

Template project documentation

Project Documentation Gebäude-Dokumentation



1 Abstract / Zusammenfassung



18 apartments in three blocks in Lichfield, England

1.1 Data of building / Gebäudedaten

The development consists of three blocks with a total of 18 apartments. The larger block (above) contains 14 apartments and the smaller blocks contain 2 apartments each and are connected via a shared external staircase. The table below, and the rest of the document refers to the larger block only.

Year of construction/ Baujahr	2017	Space heating / Heizwärmebedarf	9 kWh/(m²a)
U-value external wall/ U-Wert Außenwand	0.169 W/(m²K)		
U-value basement ceiling/ U-Wert Kellerdecke	0.135 W/(m²K)	Primary Energy Renewable (PER) / Erneuerbare Primärenergie (PER)	kWh/(m²a)

U-value roof/ U-Wert Dach	0.165 W/(m²K)	Generation of renewable energy / Erzeugung erneuerb. Energie	0 kWh/(m²a)
U-value window/ U-Wert Fenster (installed)	0.89 W/(m²K)	Non-renewable Primary Energy (PE) / Nicht erneuerbare Primärenergie (PE)	86 kWh/(m²a)
Heat recovery/ Wärmerückgewinnung	84 %	Pressure test n ₅₀ / Drucktest n ₅₀	0.48 h ⁻¹
Special features/ Besonderheiten	Centralised ventilation, domestic hot water and space heating.		

1.2 Brief Description

St Johns Almshouses are a group of privately rented apartments for the over 50s, owned by the charitable trust St Johns Hospital. The site dates to 1129 and the existing Grade 1 listed buildings date back to 1495. The new Passivhaus buildings needed to provide the very best in comfort, affordability and style, as well as being in keeping with the existing buildings on the site. As a result, oak features heavily in the external access corridors, stairwells and lifts and the new buildings include chimney-like designs at the gables, that echo the other buildings on the site.

The new Passivhaus buildings form two sides of a square courtyard, with the existing buildings on the site making up a third side and an occasional access road on the fourth. The larger, three storey Passivhaus block is directly opposite the three storey existing apartment block and comprises 14 of the 18 new apartments. There is a walkway through the centre of the block with a view from the car park to the new landscaped courtyard, complete with an oak pergola. Access to the apartments is designed to the front of the block, facing the courtyard. The smaller two storey block sits to the side of the larger block and the four apartments are accessed via a central external stairwell that is situated between the apartments such that they are separated thermally into two blocks of two apartments. The remainder of this report focusses on the larger block only.

Responsible project participants / Verantwortliche Projektbeteiligte

Architect/ Entwurfsverfasser	Lorin Arnold, KKE Architects http://kkearchitects.co.uk/
Implementation planning/ Ausführungsplanung	Lorin Arnold, KKE Architects http://kkearchitects.co.uk/
Building systems/ Haustechnik	Graham Eastwick, Design Buro http://www.designburo.co.uk (formerly Encraft Ltd)
Structural engineering/ Baustatik	Perry Millward, MBCE http://www.mbce.co.uk/
Building physics/	Dr Sarah Price, Design Buro

Bauphysik	http://www.designburo.co.uk/ (formerly Encraft Ltd)
Passive House project planning/ Passivhaus-Projektierung	Dr Sarah Price, Design Buro http://www.designburo.co.uk/ (formerly Encraft Ltd)
Construction management/ Bauleitung	Jim Clay, Greenwood Projects http://greenwoodprojects.com/
Certifying body/ Zertifizierungsstelle	Mead Consulting, http://www.meadconsulting.co.uk/
Certification ID/ Zertifizierungs ID	ID 5913 Project-ID (www.passivehouse-database.org)
Author of project documentation / Verfasser der Gebäude-Dokumentation	Dr Sarah Price, Enhabit http://www.enhabit.uk.com/
Date, Signature/ 20 Dec 2018 Datum, Unterschrift	

2 View of the Lichfield Passivhaus

The north east elevation of the larger block (14 apartments) is shown in the cover photo.

The photo below is taken facing north and shows the south east long face and the south west shorter face of the larger block (14 apartments) and the south west shorter face of the two smaller adjoining blocks (2 x 2 apartments in total). Here you can see the false chimney-like structures at the gable ends. The balconies and extended roof overhangs provide shading to the exposed south east elevation.





The photo to the left is the north east elevation (front) and the north west shorter elevation of the larger block of apartments. The front of the building has two external towers in brick, oak and glass, one is a stairwell and the other a lift shaft providing access to the external walkways and the apartments on all three floors.

Photos of the internal finishes are shown below; bathroom designed for disabled access; bedroom with views onto a balcony and open plan living space. All apartments are dual aspect.



3 Sectional drawing of the St John's Passivhaus

Below is a short section of the three storey block of apartments. In section the thermal envelope follows the external walls, floors and roof of the apartments, thus creating a cold roof. All access walkways, stairs and lifts are external to the thermal envelope and are carefully designed such that they do not penetrate the insulation layer.

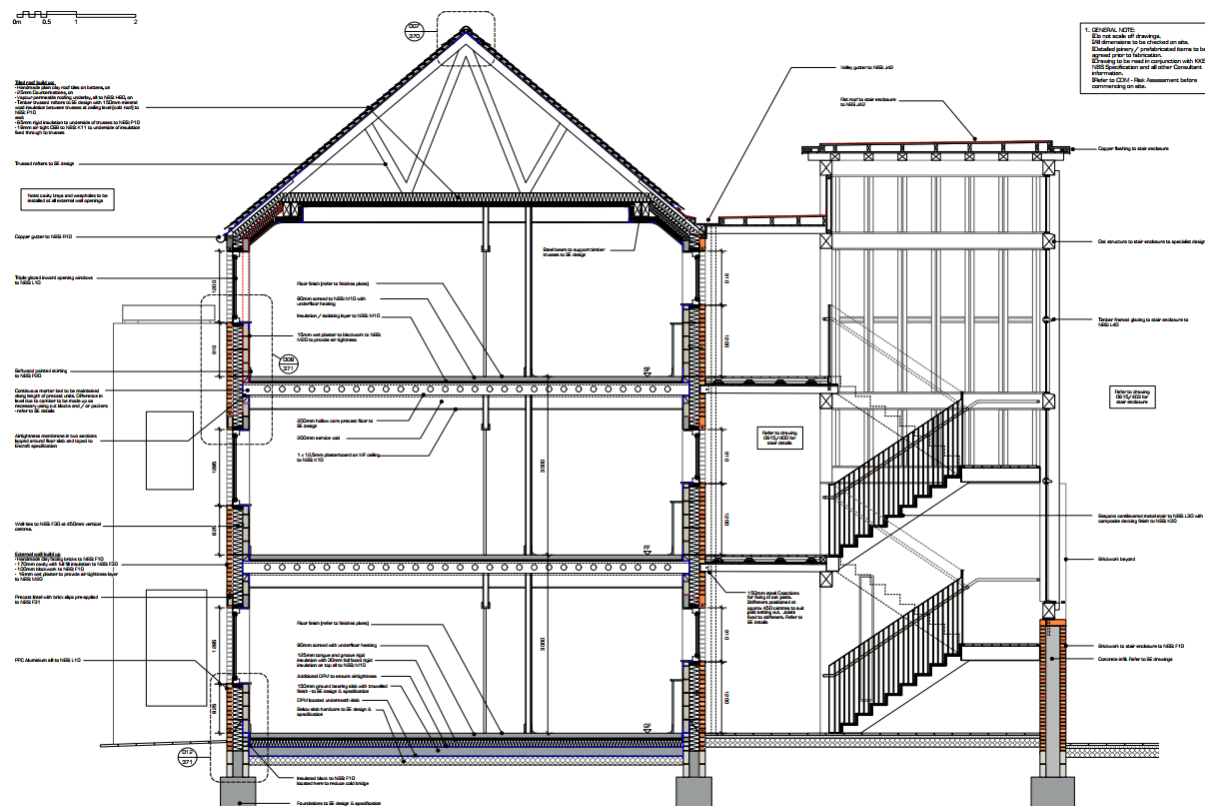
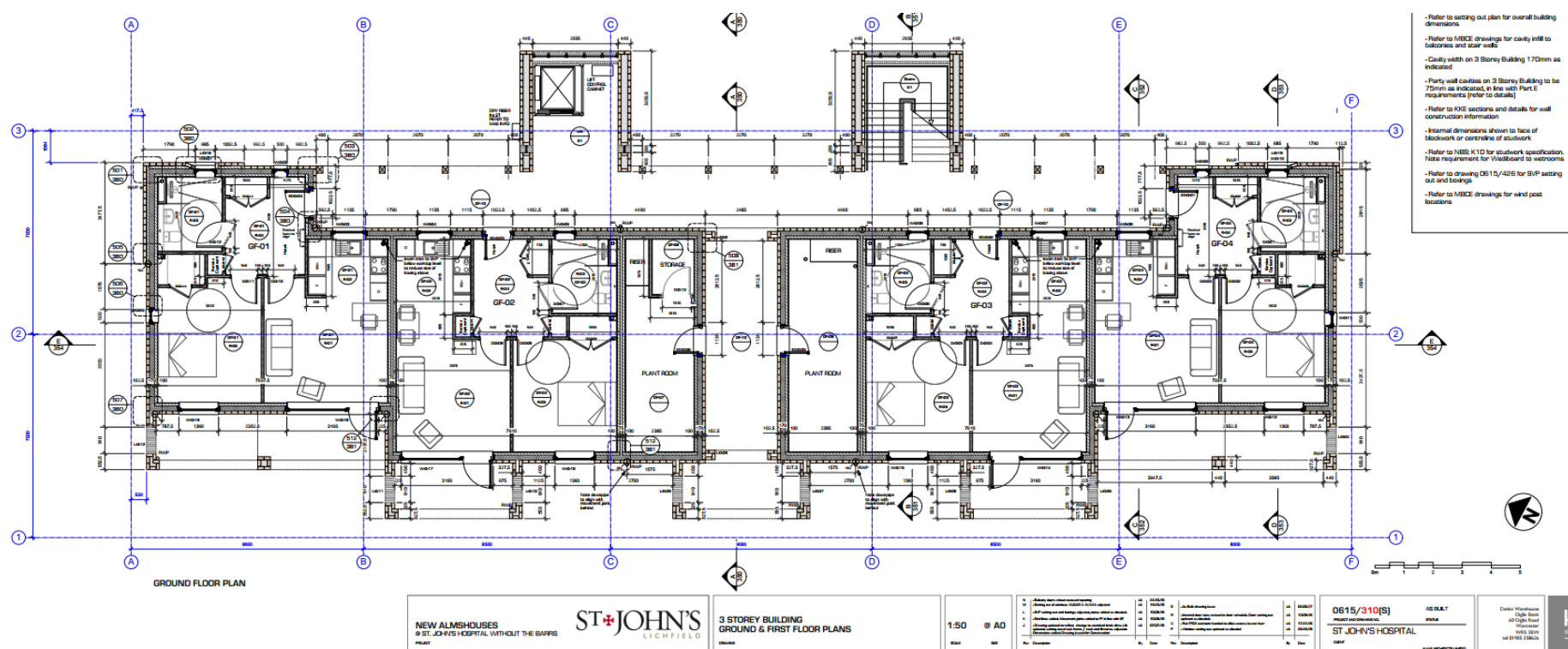


Figure 1 Short section of the 3 storey block at St John's Almshouses, Lichfield. Drawing by KKE architects.

4 Floor plans of the St John's Passivhaus

Below are the ground and first floors plans for the 14 apartments at St John's, Lichfield. The ground floor consists of 4 apartments, 2 in either wing, separated by a central walkway passing under the first floor. Either side of the walkway are plant rooms: One electrical or 'dry' plant room for the centralised MVHR and electrical systems for the 14 apartments in this block: The other a 'wet' plant room, housing the centralised heating and hot water system for all 18 apartments in this block and the two storey block.



The first and second floors are identical and consist of 5, single bedroom apartments. The thermal envelope follows the lines of the external envelope of the flats. Walkways and balconies are not within the insulated envelope. Initially, the air tightness line was to follow the thermal envelope, however the strategy was changed during the build to be contained within each apartment.

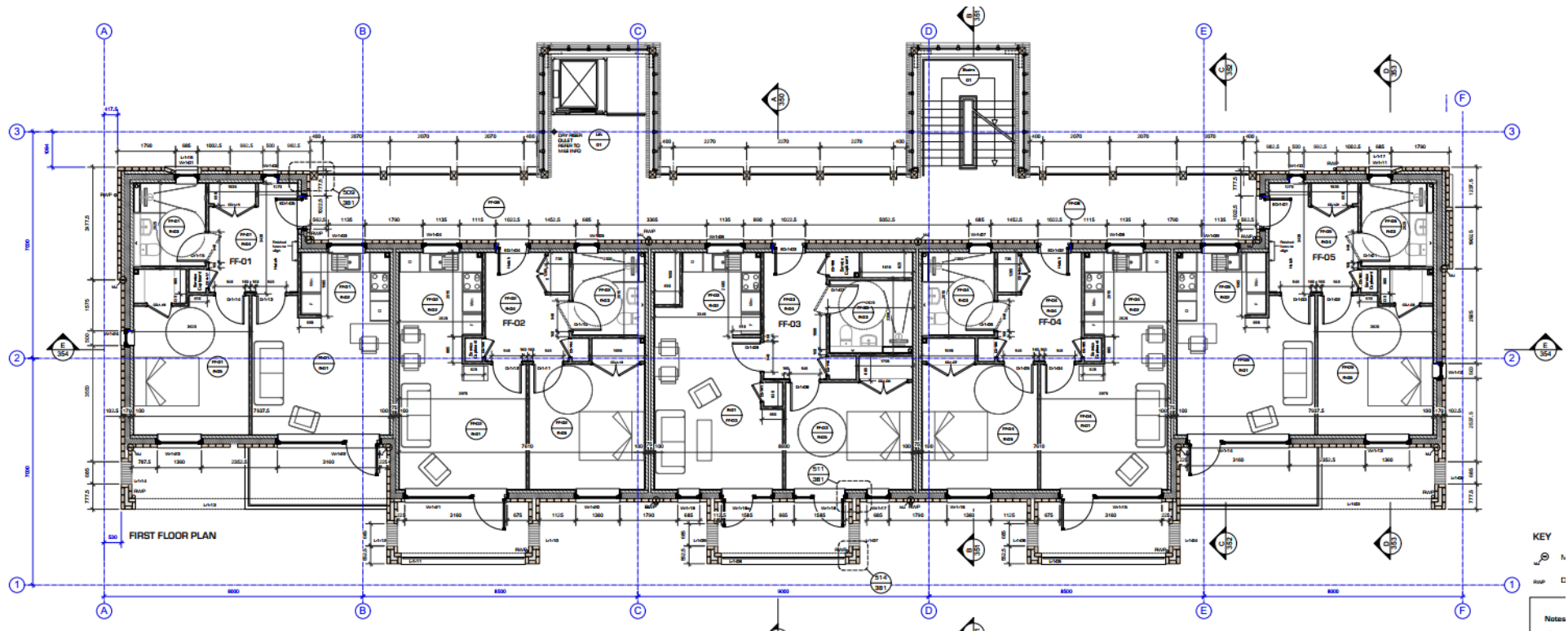


Figure 2 First and Second floor plan. Drawing by KKE Architects.

5 Construction

5.1 Floor slab

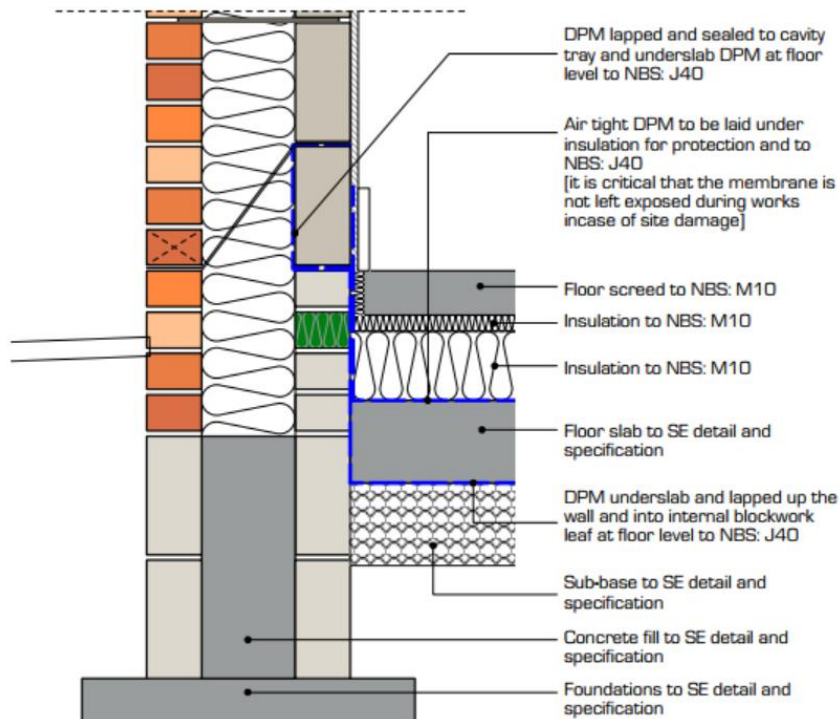


Figure 3 Ground floor to External wall junction. Drawing by KKE Architects.

The floor slab consists of (from external to internal)

- Sub-base
- Damp proof membrane
- Concrete slab
- Air tight membrane
- Xtratherm Hyfloor XT/HYF 140mm + 75mm ($\lambda = 0.022 \text{ W/mK}$)
- Xtratherm Thin-R XT/UF 30mm ($\lambda = 0.022 \text{ W/mK}$)
- 85mm screed

U-value ground floor = $0.135 \text{ W/m}^2\text{K}$

Load bearing insulated block (Foamglas, $\lambda = 0.058 \text{ W/mK}$) installed in line with top of insulation layer in floor at internal blockwork leaf to create continuous line of insulation between floor and wall cavity.

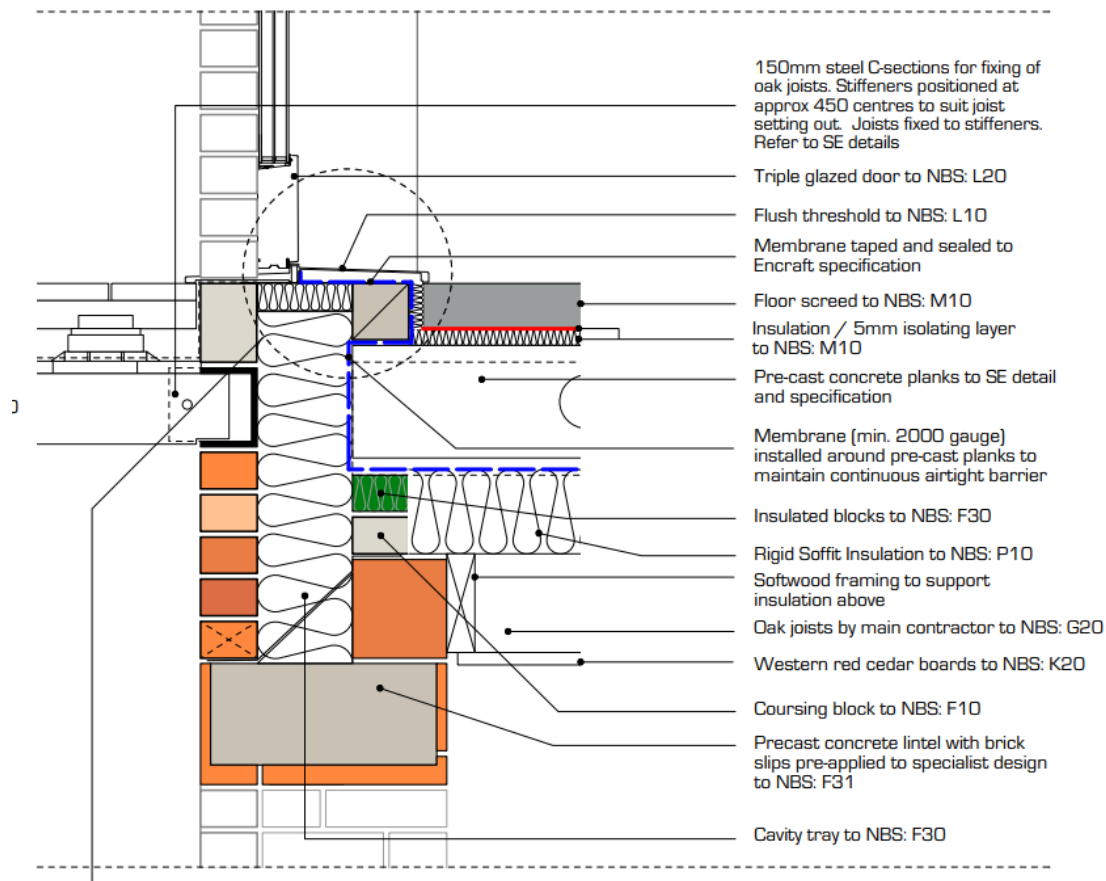


Figure 4 External wall to walkway ceiling junction. Detail by KKE Architects.

