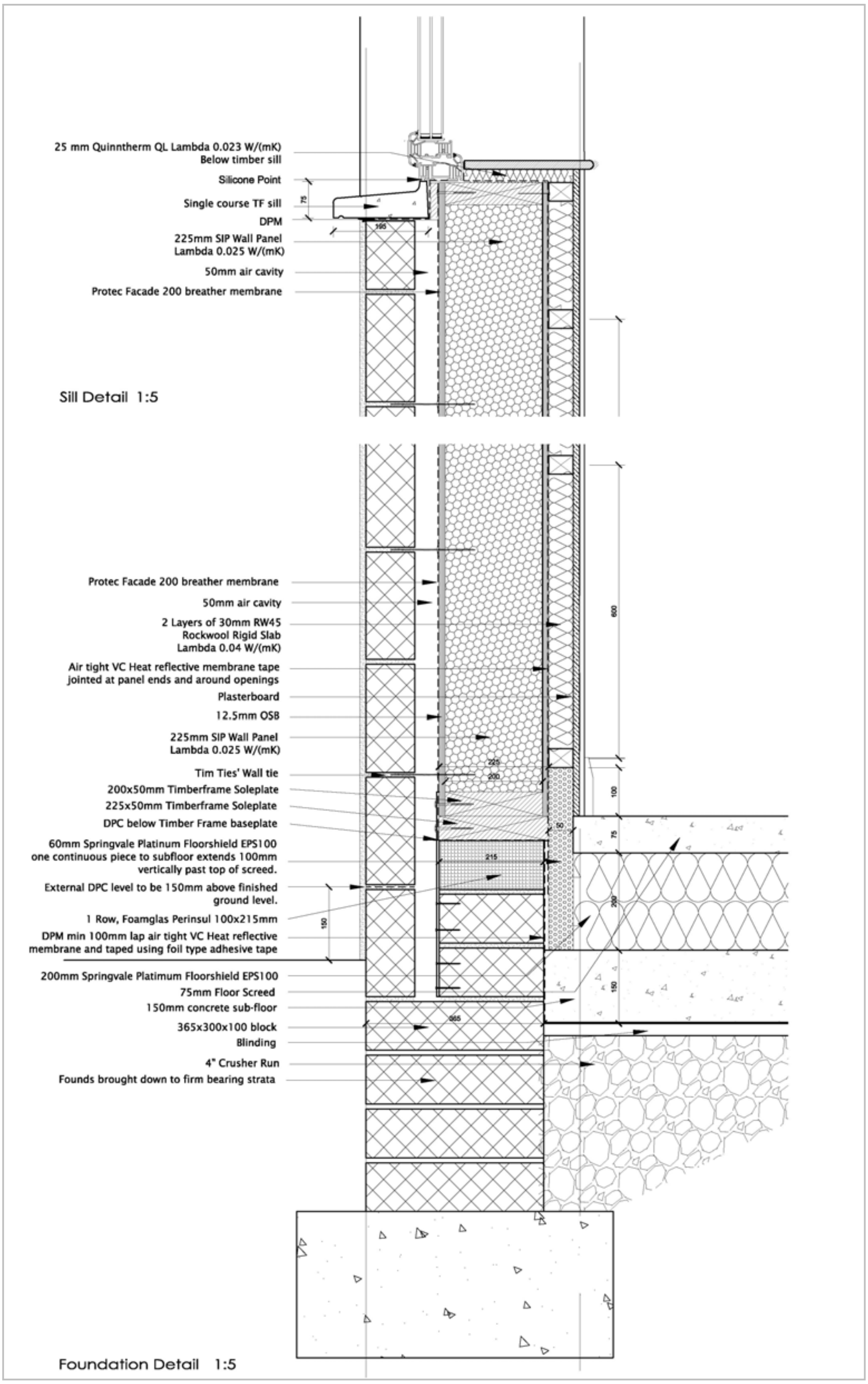
Window Jamb 1:5
4 No. Cripple Studs

Construction Details



Construction Details




25 mm Quinntherm QL Lambda 0.023 W/(mK) Below timber sill
Silicone Point
Single course TF sill
DPM
225mm SIP Wall Panel Lambda 0.025 W/(mK)
50mm air cavity
Protec Facade 200 breather membrane
Sill Detail 1:5
Protec Facade 200 breather membrane
50mm air cavity
2 Layers of 30mm RW45 Rockwool Rigid Slab Lambda 0.04 W/(mK)
Air tight VC Heat reflective membrane tape jointed at panel ends and around openings
Plasterboard
12.5mm OSB
225mm SIP Wall Panel Lambda 0.025 W/(mK)
Tim Ties' Wall tie
200x50mm Timberframe Soleplate
225x50mm Timberframe Soleplate
DPC below Timber Frame baseplate
60mm Springvale Platinum Floorshield EPS100 one continuous piece to subfloor extends 100mm vertically past top of screed.
External DPC level to be 150mm above finished ground level.
1 Row, Foamglas Perinsul 100x215mm
DPM min 100mm lap air tight VC Heat reflective membrane and taped using foil type adhesive tape
200mm Springvale Platimum Floorshield EPS100
75mm Floor Screed
150mm concrete sub-floor
365x300x100 block
Blinding
4" Crusher Run
Founds brought down to firm bearing strata
Foundation Detail 1:5

Passive House Verification Worksheet

Passive House Verification

Photo or Drawing

Building:	Detached House
Location and Climate:	IRL - Birr
Street:	65 Cootehall Road
Postcode/City:	Crawfordsburn
Country:	NI
Building Type:	Residential
Home Owner(s) / Client(s):	Patrick & Helen McGlinchey
Street:	
Postcode/City:	
Architect:	Paul McAlister Architects
Street:	64a Drumnacanvy Road
Postcode/City:	Co Armagh
Mechanical System:	
Street:	
Postcode/City:	

Year of Construction:	2012				
Number of Dwelling Units:	1		Interior Temperature:	20.0	°C
Enclosed Volume V_e:	533.8	m^3	Internal Heat Gains:	2.1	W/m^2
Number of Occupants:	5.3				

Specific Demands with Reference to the Treated Floor Area

Treated Floor Area: 185.1 m^2

	Applied:	Monthly method	PH Certificate:	Fulfilled?
Specific Space Heating Demand:	**14**	**kWh/(m²a)**	**15 kWh/(m²a)**	**Yes**
Heating Load:	**11**	**W/m²**	**10 W/m²**	
Pressurization Test Result:	**0.6**	**h^{-1}**	0.6 h^{-1}	**Yes**
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):	**91**	**kWh/(m²a)**	120 kWh/(m²a)	**Yes**
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	30	**kWh/(m²a)**		
Specific Primary Energy Reduction through Solar Electricity:		**kWh/(m²a)**		
Frequency of Overheating:	2	**%**	over 25 °C	
Specific Useful Cooling Energy Demand:		**kWh/(m²a)**	15 kWh/(m²a)	
Cooling Load:	9	**W/m²**		

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

Issued on:

signed: