Taylor Wimpey – Thermal Imaging Project

LEEDS BECKETT UNIVERSITY

Leeds Sustainability Institute

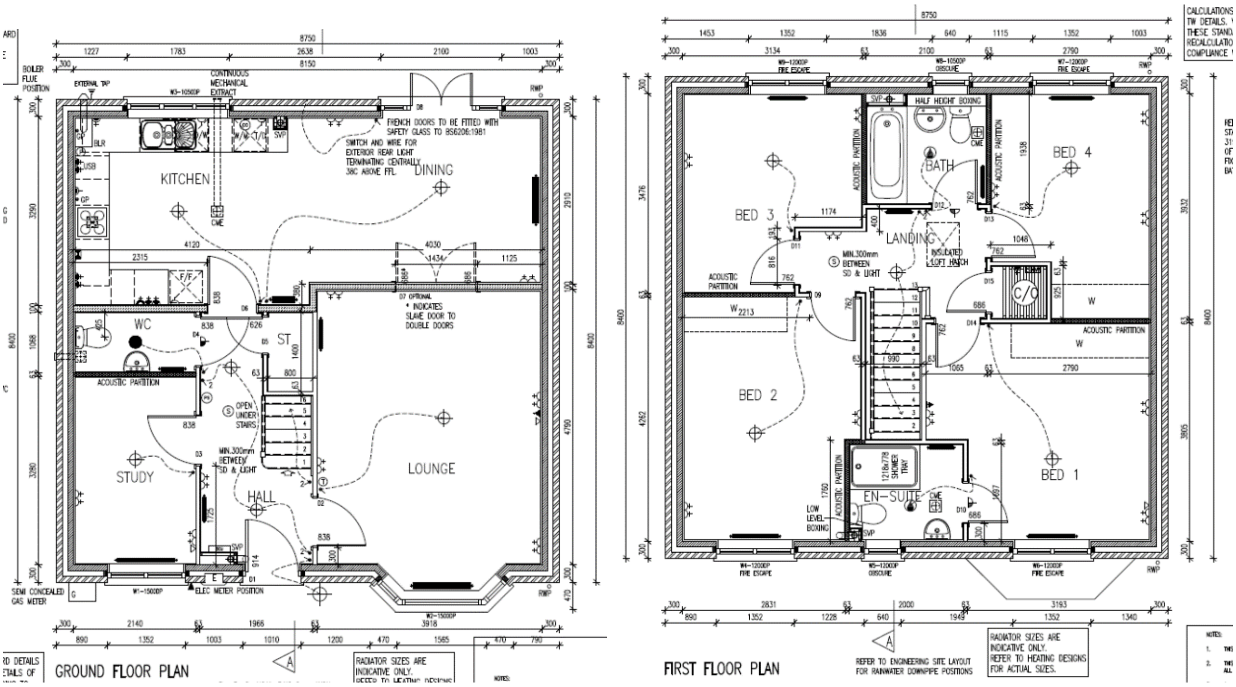
Site: Kingsbrook Place
Elmstree, Bury St Edmunds
IP30 9HA

Visit Date: 15th November 2017

Plot(s): 8 & 9

House Type: PA48 – Shelford
Full-fill Masonry, 2-Storey, 4-Bed Detached

Floor Plans: Plot 8 as below, Plot 9 handed version



Environmental Conditions:

Internal Temperature	22 °C	External Temperature	11.3 °C
Internal RH	57 %	External RH	84%
Wind Speed	0.0 ms^{-1}	Wind Direction	n/a

Cloudy with some breaks in the clouds, overnight light rain but dry for preceding 3 hours.

Pressure Test Results Plot 9:

Depressurisation Only			Pressurisation Only			Mean	
$m^3/(h.m^2)$@50Pa	ach^{-1}	r^2	$m^3/(h.m^2)$@50Pa	ach^{-1}	r^2	$m^3/(h.m^2)$@50Pa	ach^{-1}
4.53	4.11	1.000	4.65	4.22	1.000	4.59	4.17

Observations:

The thermal images below are shown on varying temperature scales to highlight what was being observed, please take into account these different image spans when directly comparing images. The minimum span used is 5° so as not to over-exaggerate any thermal anomalies observed.

Thermal images under depressurisation were captured at an average pressure of -50.4 Pa.

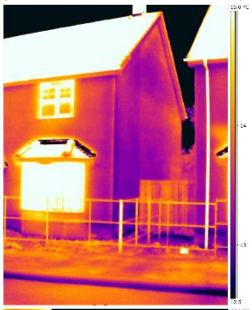
External - Under natural conditions

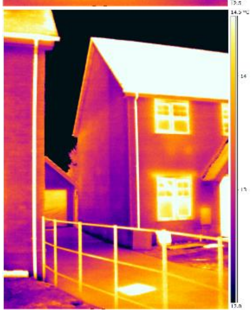
Plots 8 & 9 are both SW facing and had been heated overnight. Plot 9 was surveyed first, by the time Plot 8 was surveyed there had been some light drizzle and breaks in the cloud allowing direct sunlight onto the roof.

Plot 8 External - Under natural conditions

There had been recent direct solar and drizzle prior to the external thermal survey for this property, affecting apparent surface temperatures.

Even reducing the thermal image span to 2.5° to intensify any surface temperature differences little extra can be observed besides warmer areas of walls where radiators are positioned internally:





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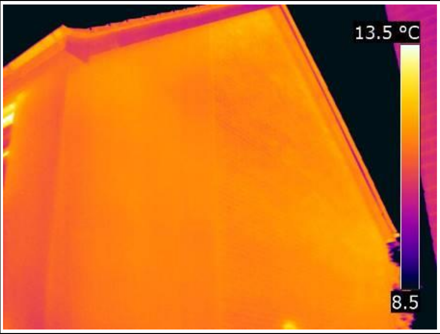
The heat loss observed in the previous survey of this house type at the ground floor perimeter (Pipers Green, 08-Nov-2017) was not apparent on this site.

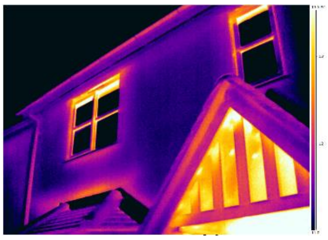
		
		Issues around meter boxes had been observed on this house type in a previous survey (Pipers Green), although then both utility boxes were positioned on the gable wall adjacent to the study rather than on the front façade; no significant issues were observed here.
		
		
		

Plot 9 External - Under natural conditions



No significant thermal anomalies were seen from outside the property; slightly warmer areas were again observed adjacent to the bedroom radiators, the meter boxes showed no reasons for concern.

Warmer areas were observed on the external wall at window openings, particularly heads, and above the bay roof but these only appeared significant when manipulating the thermal image span to 2.5° to accentuate any differences:



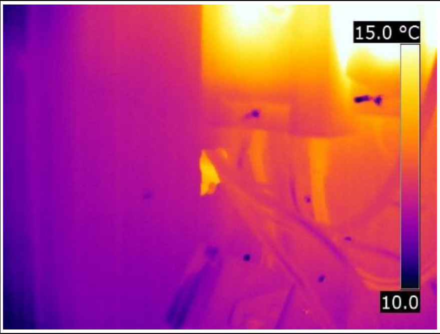

14.0 °C
9.0

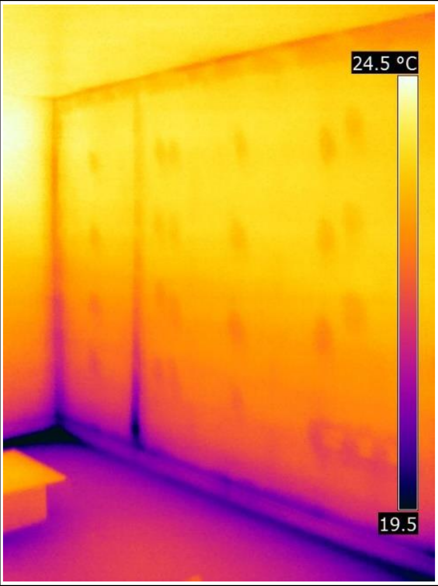

14.0 °C
9.0


14.0 °C
9.0

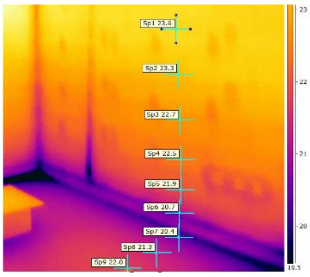

15.0 °C
10.0


15.0 °C
10.0

		
		
		
		
Plot 8 Lounge – Under natural conditions		
		The bay ceiling appeared to show a colder section, but this was difficult to see due to the trickle vent being open beforehand and the reflection of the glazing. There was some natural stratification of temperature within the lounge as the air was not mixing but the base of the external wall

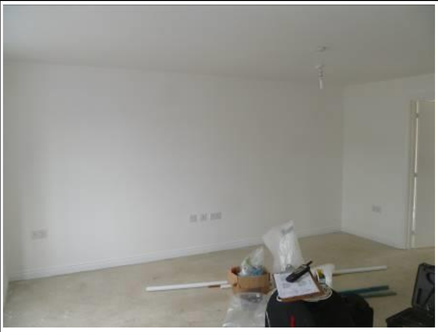


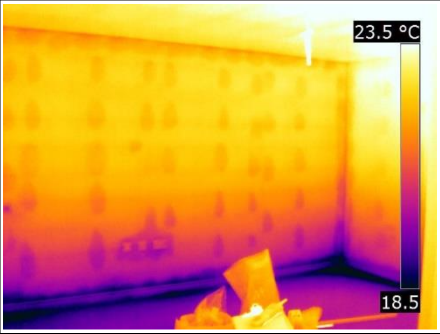
still appeared slightly cooler than expected, although this was not reflected in the external images.

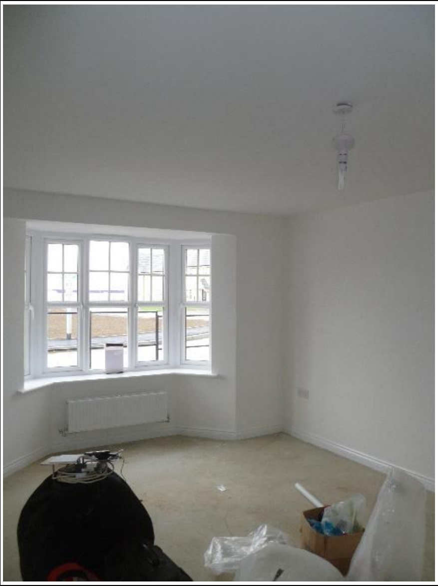


There was also colder vertical strip which was not observed from outside due to the fence between the dwellings.

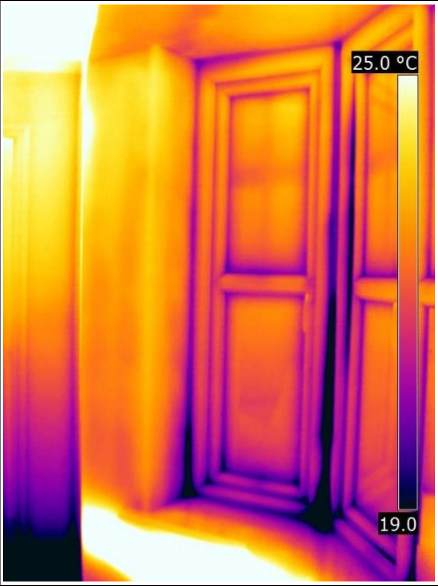
Plot 9 Lounge – Under natural conditions



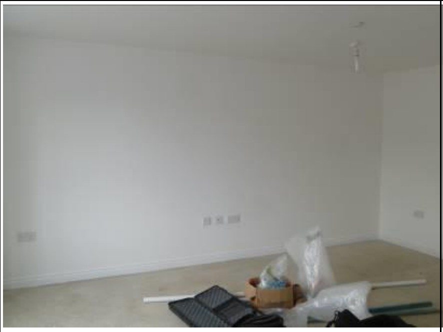


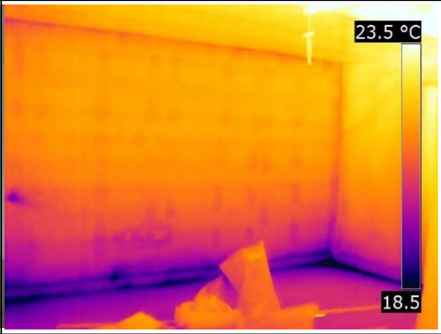


Again, the external wall appeared marginally cooler at the bottom than was expected from just the natural temperature stratification in the room and the fact that the top part of the wall reflected the warm ceiling and the bottom part reflected the colder floor.
The bay roof again showed minor cooler spots along the lines of the external wall above. There was also some noticeable cold air infiltration at the bay window without any induced negative pressure.

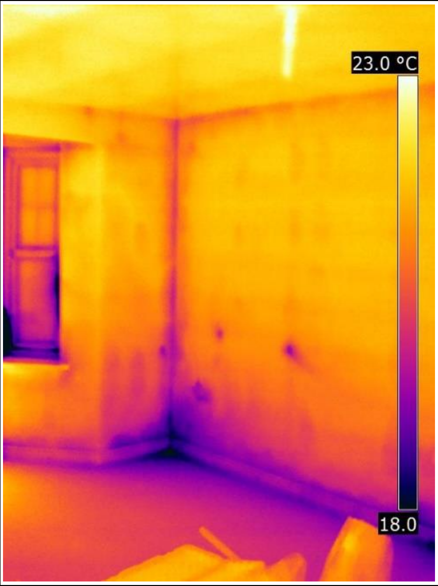


Plot 9 Lounge – Under depressurisation



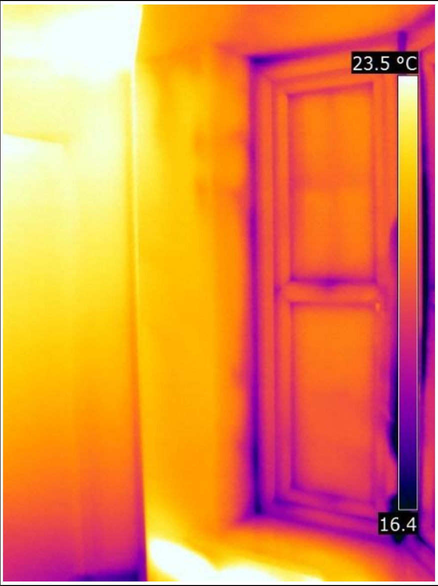


There appear to be some spots on the external wall where air is being drawn into the void behind the plasterboard directly from the external wall cavity, most probably due to gaps in the mortar in the inner leaf blockwork. This air from the cavity appears to have cooled the void behind the plasterboard



enough to reduce the temperature differential between areas of dry lining directly over and away from the adhesive dabs.

The line of the external wall is more distinct on the bay ceiling, as is air infiltration around the window and through/around the closed trickle vent.

<table>
<tr>
<td></td>
<td>
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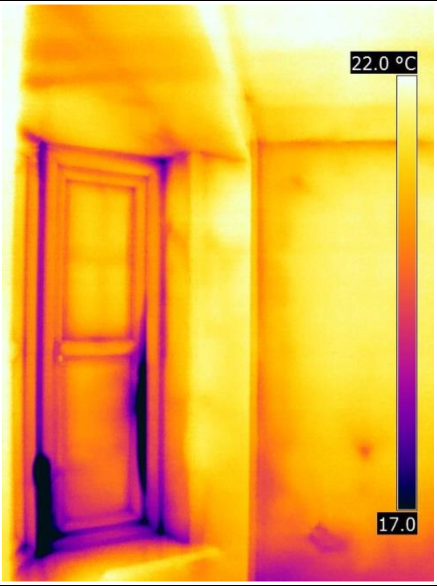
<td>
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<tr>
<td colspan="3">Plot 8 Dining / Kitchen – Under natural conditions</td>
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<td rowspan="2">Some additional thermal bridging around the patio doors was observed, in comparison to the kitchen window, where the patio doors were positioned further out into the external wall than the window, but nothing substantial. The external walls appeared to show a slightly decreased temperature gradient to those in the lounge.</td>
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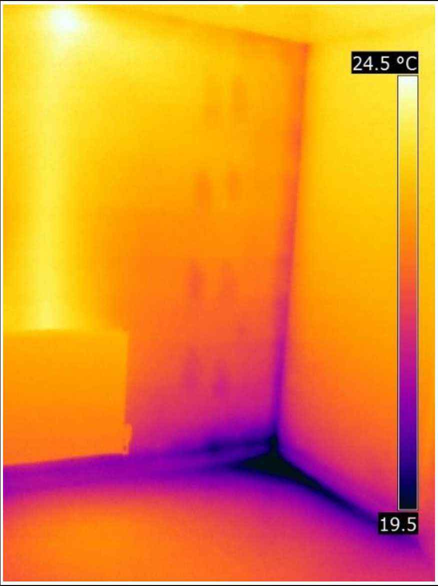
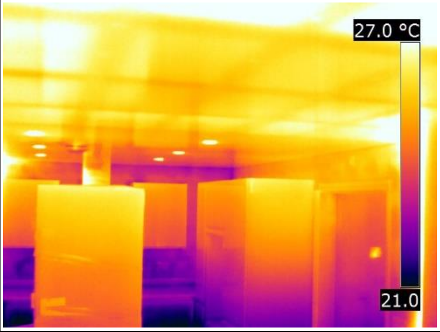
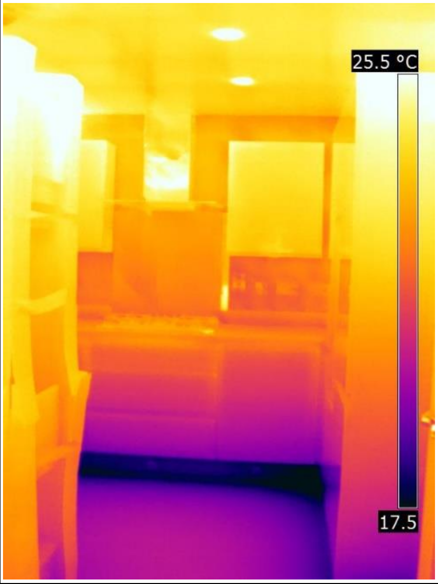
<tr><td></td><td>
</td><td></td></tr>
<tr><td colspan="3">Plot 9 Dining / Kitchen – Under natural conditions</td></tr>
<tr><td></td><td>
</td><td rowspan="3">This was much as in Plot 8, but the floor to ceiling thermal gradient was more like that observed in the lounges.
Another unexplained cold vertical strip, as seen in the lounge in plot 8 was visible to the right of the patio doors</td></tr>
<tr><td></td><td>
</td></tr>
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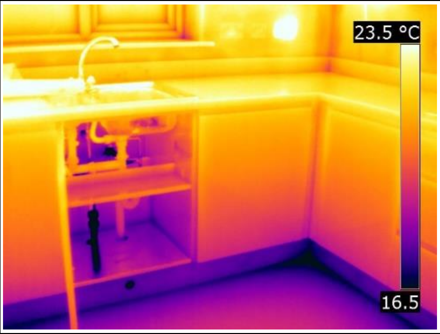
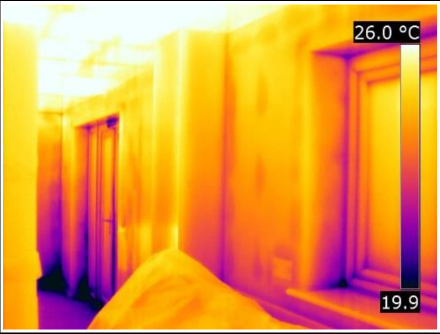
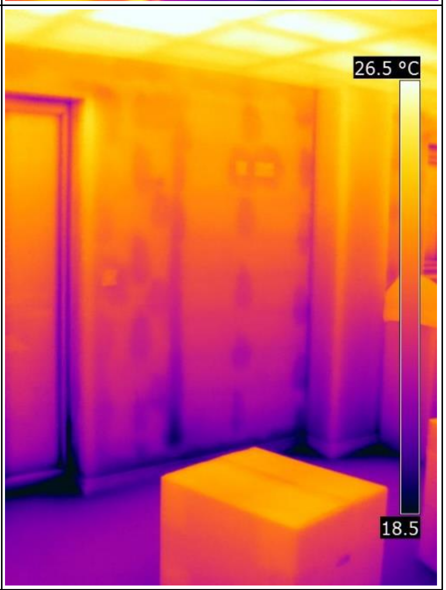

23.5 °C
16.5

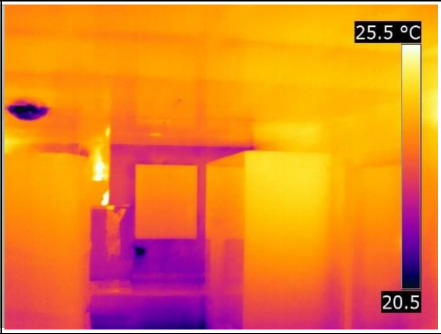
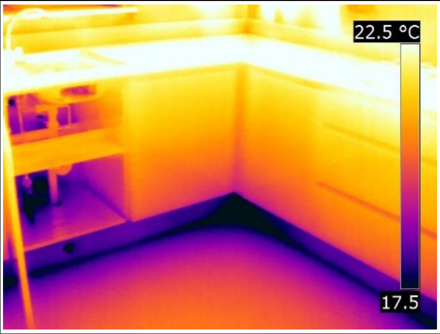
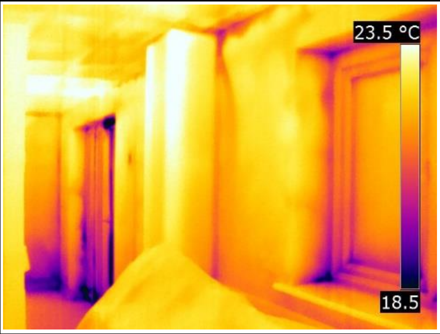

26.0 °C
19.9

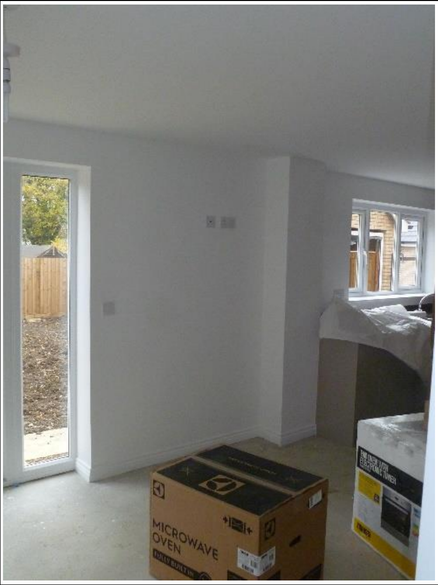

25.5 °C
18.5

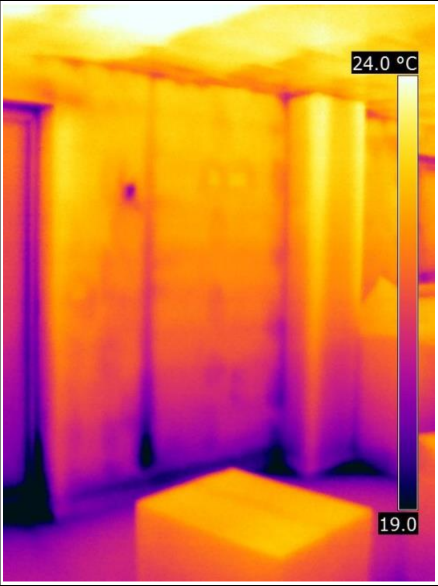

MICROWAVE OVEN

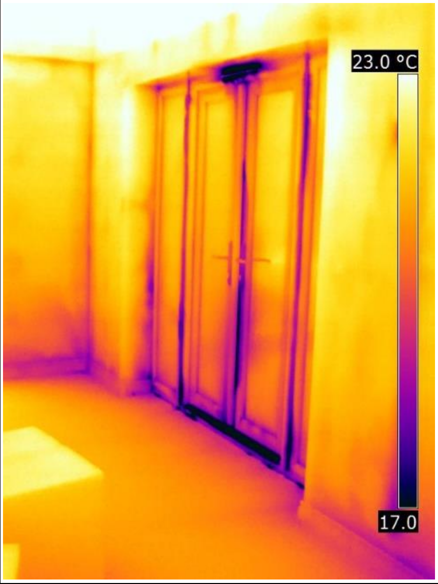

26.5 °C
18.5

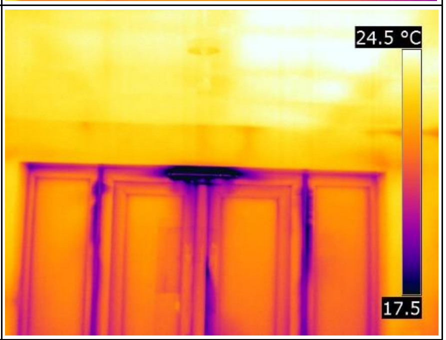

26.5 °C
18.5

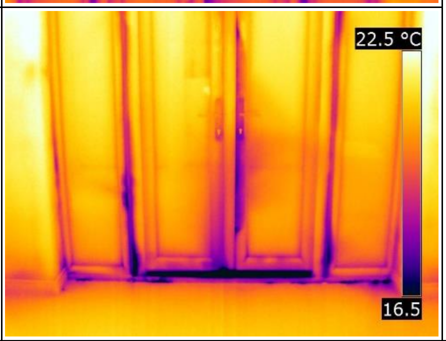
Plot 9 Dining / Kitchen – Under depressurisation		
		Cold air infiltration was detected around some electrical service penetrations into the void behind the dry lining, including the outside light by the patio doors, and at the floor/ceiling junction by the boxed-in SVP. The patio doors appeared to allow a greater amount of air movement between the doors, between the doors and side lights and through/around the trickle vent.
		
		
		



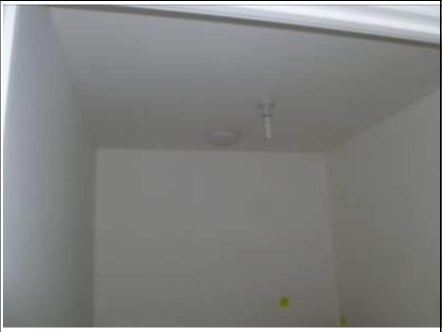


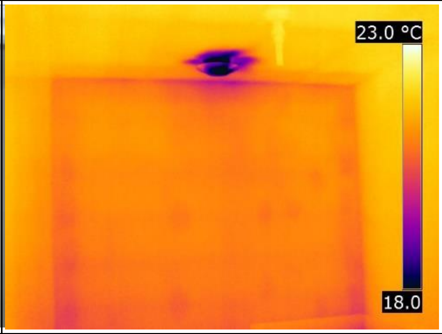


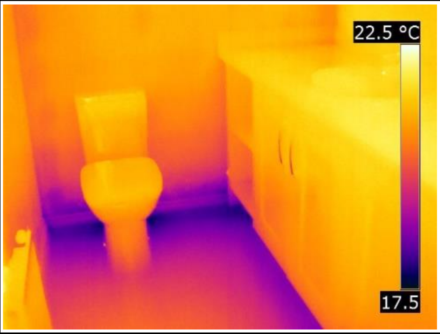




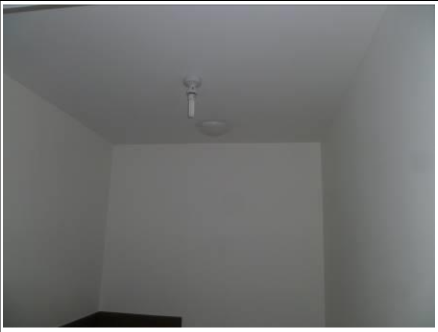
Plot 8 Ground Floor WC – Under natural conditions

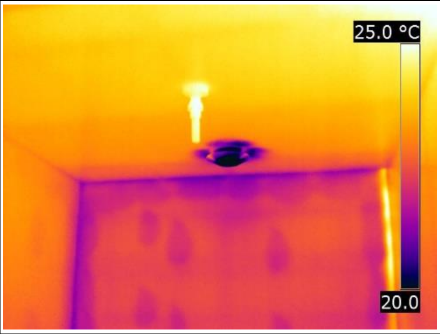




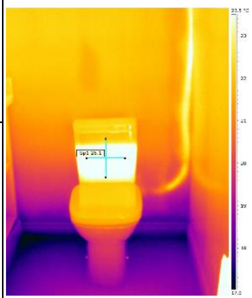


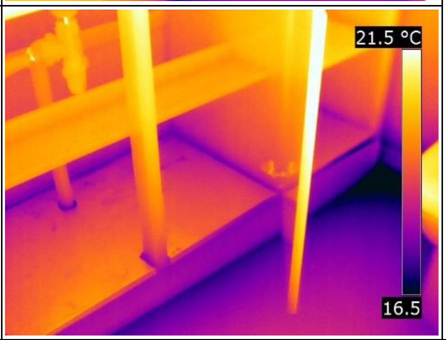
Plot 9 Ground Floor WC – Under natural conditions



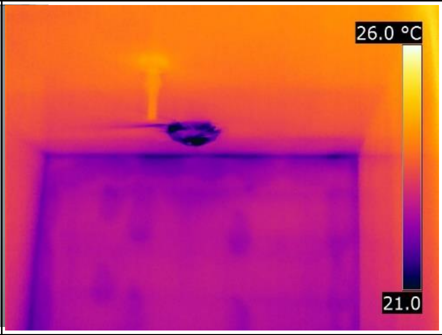
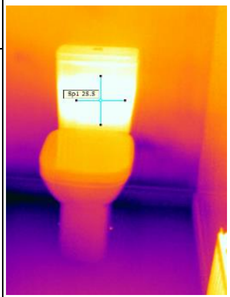
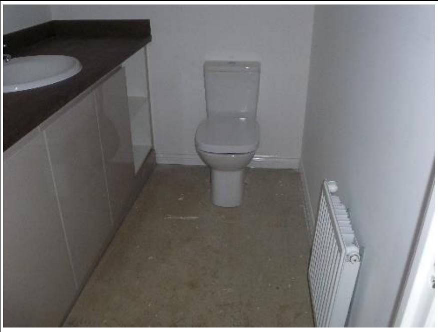
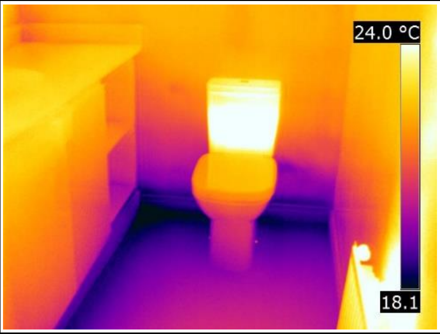
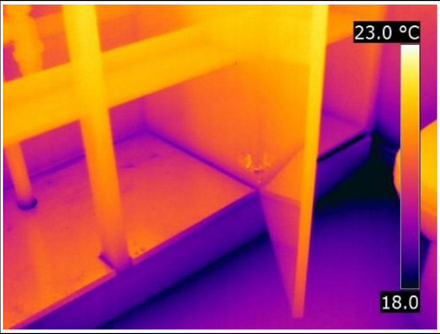


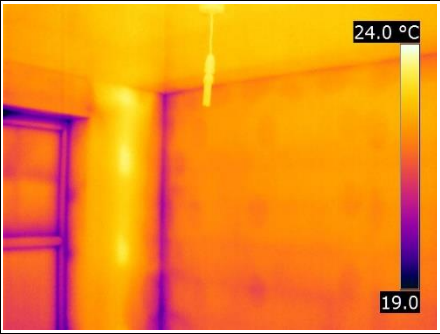
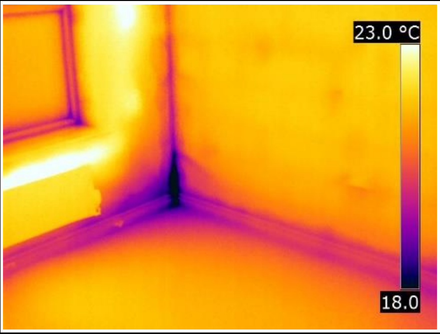
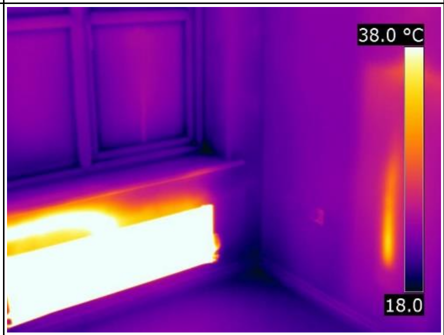
As observed in plot 8, apart from the curiously warm water in the cistern at over 26°C (this had been recently flushed to ensure all traps were full, but it was still warmer than the rest of the house).

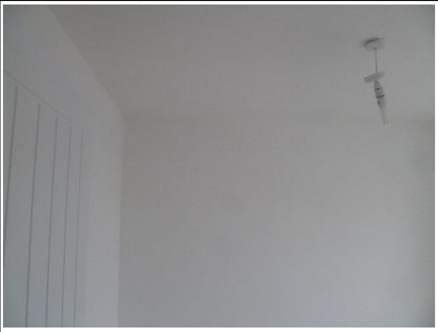


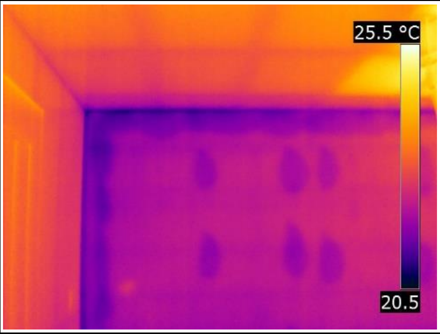


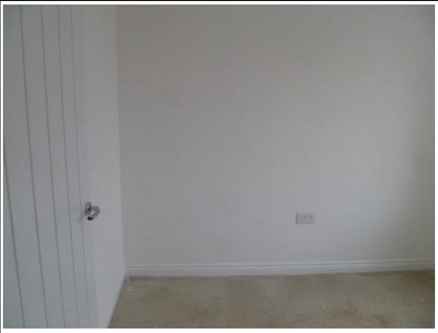
Plot 9 Ground Floor WC – Under depressurisation

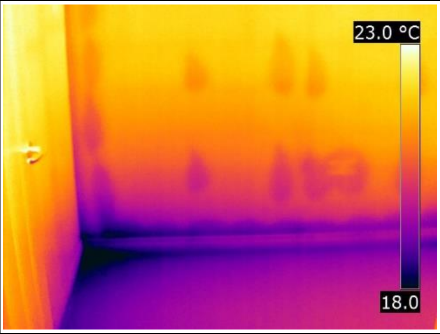
		No real differences were observed under depressurisation, although in the 1hr 20min since the previous thermal images the temperature of the cistern has dropped to 25.5°C and the supply pipe fallen to the ambient temperature of the external wall. 
		
		
Plot 8 Study – Under natural conditions		
		A cooler section was seen on the internal wall adjacent to the boxed-in services in the hall where the electric box and consumer unit were sited, this was noticeably cooler nearer the floor junction. The external corner on the front façade backing onto the gas meter box also appeared cooler.
		

		
		
Plot 9 Study – Under natural conditions		
		As in plot 8 a cooler section was seen on the internal wall adjacent to the boxed-in services in the hall for the electric box and consumer unit. This appears worse due to the hot spot on the internal wall where the hall radiator pipework was visible.
		
		Again, the external corner where the gas meter box was positioned was noticeably cooler than the surrounding areas, even considering corner effects of the thermal imaging (where colder surfaces are reflecting each other making the internal corners appear cooler than they actually are).

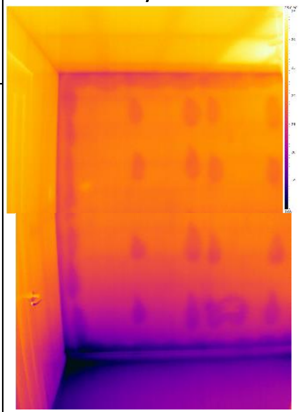




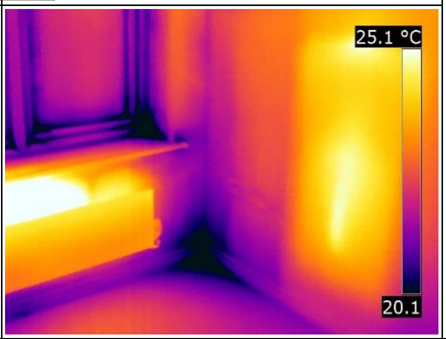




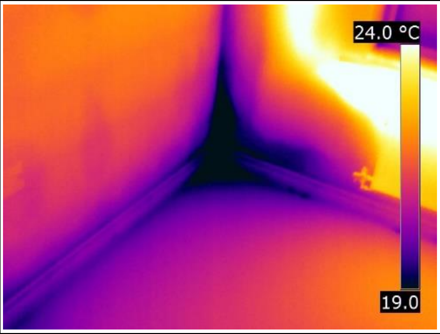
The thermal gradient from floor to ceiling is once again apparent, the images opposite are on different temperature levels, but manipulating them both to the same level and span it can be seen more clearly:

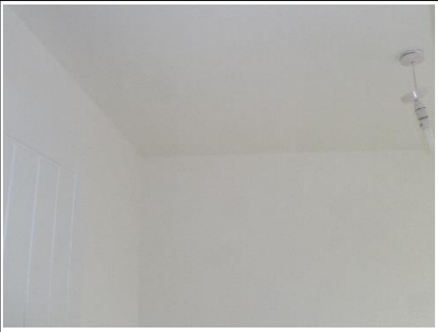


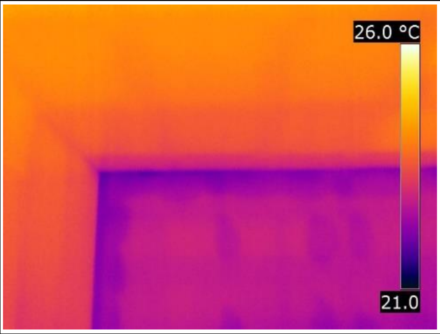
Plot 9 Study – Under depressurisation

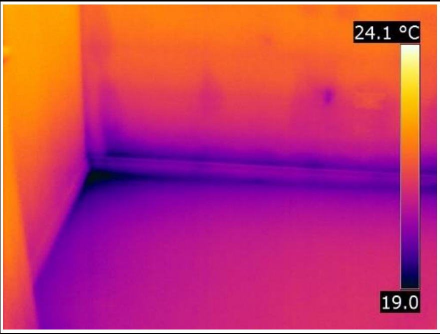


The internal wall adjacent to the boxed-in services in the hall for the electric box and consumer unit appears even more distinct, possible due to air infiltration into this void under depressurisation; with a clear stratification along the study/hall partition from the external wall to where the hall radiator pipework remains visible. The gas meter box also remain well-defined, without air infiltration spreading out from it, indicating that the cooler patch here is due to it being less well insulated than the surrounding area rather than cold air entering through inner leaf wall penetrations.

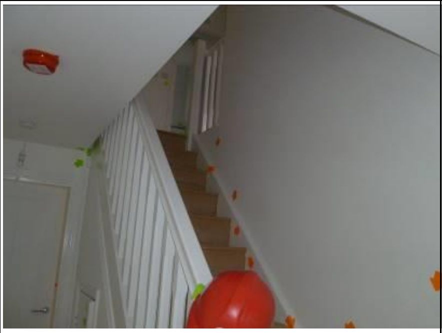


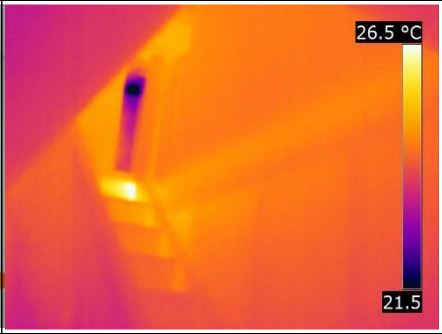




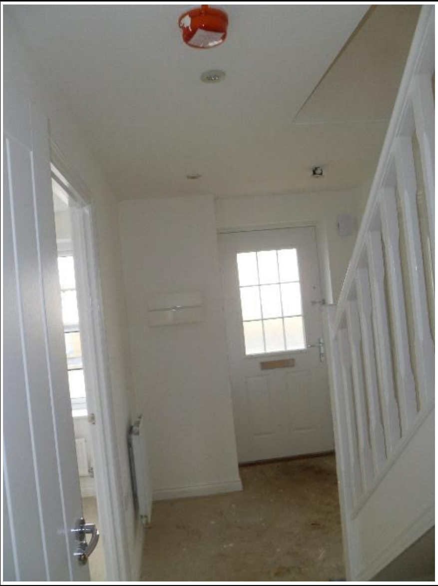


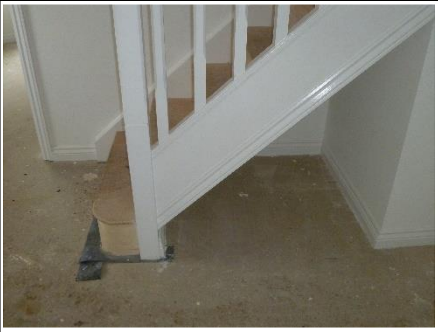
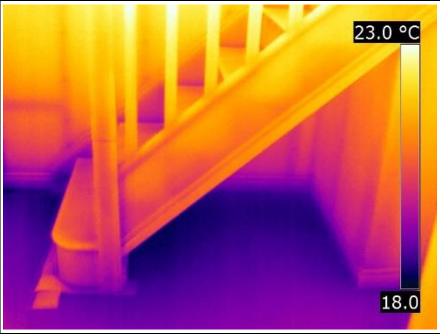
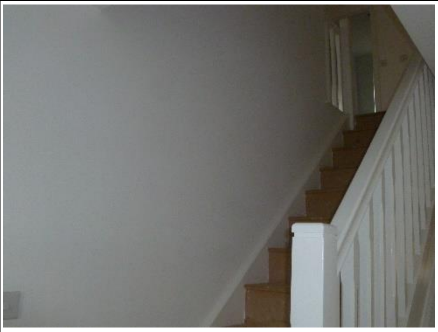
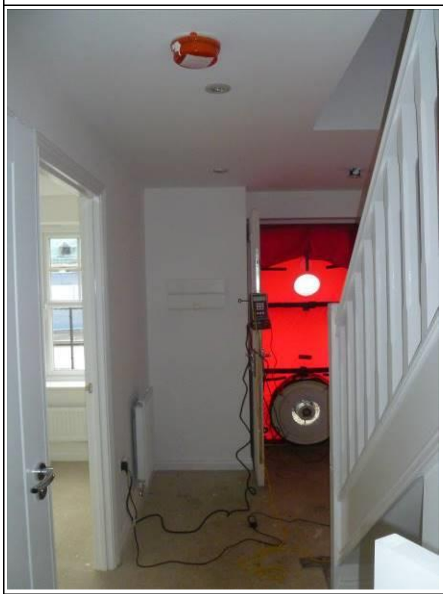
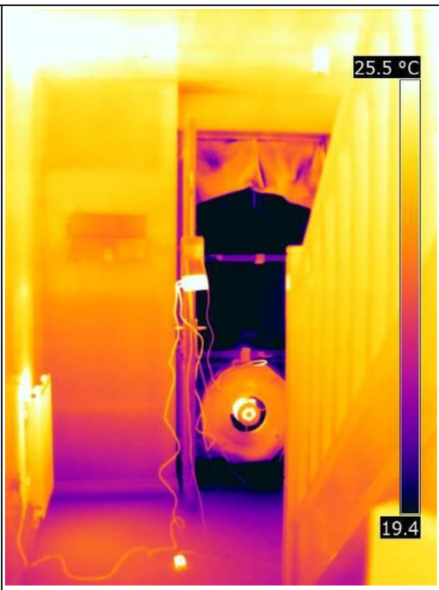
Plot 8 Hall – Under natural conditions

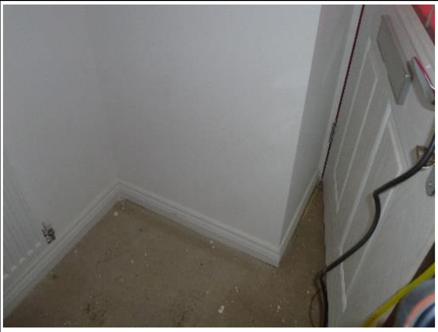
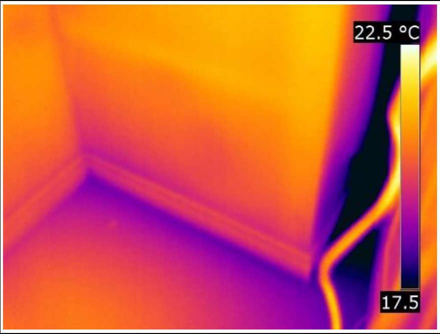
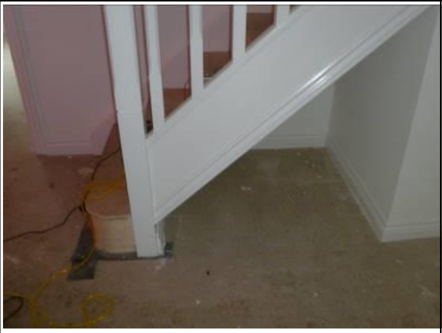
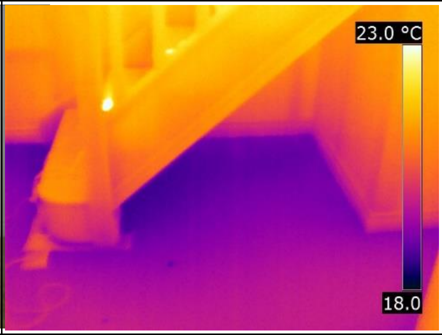
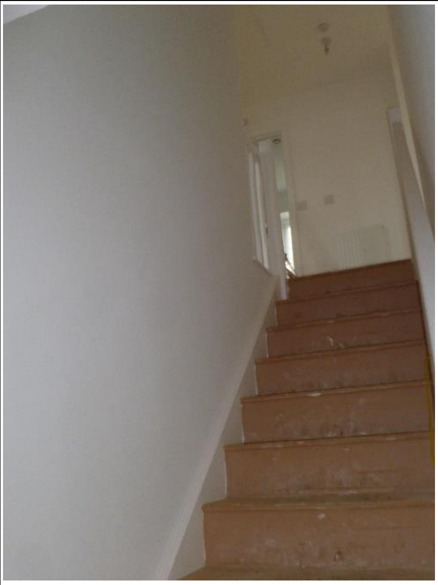
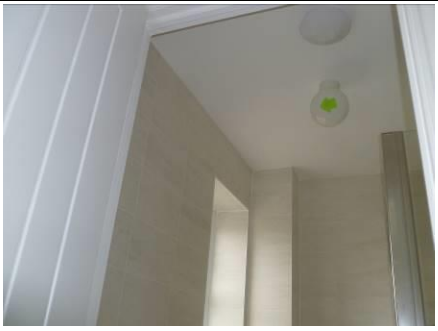
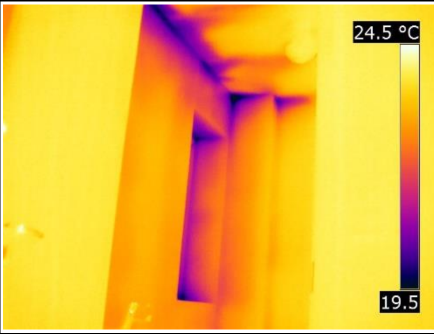


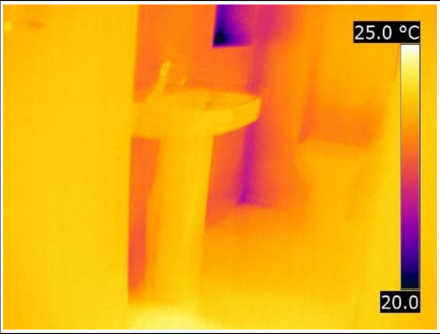


Plot 9 Hall – Under natural conditions

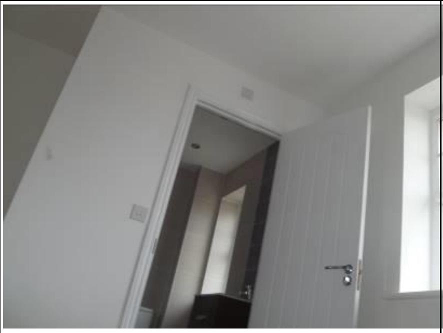


		
		
		
Plot 9 Hall – Under depressurisation		
		Under depressurisation it appears that colder air is being drawn into the boxed-in service void, as differing wall temperatures can be seen below the consumer unit.

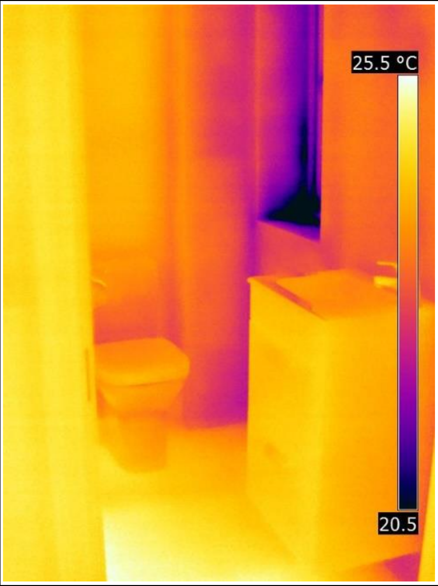
		
		
		
Plot 8 En-Suite – Under natural conditions		
		The cold section of ceiling at the eaves suggests that the loft insulation does not extend fully to meet up with the wall insulation. Whether this also accounts for the seemingly cooler section at the top of the wall is unclear.

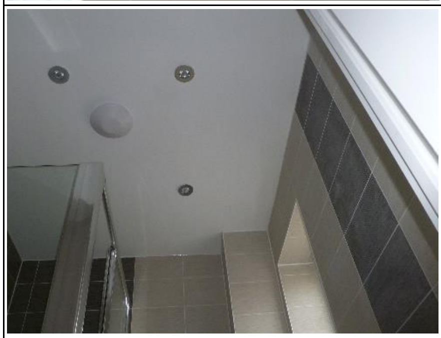


Plot 9 En-Suite – Under natural conditions



As in plot 8, the cold section of ceiling at the external wall junction suggests that the loft insulation does not extend fully to meet up with the wall insulation.
The boxed-in SVP also appears to be cooler.





Plot 9 En-Suite – Under depressurisation

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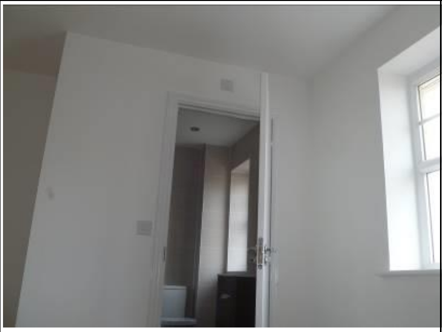
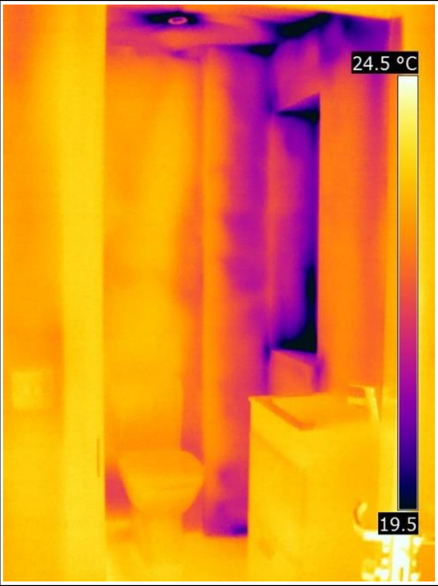
<tr><td></td><td>
</td><td rowspan="4">Cooler air is detected drawn in from the loft around recessed ceiling lights, into the internal partition walls, into the void behind the plasterboard on the external walls, into the bowed-in SVP riser and around some of the beading of the glazing panels.</td></tr>
<tr><td></td><td>
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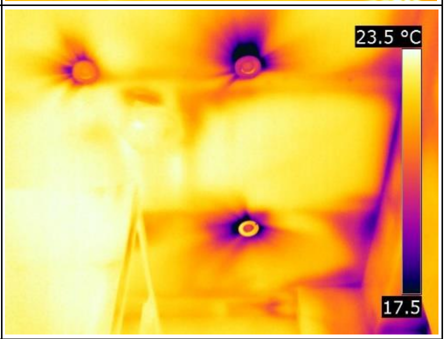
<tr><td></td><td>
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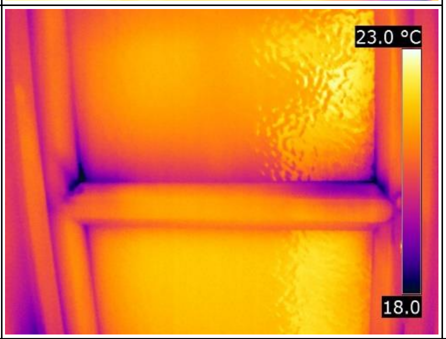
<tr><td></td><td>
</td></tr>
<tr><td colspan="3">Plot 8 Bedroom 1 – Under natural conditions</td></tr>
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<table>
<tr>
<td></td>
<td>
</td>
<td rowspan="3">As in the En-suite there are some issues at the eaves but not as pronounced. The thermal gradient from floor to ceiling observed downstairs on the external walls is not present on the first floor where the floor and ceiling appear to be similar temperatures.</td>
</tr>
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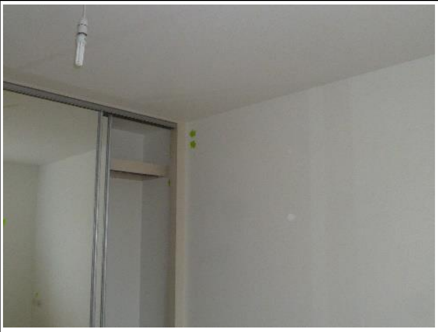
<td></td>
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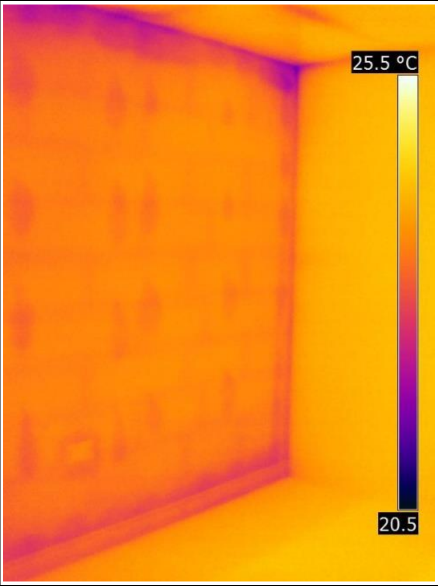
<td>
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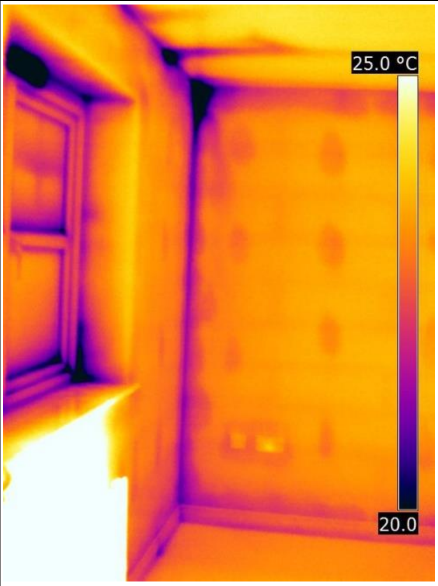
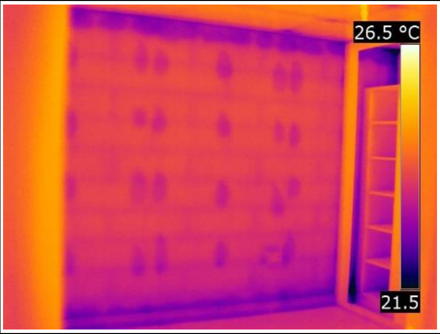
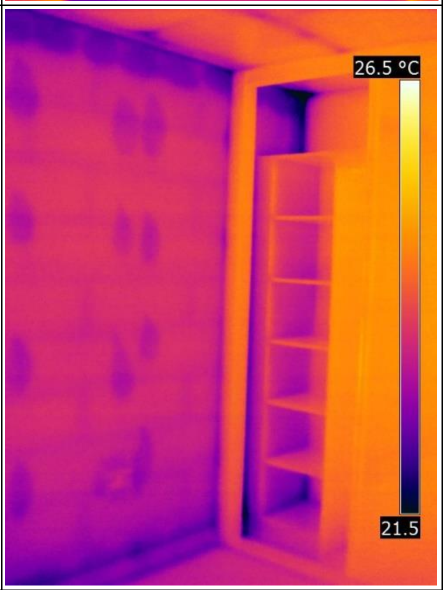
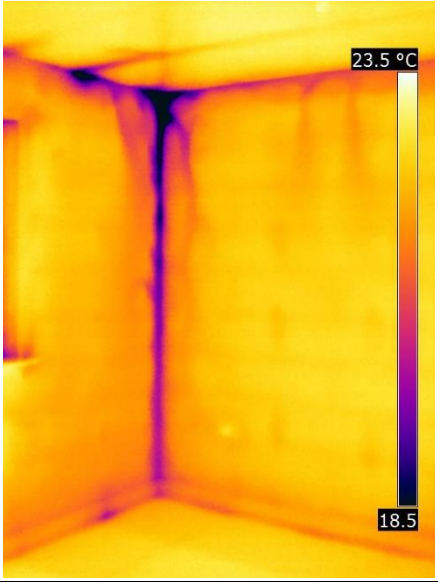
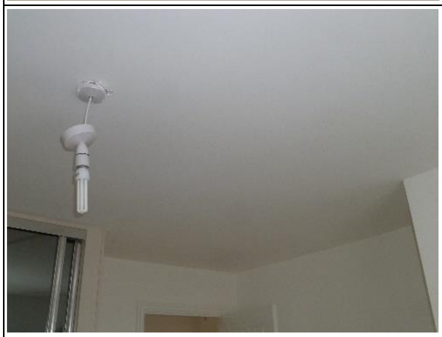






As observed in plot 8.
There also appears to be additional cooler patches in the ceiling where the trussed rafter angled junctions prevent the loft insulation from being laid as effectively.

Plot 9 Bedroom 1 – Under depressurisation

		Under depressurisation colder air can be seen being drawn down the dry lining voids on the external wall through gaps in the adhesive ribbons. Cold air in the loft can also be seen tracking the cabling for the central ceiling light, emerging at the rose fitting. There is some stratification between joists of the intermediate floor which was not observed from beneath.
		
		
		

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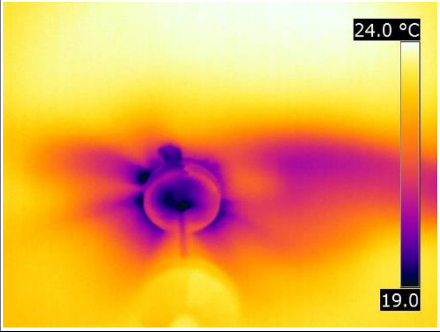
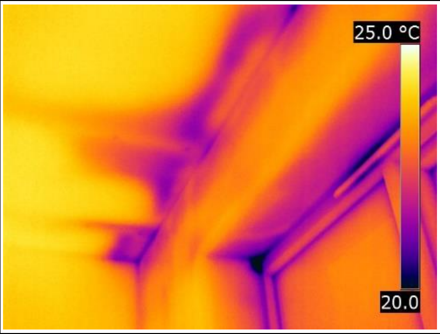
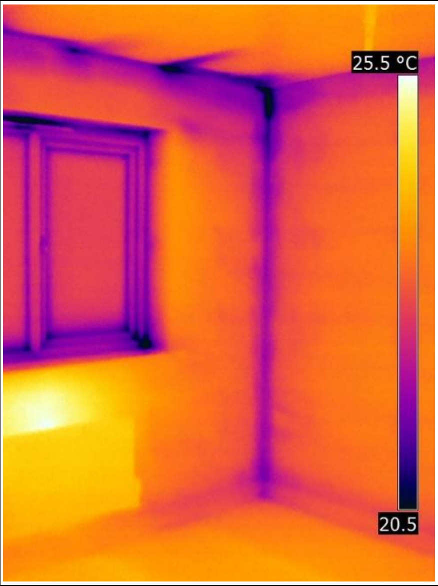
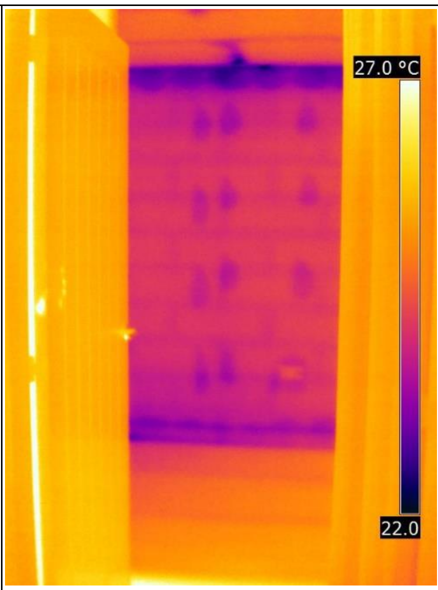
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="3">Plot 8 Bedroom 4 – Under natural conditions</td></tr>
<tr><td></td><td></td><td rowspan="2">The issues at the eaves observed in Bedroom 1 appear more pronounced at the rear of the dwelling.
The window head reveal appears slightly cooler than the jamb reveal.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="3">Plot 9 Bedroom 4 – Under natural conditions</td></tr>
<tr><td></td><td></td><td>As observed in plot 8.</td></tr>
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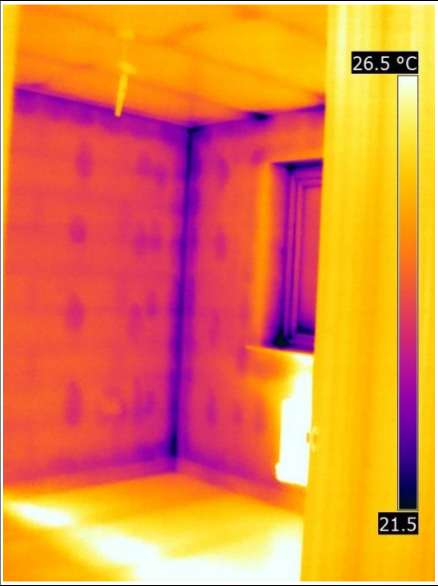
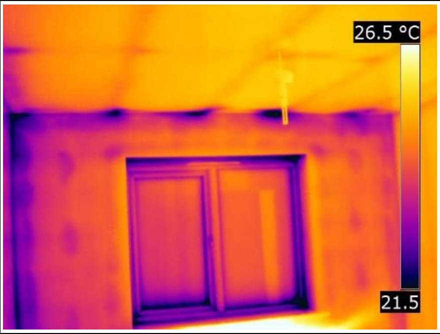
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
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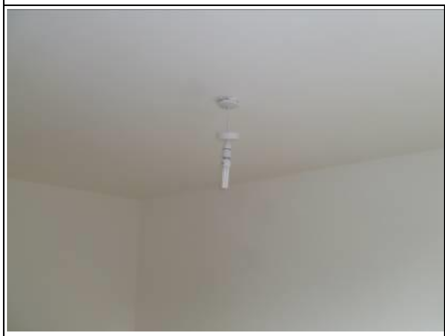
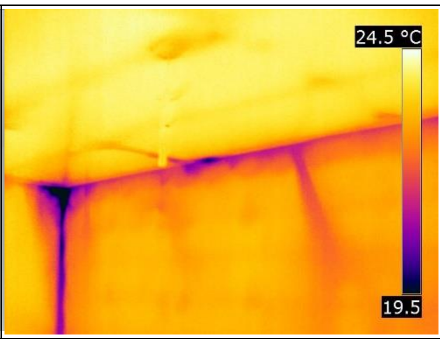
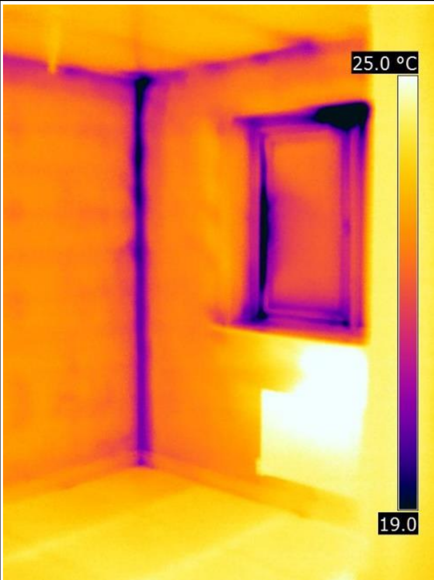
<tr><td></td><td></td><td>Air was again observed being drawn in from the loft into the dry lining void, although to a lesser extent than seen in Bedroom 1 along the gable wall.
The internal partition wall that backs onto the service void in the bathroom was cooler than the rest of the wall, and allowed colder air</td></tr>
</table>

<table>
<tr><td></td><td>
</td><td rowspan="3">to enter the dry lining void along its full height and air to emerge around the floor/wall junction at the bottom.
Direct air infiltration at the window was also clear.</td></tr>
<tr><td></td><td>
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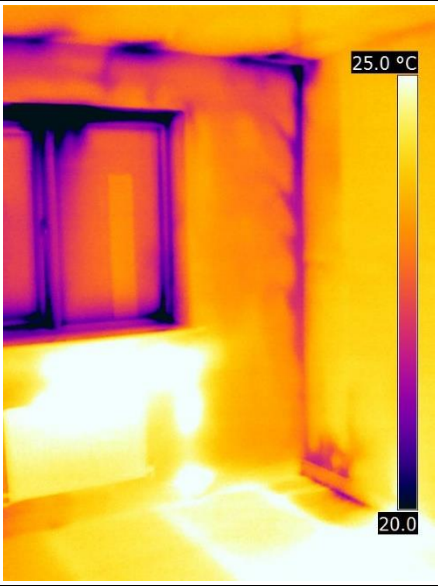
<tr><td></td><td>
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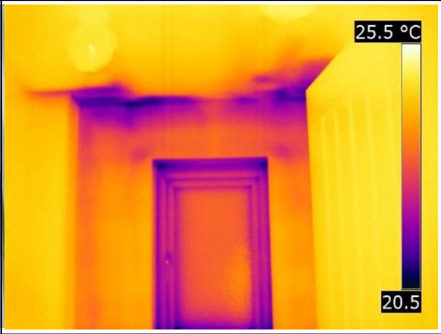
<tr><td colspan="3">Plot 8 Bathroom – Under natural conditions</td></tr>
<tr><td></td><td>
</td><td>As seen previously there are colder patches at the eaves junction; these appear cooler than the window frame, and if condensation forms in the bathroom it will form on the coldest surfaces first, so may cause future issues.</td></tr>
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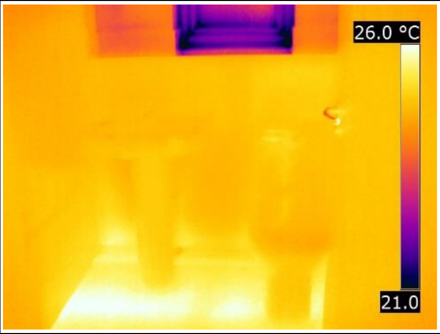
<tr><td></td><td>
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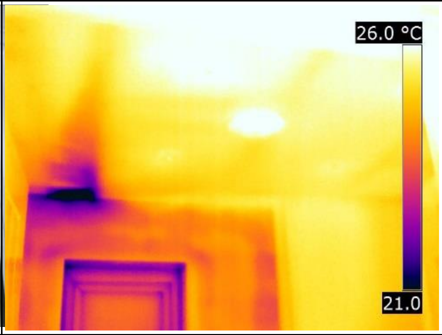
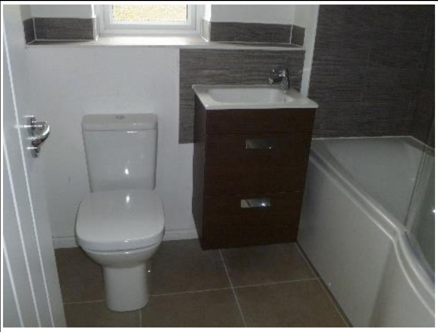
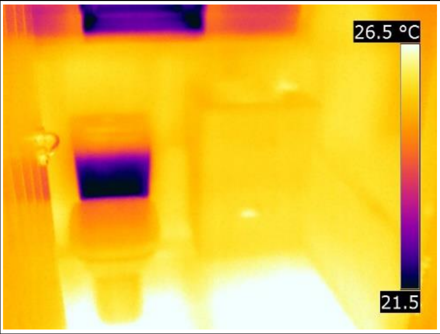
<tr><td colspan="3">Plot 9 Bathroom – Under natural conditions</td></tr>
<tr><td></td><td>
</td><td rowspan="2">As in plot 8, the coldest surface appears to be at the eaves junction.</td></tr>
<tr><td></td><td>
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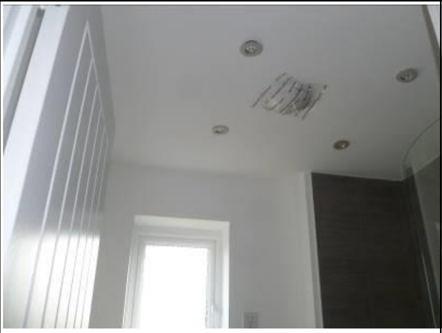
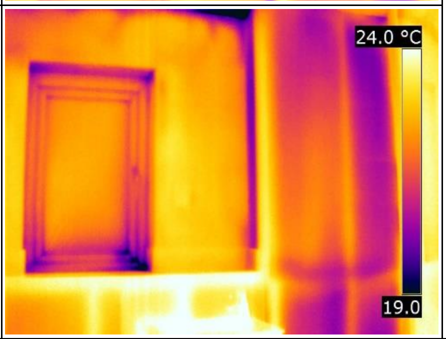
<tr><td colspan="3">Plot 9 Bathroom – Under depressurisation</td></tr>
<tr><td></td><td>
</td><td rowspan="2">As in the En-suite, cooler air is drawn in from the loft in many places.
The boxed-in service void to the right of the window was warmer than the external wall under natural conditions, under depressurisation it is now markedly cooler. Air was also detected in the void behind the toilet and basin, emerging around the soil pipe penetration.</td></tr>
<tr><td></td><td>
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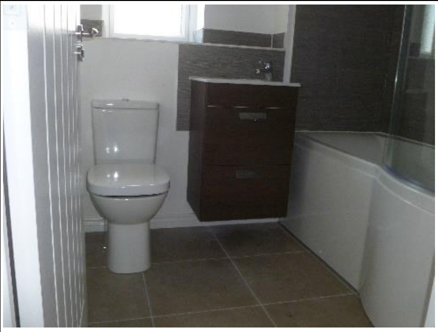
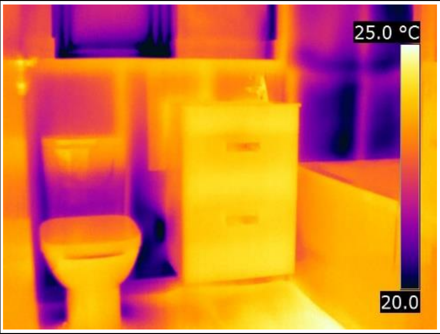
<tr><td></td><td>
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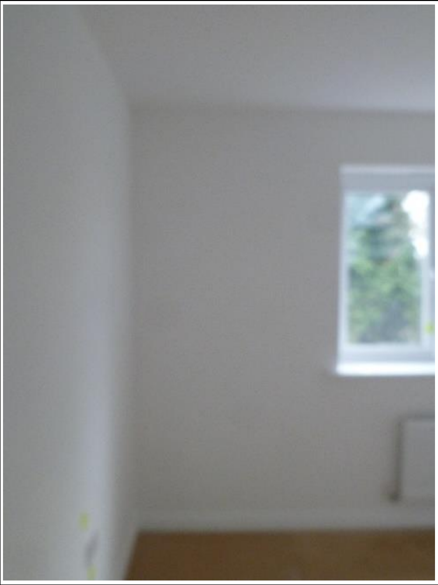
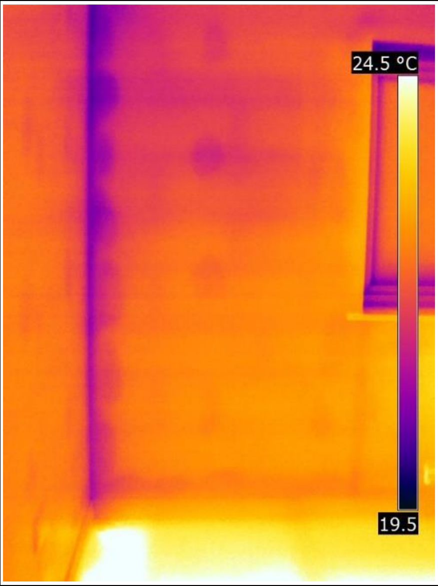
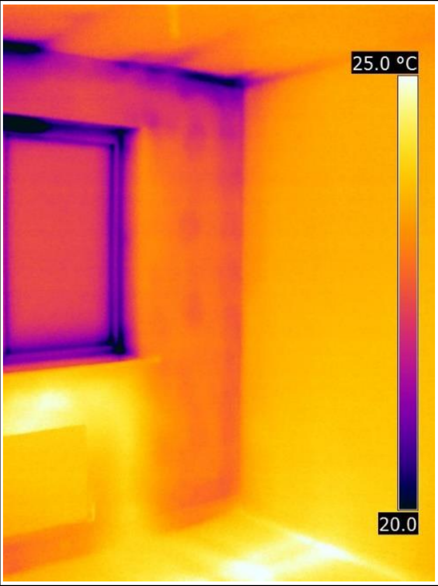
<tr><td colspan="3">Plot 8 Bedroom 3 – Under natural conditions</td></tr>
<tr><td></td><td>
</td><td>As observed in previous bedrooms.</td></tr>
<tr><td></td><td>
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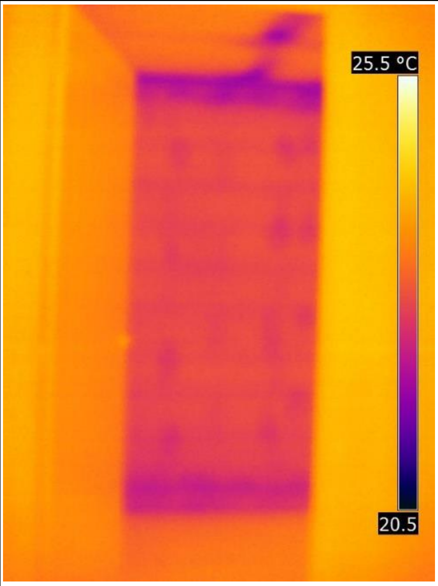
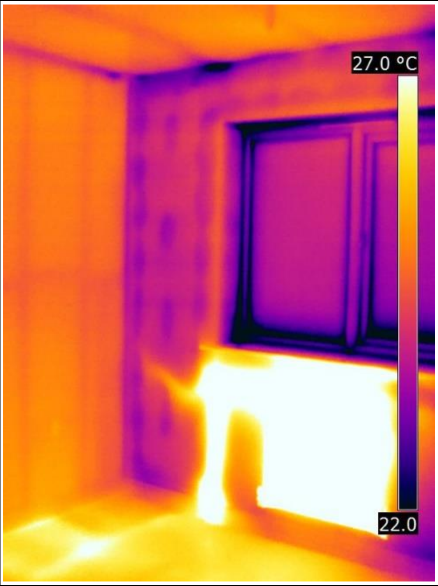
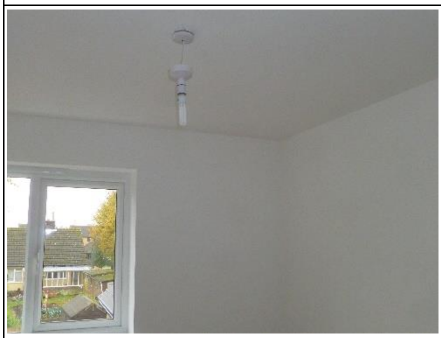
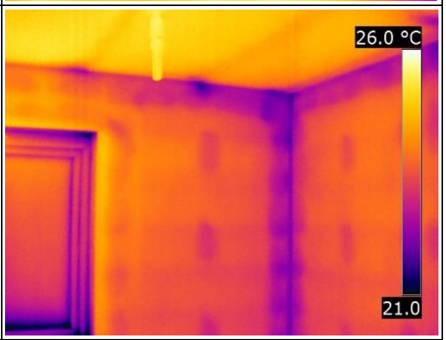
		
Plot 9 Bedroom 3 – Under natural conditions		
		As observed in previous bedrooms.
		
		

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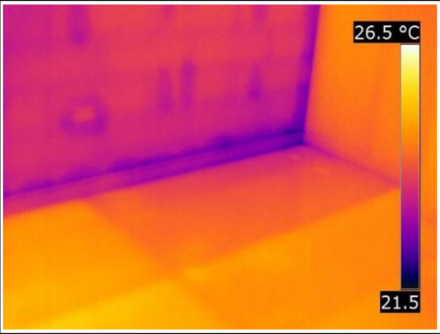
<tr><td></td><td>
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<tr><td colspan="3">Plot 9 Bedroom 3 – Under depressurisation</td></tr>
<tr><td></td><td>
</td><td rowspan="4">As observed in Bedroom 4; here the partition wall backing onto a service void in the bathroom was even cooler with cooler air appearing to spread into the intermediate floor void.</td></tr>
<tr><td></td><td>
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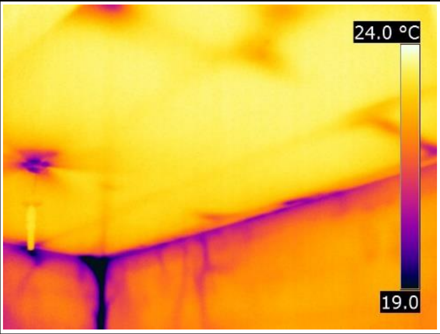
<tr><td></td><td>
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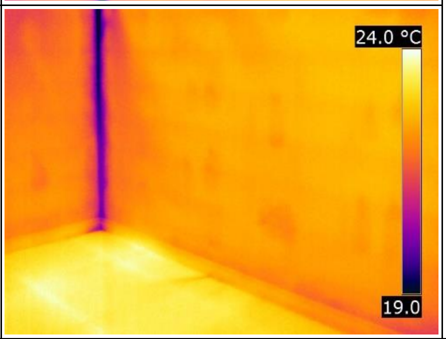
<tr><td></td><td>
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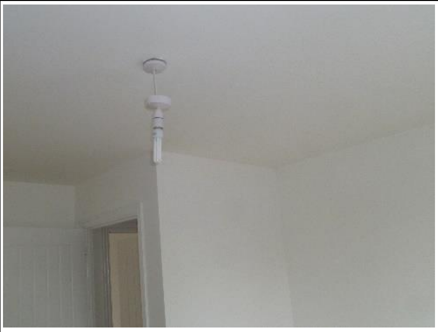
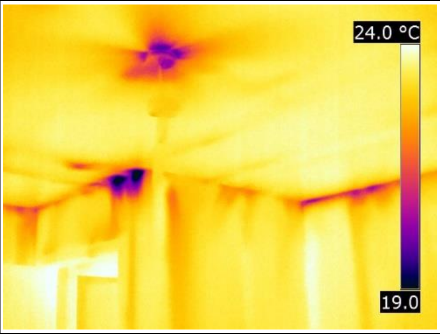
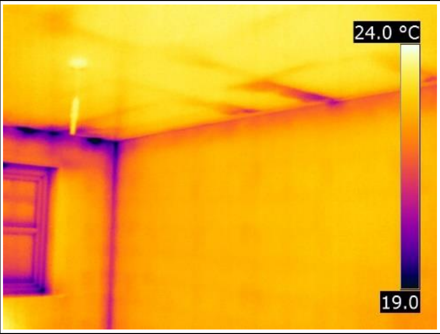


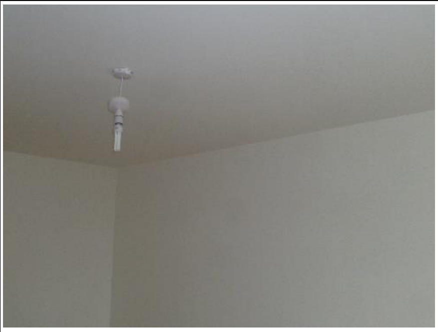


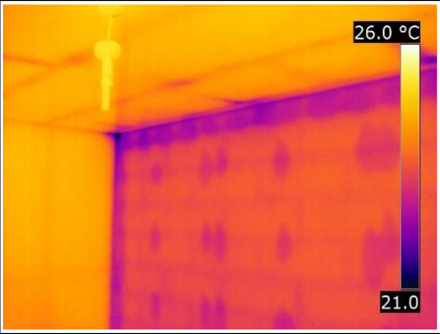
Plot 8 Bedroom 2 – Under natural conditions



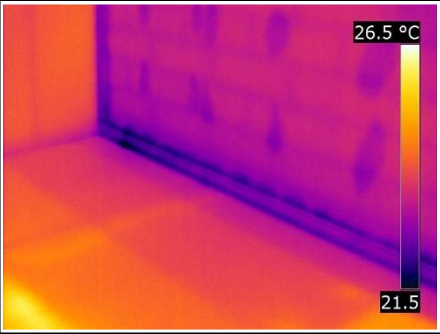
As observed in previous bedrooms, with the section of partition wall adjacent to the service void in the En-suite clearly visible in the thermal image.

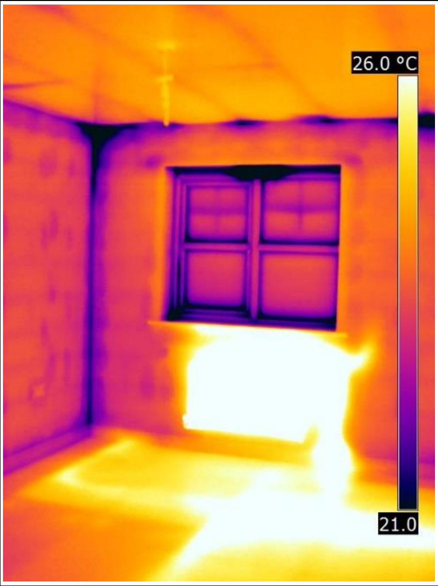
Plot 9 Bedroom 2 – Under natural conditions

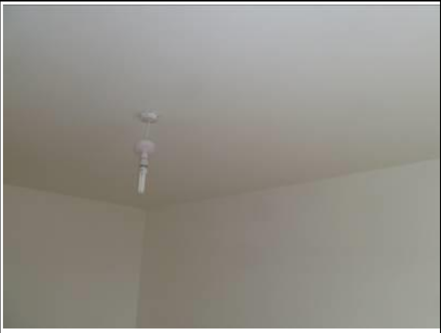
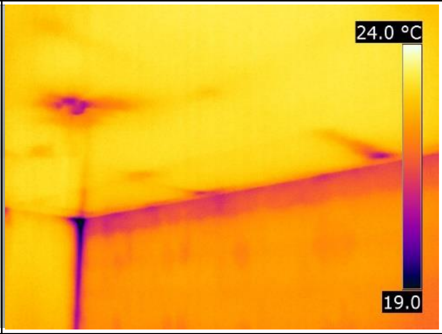
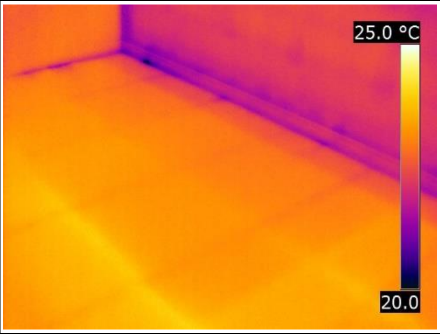




As seen in Plot 8.





<table>
<tr><td colspan="3">Plot 9 Bedroom 2 – Under depressurisation</td></tr>
<tr><td></td><td>
</td><td rowspan="4">As seen in Bedroom 4 air was drawn in from the loft under depressurisation with the greatest area of concern being the junction of the internal and external walls backing on to the service void in the En-suite.</td></tr>
<tr><td></td><td>
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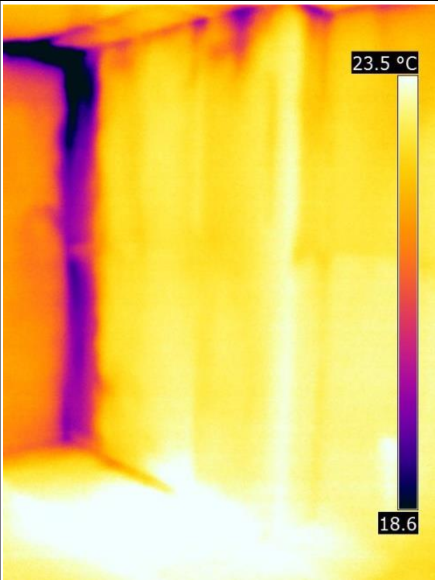
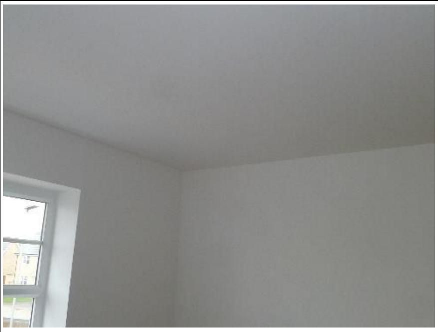
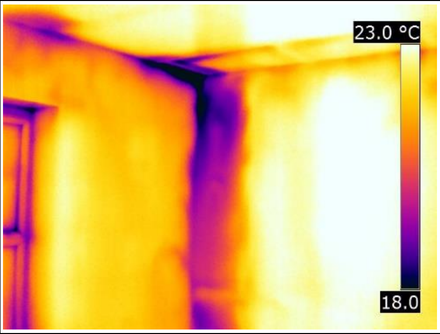
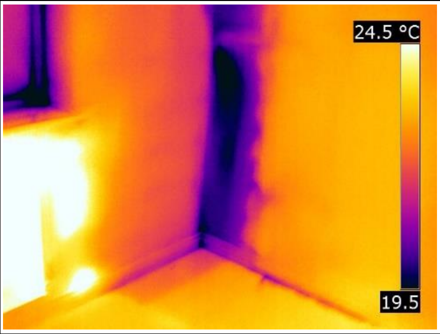
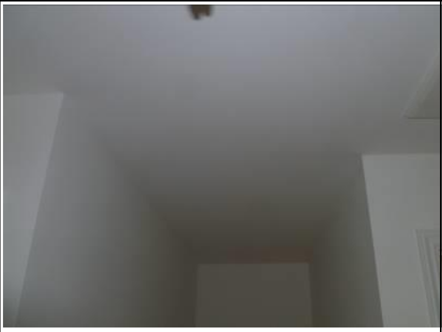
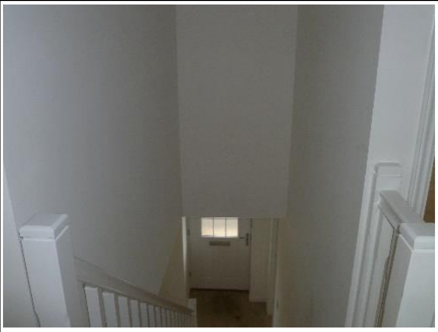
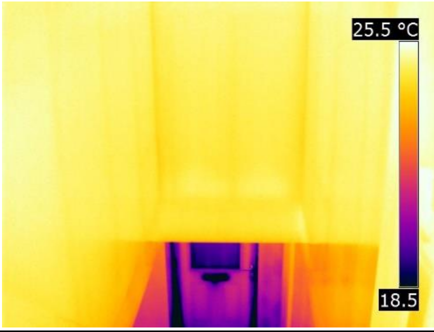
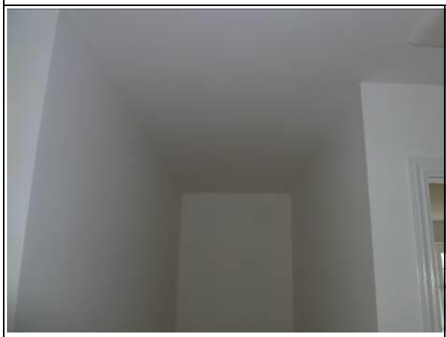
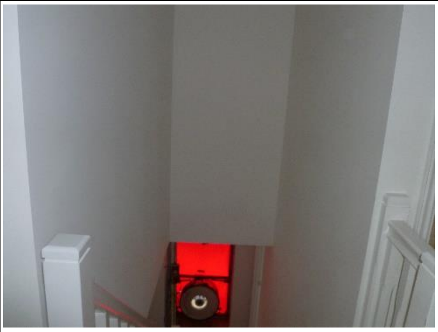
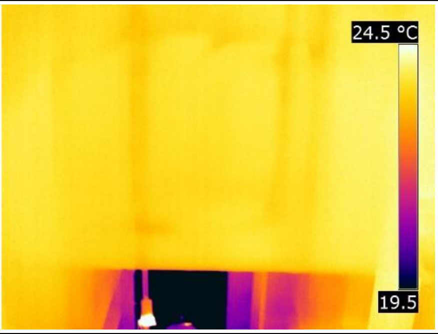
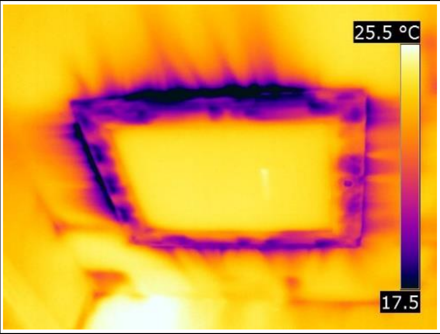
		
		
		
Plot 8 Landing – Under natural conditions		
		Some colder areas where the loft insulation appears to not be in full contact with the ceiling plasterboard.
Plot 9 Landing – Under natural conditions		

<table>
<tr><td></td><td>
</td><td rowspan="4">No obvious issues.</td></tr>
<tr><td></td><td>
</td></tr>
<tr><td></td><td>
</td></tr>
<tr><td></td><td>
</td></tr>
<tr><td colspan="3">Plot 9 Landing – Under depressurisation</td></tr>
<tr><td></td><td>
</td><td>With cooler air being drawn in from the loft space the thermal images appeared quite different from those captured under natural conditions; with air movement around the loft hatch, other ceiling penetrations and partition wall junctions all becoming evident.</td></tr>
</table>

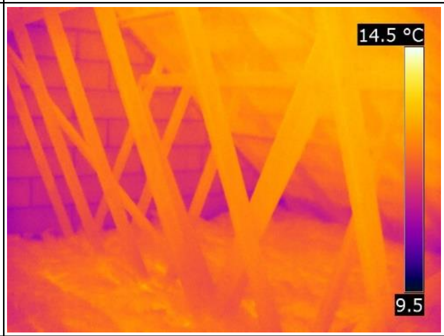
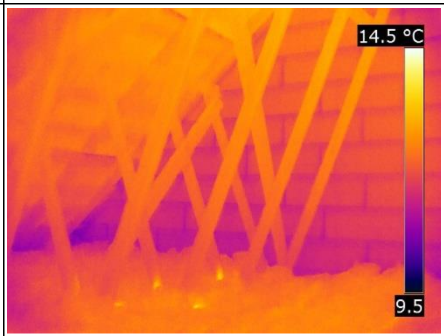






Plot 9 Loft – Under natural conditions

Looking toward the SE Gable the loft insulation appeared to be laid reasonably well, right up to the gable wall and without gaps.
At some of the truss rafter angled junctions additional heat loss could be detected, as could be seen from cooler areas below.
It was not possible to see the insulation at the eaves junctions, no attempt was made to lift the insulation to view services running beneath it.

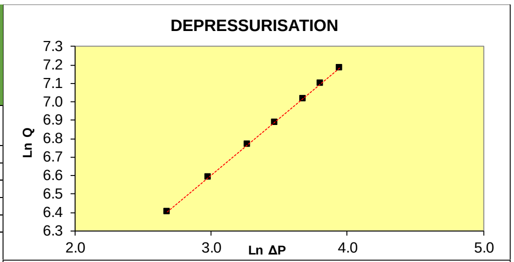
		
		
		Looking towards NE gable, as above.
		
		

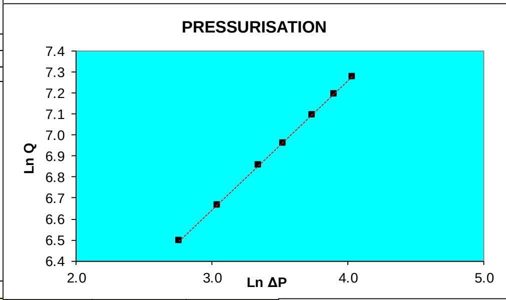
	14.5 °C 9.5	

Pressure Test Spreadsheet:

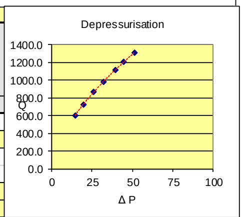
MINNEAPOLIS BLOWER DOOR DATA INPUT AND CALCULATION

date:	15/11/2017		Version 16d	19 June 2017
test house address:	Plot 9 - Kingsbrook Place, Elmswell, Suffolk, IP30 9HA			
company:	Knauf Insulation - Taylor Wimpey			
house type:	Shelford			
tester:	DMS			
test reference number:			Blower Door & Gauge Used	Model 3 with DG700
outdoor temp (°C)	11.3	°C	Note: ENSURE THAT FLOW SETTINGS ARE IN m3/h - When using the DG700 gauge run baseline pressure adjustment for minimum 60s with fan switched on but not rotating	
indoor temp (°C)	22	°C		
outdoor humidity (%rh)	84.5	%RH		
indoor humidity (%rh)	57.2	%RH		
outdoor barometric pressure	1013.1	mbar or hPa	Calculated Outdoor Air Density	1.24 kg/m^3
indoor barometric pressure	1013	mbar or hPa	Calculated Indoor Air Density	1.19 kg/m^3
temperature corr. fact. depress.	0.964	WARNING!!	description of main construction details:	
temperature corr. fact. press.	1.038	Extreme Test	New build, masonry, blown full-fill, detached	
wind speed (m/s):	0	Conditions		
baseline pressure diff (Pa) (+/-)		Pa		
house width:	8.15	m		
house depth:	8270	m		
house height:	4.92	m		
floor area:	129.05	m^2		
volume:	317.47	m^3		
envelope area including floor:	287.92	m^2		
Pressure Difference for ELA	10	Pa		
RESULTS:				
Q50 Mean Flow at 50Pa =	1322.60	m^3/h		
Mean Air Leakage at 50Pa =	4.17	h^{-1}		
Mean Air Permeability at 50 Pa =	4.59	m/h or m^3h/m^2		
Equivalent Leakage Area =	0.055	m^2 at	10	Pa





DEPRESSURISATION	RING - O,A,B,C,D,E for BD3 0,1,2,3 for DuctBB	MEASURED FAN PRESSURE (Pa) Max. 90 Pa	MEASURED FLOW (m^3/h)	ADJUSTED FLOW (m^3/h)	FLOW RANGE OK FOR SELECTED RING?	Adjusted Pressure (Pa)	Ln delta P	Ln Q	Q50 Calculated Flow at 50Pa (m^3/h)	Permeability Depressurisation Only ($m^3/(h.m^2)$)	Air Leakage Depressurisation Only (h^{-1})
Approx 65 Pa	b	51.5	1366	1314.5	OK	51.5	3.942	7.181	1305.25	4.53	4.11
Approx 57 Pa	b	44.9	1257	1209.6	OK	44.9	3.804	7.098	r^2	1.000	
Approx 49 Pa	b	39.4	1157	1113.4	OK	39.4	3.674	7.015	C_{env}	115.540	$m^3/h.Pa^n$
Approx 41 Pa	b	32	1017	978.6	OK	32	3.466	6.886	n	0.617	
Approx 33 Pa	b	26.3	902	868.0	OK	26.3	3.270	6.766			
Approx 25 Pa	b	19.7	757	728.4	OK	19.7	2.981	6.591	C_L (corrected)	116.838	$m^3/h.Pa^n$
Approx 20 Pa	b	14.6	627	603.3	OK	14.6	2.681	6.402			



PRESSURISATION	RING - O,A,B,C,D,E for BD3 0,1,2,3 for DuctBB	MEASURED FAN PRESSURE (Pa) Max. 90 Pa	MEASURED FLOW (m^3/h)	ADJUSTED FLOW (m^3/h)	FLOW RANGE OK FOR SELECTED RING?	Adjusted Pressure (Pa)	Ln delta P	Ln Q	Q50 Calculated Flow at 50Pa (m^3/h)	Permeability Pressurisation Only ($m^3/(h.m^2)$)	Air Leakage Pressurisation Only (h^{-1})
Approx 65 Pa	b	56.5	1397	1451.8	OK	56.5	4.034	7.281	1339.96	4.65	4.22
Approx 57 Pa	b	49.4	1285	1335.4	OK	49.4	3.900	7.197	r^2	1.000	
Approx 49 Pa	b	42	1163	1208.6	OK	42	3.738	7.097	C_{env}	121.063	$m^3/h.Pa^n$
Approx 41 Pa	b	34	1018	1057.9	OK	34	3.526	6.964	n	0.615	
Approx 33 Pa	b	28.4	914	949.8	OK	28.4	3.346	6.856			
Approx 25 Pa	b	21	756	785.6	OK	21	3.045	6.666	C_L (corrected)	120.631	$m^3/h.Pa^n$
Approx 20 Pa	b	15.8	639	664.0	OK	15.8	2.760	6.498