The ceiling of the walkway through the ground floor has a different build up to the ground floor slab and is as follows (external to internal):

- Western red cedar boards
- Service void
- Thin R XT/Hyfloor 170mm ($\lambda = 0.022 \text{ W/mK}$)
- Pre-cast concrete planks
- Thin R XT/UF 30mm ($\lambda = 0.022 \text{ W/mK}$)
- 85mm screed

U-value walkway ceiling = $0.104 \text{ W/m}^2\text{K}$

Similar to the ground floor, the line of insulation between the walkway ceiling and the external walls of the flats is kept continuous using a load bearing insulated block (Foamglas, $\lambda = 0.058 \text{ W/mK}$).

5.2 External walls

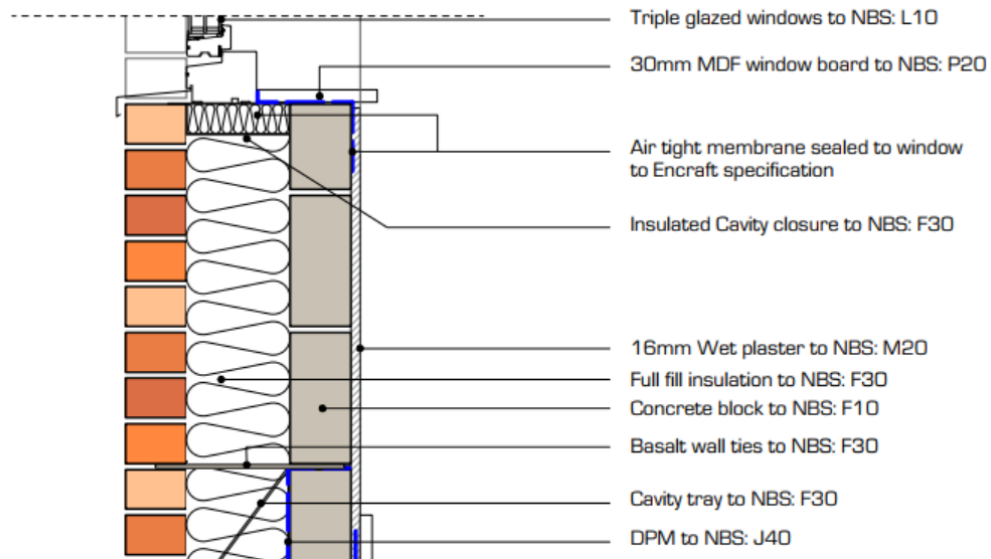


Figure 5 External wall buildup. Drawing by KKE Architects.

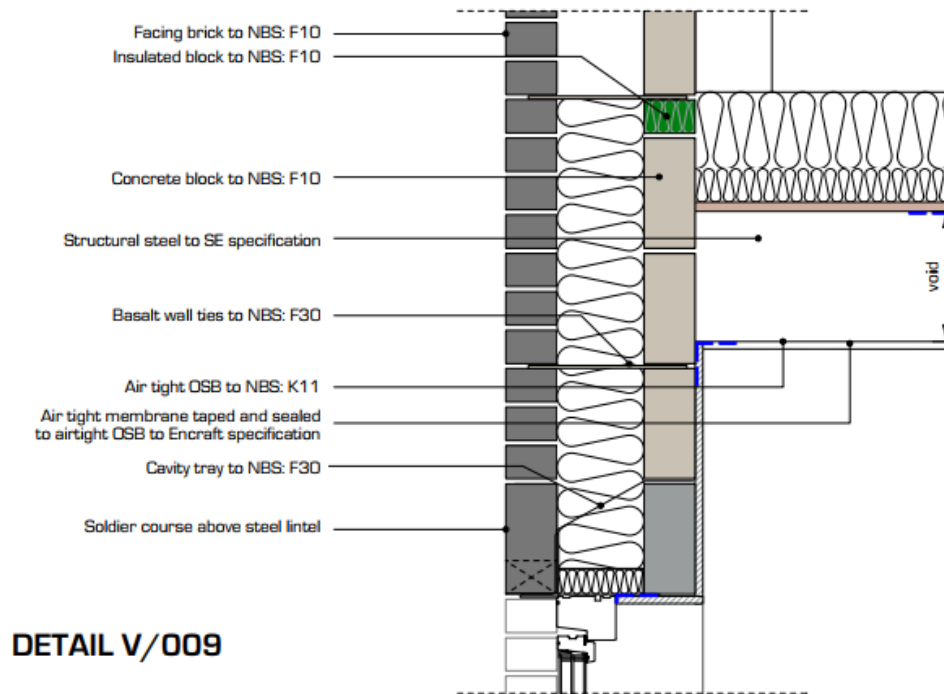
The external walls consist of (from external to internal)

- Brickwork 100mm
- Isover Mineral wool 170mm ($\lambda = 0.032 \text{ W/mK}$)
- Hemalite blockwork 100mm ($\lambda = 0.49 \text{ W/mK}$)
- Plaster 16mm

U-value external walls = $0.169 \text{ W/m}^2\text{K}$

The brick, block cavity wall construction is held together with basalt wall ties (Ancon Teplotie). The Isover mineral wool is slightly compressed in the cavities to ensure no thermal bypass.

5.3 Roof



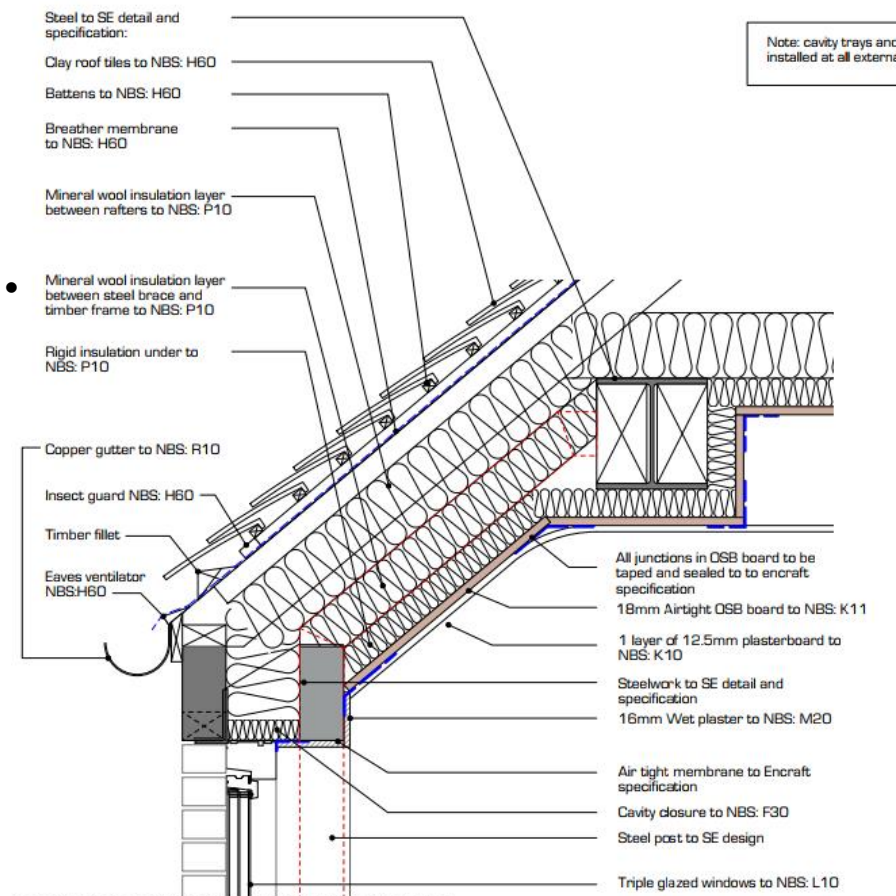
The roof is insulated at ceiling level with the following build up (from external to internal):

- Isover Spacesaver Plus 150mm ($\lambda = 0.04 \text{ W/mK}$) between timber rafters
- Thin-R XT/PR 65mm ($\lambda = 0.022 \text{ W/mK}$) below rafters.
- Air tight OSB (Smart ply) 18mm

U-value ceiling = $0.165 \text{ W/m}^2\text{K}$

Load bearing insulated block (Foamglas, $\lambda = 0.058 \text{ W/mK}$) installed in line with top of insulation layer in ceiling at internal blockwork leaf to create continuous line of insulation between ceiling insulation and wall cavity.

Figure 6 External wall to insulated ceiling junction. Drawing by KKE architects.



Part of the sloped roof at the eaves forms a skelining detail in the room, as such this part of the roof is insulated and form a continuous line of insulation with the walls as shown in Figure 6. Here the Isover mineral wool and Thin-R XT/PR wrap around the structural steel. An additional layer of Isover mineral wool is included on the sloped part of the ceiling between the steel brace and the timber frame.

Figure 7 Eaves junction at sloped roof. Drawing by KKE Architects.

5.4 Windows and Doors

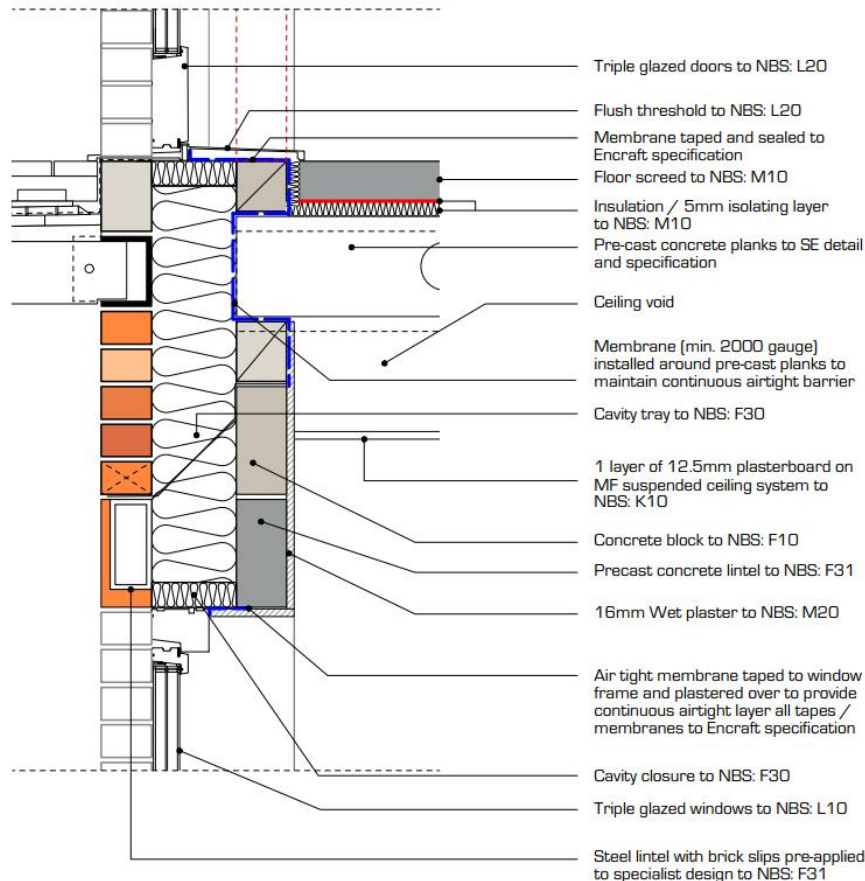


Figure 8 Door threshold and window head junction with external walls.
Drawing by KKE Architects.

Windows and doors are Nordan Ntech Passive. All windows and doors were installed in line with the insulation in the cavity, using a structural, insulated cavity closer (Cavalock Bigblok).

U-value (averaged) for installed windows and doors = 0.89 W/m²K

			Ntech Passive Fixed Light	Ntech Passive Opening Light
U-value of frame	left	W/(m ² K)	0.86	0.9
	right	W/(m ² K)	0.86	0.9
	bottom	W/(m ² K)	1.13	1.12
	above	W/(m ² K)	0.86	0.88
Frame width	left	m	0.056	0.094
	right	m	0.056	0.094
	bottom	m	0.056	0.101
	above	m	0.056	0.105
Glazing edge thermal bridge	$\Psi_{\text{Glazing edge}}$	W/(mK)	0.038	0.038

- Glazing U-value = 0.58 W/m²K
- Glazing g-value = 0.5

6 The air tight envelope

The original air tightness design followed the external walls, roof and floors of the building such that it would continue behind party walls and floors between the apartments. However, it soon became apparent that the strategy had to be changed on site due to remedial work required to improve the air tightness. It was decided that the air barrier be within each apartment comprising the apartment ceiling, the external walls and the apartment floor.

The main air barrier was comprised as follows:

- Internal plaster layer for external walls
- Intermediate precast concrete floors for apartment ceilings.
- Air tight OSB board (Smart Ply) in the ceiling of the top floor apartments
- Screed in the floor for all apartments.
- Nordan windows and doors

For junctions and other elements the following products were used:

Proprietary air tightness tape

- Between air tight OSB board and plaster
- Between screed and plaster
- Between Windows and doors and plaster
- Around ducts and pipework penetrations between apartments

Blowerproof air tightness paint

- Behind internal partition walls on the internal blockwork layer of external walls.
- In chasing for electrical switch boxes and wires in the blockwork.
- Around ducts and pipework penetrations between apartments

Firestopping grommets

- Air tight firestopping grommets were installed where required, to fit around ductwork and pipework that passed between apartments.



Figure 9 Air tight OSB Board in top floor ceiling taped with proprietary air tightness tape at junctions



Figure 10 Blowerproof paint applied to socket/wiring cutouts in blockwork. Paint is blue when applied and black when dried and air tight.

Air Leakage Certificate

In accordance with BS EN 13829 and ATTMA TSL1 (2016)

Building Tested:	Flat 18, The Oaks, St Johns Hospital, St Johns Street Lichfield, Staffordshire WS13 6PB
Test Date:	26 th May 2017
Test Engineer:	Paul Jennings, Encraft
Certificate No:	P3150-C14

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 ATTMA as specified in TSL1 (2016). The additional requirements of the Passivhaus Institute when Passivhaus Certification is required were also met. The average Leakage Characteristics of the dwelling were recorded as follows:

Airflow @ 50 Pa:	66.1 m ³ /hr		
Air Permeability @ 50 Pa:	0.34 m ³ / (hr.m ²)		
Air Change Rate @ 50 Pa:	0.46 ACH ⁻¹		
Data consistency, r ² (requirement, r ² > 0.98):	0.999		
Slope, n (requirement, 0.5 < n < 1.0):	0.72		
Intercept, C _{env} :	4.01 m ³ / (hr.Pa ⁿ)		
Test Parameters			
Envelope, A _E :	197 m ²		
Volume, V:	144 m ³		
Env. Calc. prepared by:	Adam Moring, Encraft		
Initial Offset Pressure	0.34 Pa	Final Offset Pressure:	0.22 Pa
Initial Inside Temperature:	18.3°C	Final Inside Temperature:	18.4°C
Average Outside Temperature:	21.1°C	Barometric Pressure:	101.1 kPa

This certificate should be read in conjunction with the full airtightness test report P3150-03 and associated test method statement.

Signed:  Name: Paul Jennings Date Issued: 23rd June 2017
Position: Air Leakage Specialist

Deviations from TSL1 methodology: None.

Figure 11 Example front page of the air tightness testing report for one of the apartments at St John's Almshouses, Lichfield

The air tightness testing was carried out by Paul Jennings of Encraft (now of Aldas) who has extensive experience of testing Passivhaus and low energy buildings in the UK. Each apartment was tested individually, and since the air barrier was within each apartment, no co-pressure testing of adjacent apartments was required.

The air tightness results from each apartment were as follows:

Apartment No.	ACH ⁻¹ @ 50Pa
18	0.46
19	0.59
20	0.45
21	0.49
22	0.50
23	0.47
24	0.64
25	0.50
26	0.43
27	0.60
28	0.41
29	0.47
30	0.30
31	0.47
Average	0.48

7 Ventilation

7.1 Ventilation duct work

The MVHR and ductwork design for the centralised system was completed by the Green Building Store. Below is the ground floor plan showing a branch design from the centralised MVHR in the plant room. Large main branch ducts rise up through the centre of the building and extend out to all apartments on the first and second floors in a similar fashion. Air is supplied to bedrooms and living areas (blue) and extracted (green) from bathrooms and kitchens.

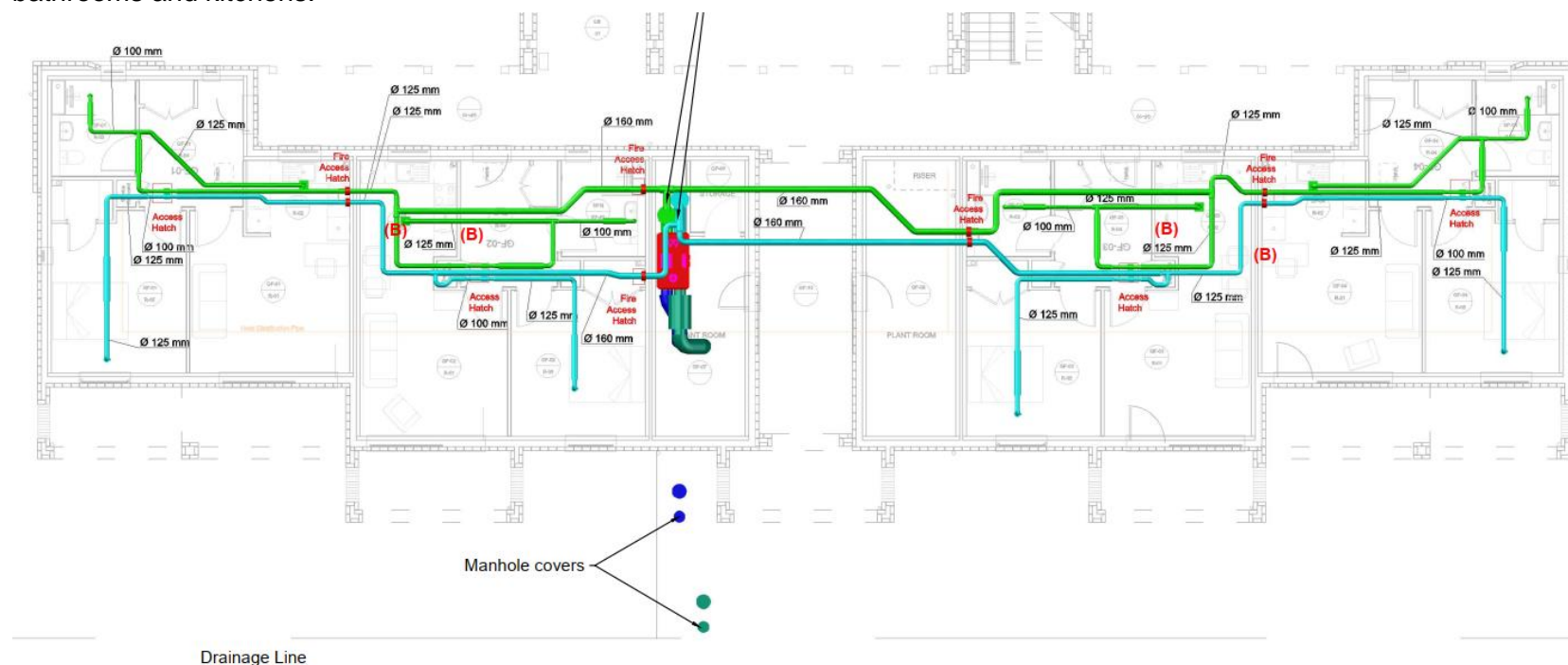
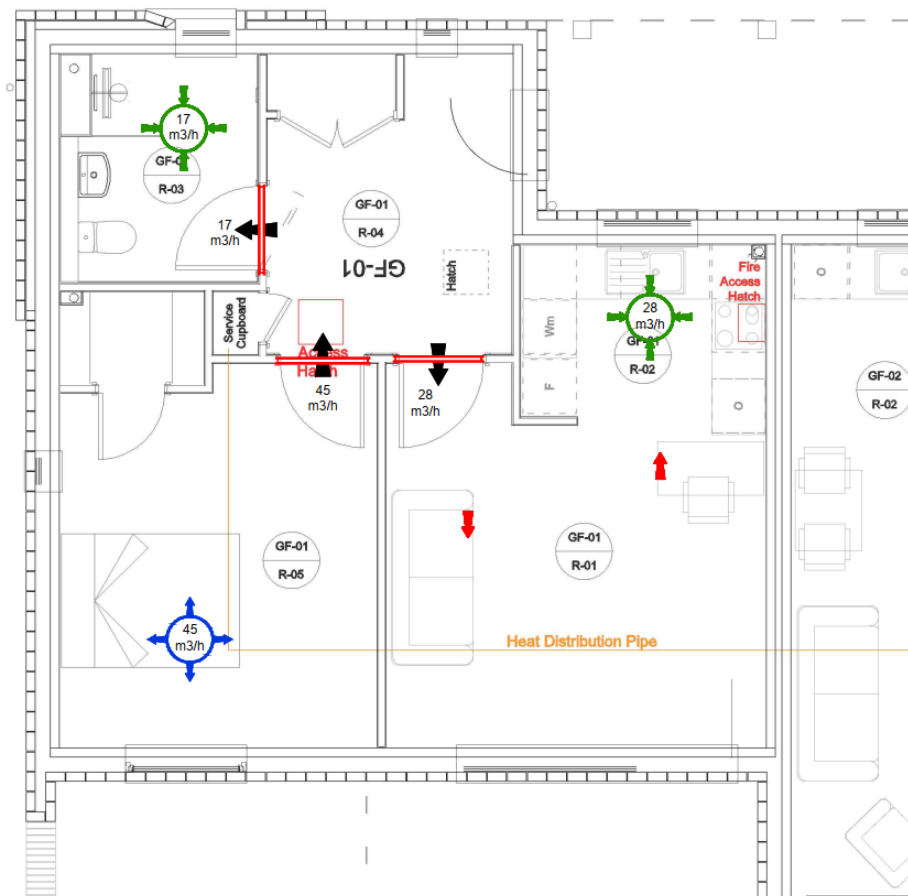


Figure 12 Typical duct layout for the ground floor of St John's Almshouses. Drawing by the Green Building Store



Ventilation Rate

Standard: 45 m³/h

Boost: 80 m³/h

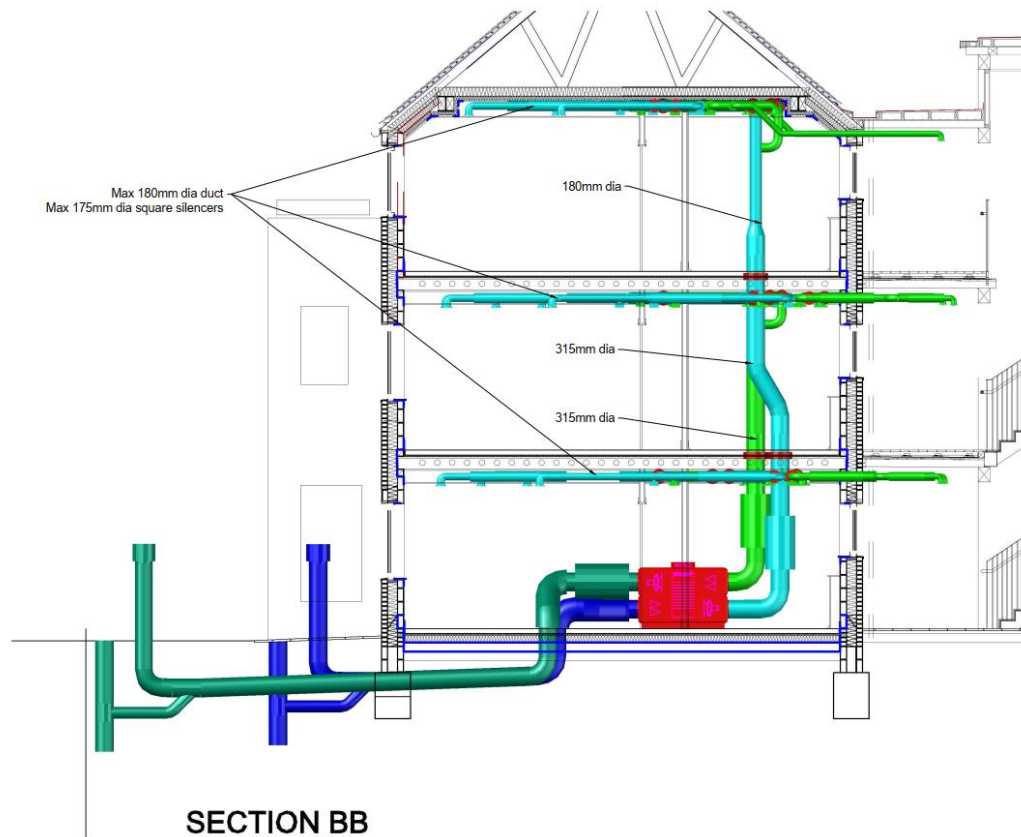
Accessible fire dampers were required between each intermediate floor and between each apartment. Constant volume dampers were also installed in each apartment to allow a Boost mode to be operated without effecting the flow rates in other apartments.

Silencers were fitted on each supply branch and each extract duct to every apartment to avoid cross talk.

Noise from the MVHR system was very low due to the long duct runs and isolated, centralised system in the plant room.

Figure 13 Typical apartment flow rates for supply (blue) and extract (green). Drawing by the Green Building Store.

7.2 MVHR unit



The MVHR unit is a Swegon Gold RX Series (shown in red) with 84% effective heat recovery efficiency and 0.45 Wh/m³ electrical efficiency.

The unit has intake (dark blue) and exhaust (turquoise) ducts that pass under the building and come up to the south west (car park) side of the building. Exhaust and intake are over 2m apart to ensure no mixing of outgoing and incoming air into the system. The underground duct system also offers slight tempering of the air, although the lengths are very short and have not been included in the PHPP calculations.

Figure 14 Section of MVHR system showing intake, exhaust and the main duct riser through the building. Drawing by the Green Building Store.

8 Centralised heating system

Heating and hot water is provided by two 30kW gas boilers situated in the plant room, supplying a 900L buffer tank for hot water. A hot water circulation loop supplies SAV heat exchangers in each apartment. Heat loss from the circulation pipework, the buffer tank and the SAVE heat exchangers was carefully calculated in the PHPP. These will remain hot all year around to supply domestic hot water so it was important to consider their contribution to any overheating that may occur.

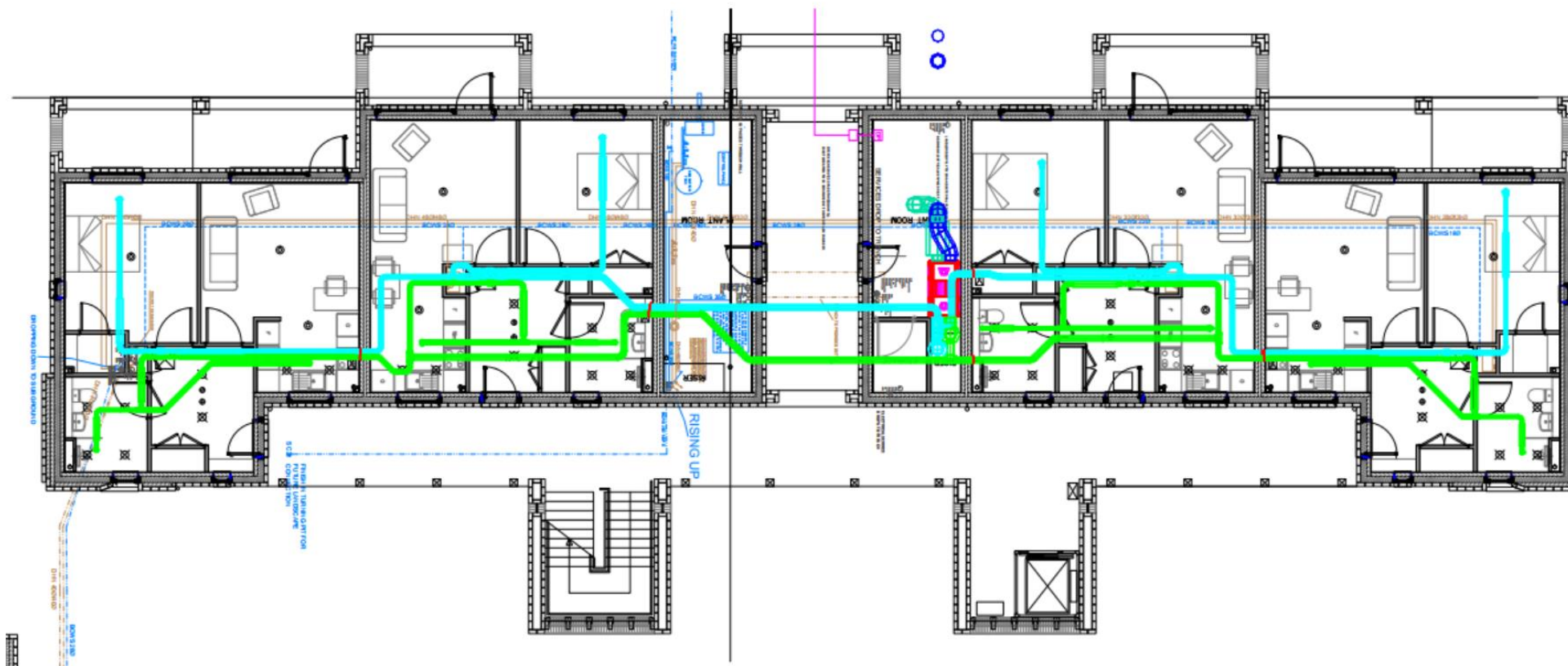


Figure 15 Communal heating network for hot water and space heating. Drawing by Encraft Ltd.

9 PHPP results

Building:	3 Storey - St. John's Almshouses		
Street:	Birmingham Road		
Postcode / City:	WS13 6PB Lichfield		
Country:	UK		
Building type:	Residential apartments		
Climate:	[UK] - Midlands (Sutton Bonnington)	Altitude of building site (in [m] above sea level):	87
Home owner / Client:	St John's Lichfield		
Street:	Birmingham Road		
Postcode/City:	WS13 6PB Lichfield		
Architecture:	KKE		
Street:	60 Danks Warehouse, Diglis Road		
Postcode / City:	WR53BW Worcester		
Mechanical system:	Encraft Ltd		
Street:	Brandon House Courtyard, William Street		
Postcode / City:	CV324HJ /Leamington Spa		
Year of construction:	2017	Interior temperature winter:	20.0 °C
No. of dwelling units:	14	Interior temperature summer:	25.0 °C
No. of occupants:	14.0	Internal heat sources winter:	4.1 W/m²
Spec. capacity:	180	Ditto summer:	4.4 W/m²
	Wh/K per m² TFA		
		Enclosed volume V _e m³:	3503.0
		Mechanical cooling:	

Specific building demands with reference to the treated floor area				
	Treated floor area	Requirements	Fulfilled?*	
Space heating	789.0 m²			
	Heating demand	9 kWh/(m²a)	15 kWh/(m²a)	yes
	Heating load	10 W/m²	10 W/m²	yes
Space cooling	Overall specif. space cooling demand	kWh/(m²a)	-	-
	Cooling load	W/m²	-	-
	Frequency of overheating (> 25 °C)	1.2 %	-	-
Primary energy	Heating, cooling, dehumidification, DHW, auxiliary electricity, lighting, electrical appliances	86 kWh/(m²a)	120 kWh/(m²a)	yes
	DHW, space heating and auxiliary electricity	56 kWh/(m²a)	-	-
	Specific primary energy reduction through solar electricity	kWh/(m²a)	-	-
Airtightness	Pressurization test result n ₅₀	0.5 1/h	0.6 1/h	yes

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

Passive House?	yes
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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:	Sarah	PHPP Version 8.4
	Registration number PHPP:	CHAUK_060913_13428800_en	
	Issued on:	01/10/2013	
	Signature:		
	Surname:	Price	
	Company:	Encraft	

The PHPP was completed by Dr Sarah Price of Encraft Ltd (now of Enhabit Ltd) using PHPP Version 8.4. The main PHPP results from the Verification page are shown to the left.

Heating demand was low due to the excellent form factor of the building. Overheating was also very low at 1.2% because of well designed balconies and overhangs to reduce solar gains.

10 Costs

10.1 Overall construction costs

The construction costs were £2,685 per sqm.

10.2 Building costs

Total building costs came in at £2,838,000, despite the demise of the main contractor early in the construction process. The client took on a construction management role to complete the build.

11 In-use data

	Estimated from PHPP (final energy)	Actual energy bills (2017 to 2018)
Electricity	(20,115 kWh at 14p/kWh) £2,816	£3,080
Gas	(42,886 kWh at 5p/kWh) £2,144	£1,836