Taylor Wimpey – Thermal Imaging Project

LEEDS BECKETT UNIVERSITY

Leeds Sustainability Institute

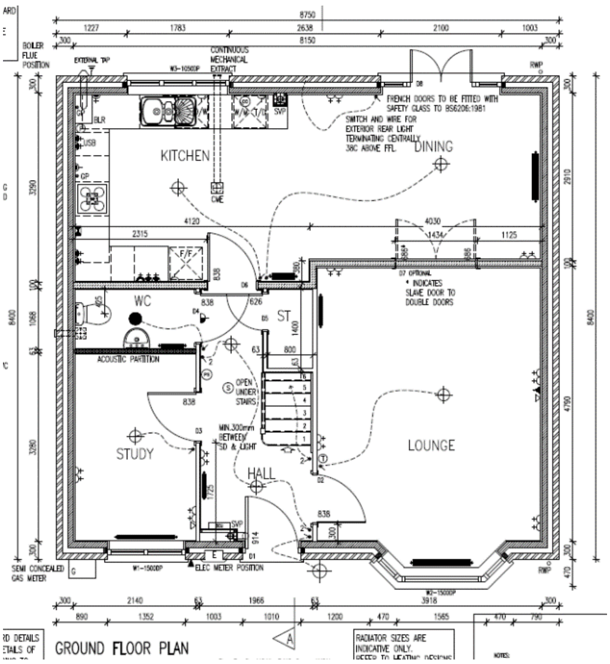
Site: Pipers Green
Crigglestone
WF4 3HY

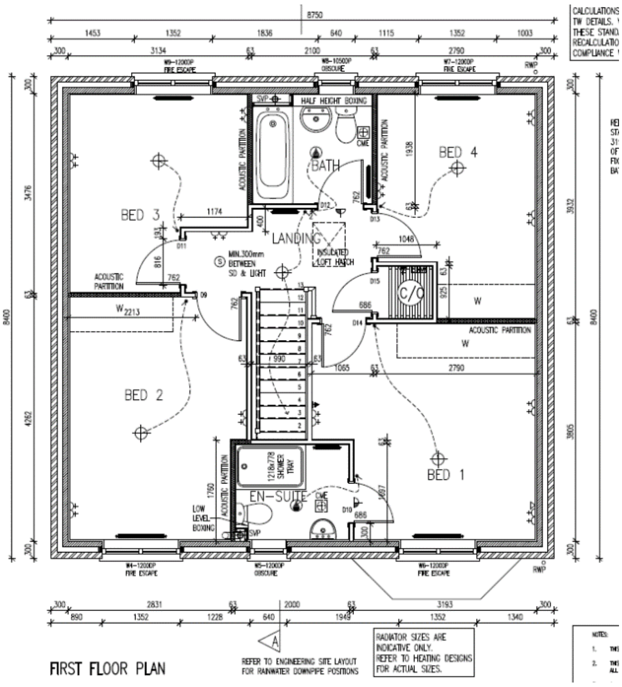
Visit Date: 8th November 2017

Plot(s): 288

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

Floor Plans:





Environmental Conditions:

Internal Temperature	22 °C	External Temperature	8.2 °C
Internal RH	51 %	External RH	62%
Wind Speed	0.2 ms^{-1}	Wind Direction	SW

Clear skies, no rain in preceding 18 hours.

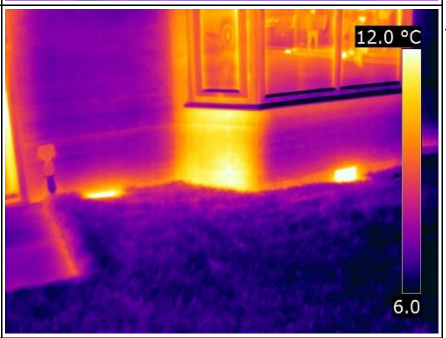
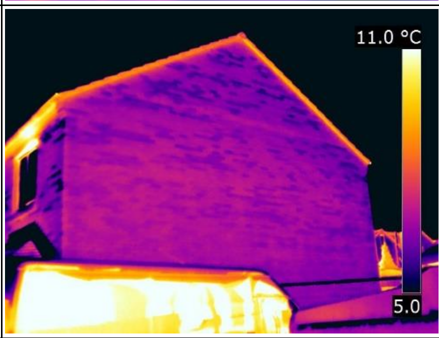
Pressure Test Results:

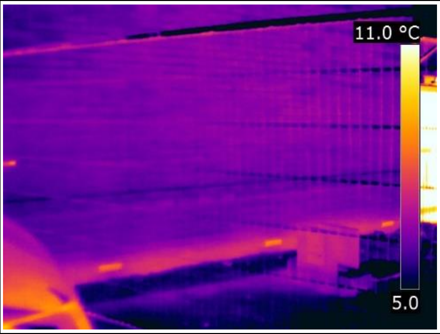
Depressurisation Only			Pressurisation Only			Mean	
$m^3/(h.m^2)$@50Pa	ach^{-1}	r^2	$m^3/(h.m^2)$@50Pa	ach^{-1}	r^2	$m^3/(h.m^2)$@50Pa	ach^{-1}
4.65	4.22	0.999	4.98	4.51	1.000	4.81	4.37

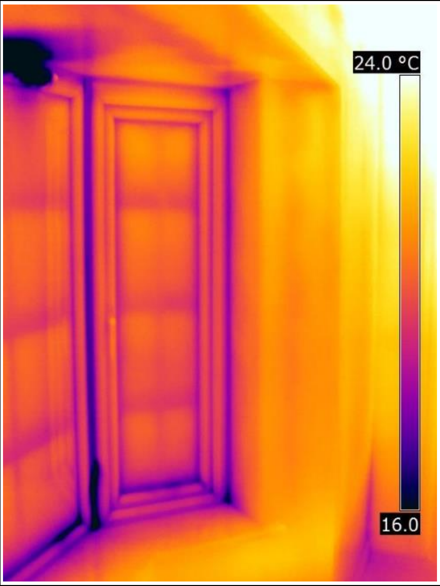
Observations:

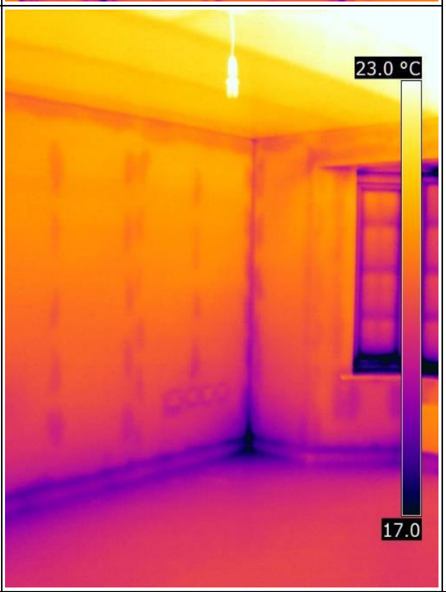
The thermal images below are shown on varying temperature scales to highlight what was being observed, please take into account these different image spans when directly comparing images. The minimum span used is 5° so as not to over-exaggerate any thermal anomalies observed.

Thermal images under depressurisation were captured at an average pressure of -52.4 Pa.

External - Under natural conditions		
		NE Front Façade Some direct sunlight on the East-facing bay wall is apparent. First floor trickle vents had been left open making it difficult to assess whether there is additional unplanned heat loss at the eaves. Warmer area above bay roof possibly due to a radiator directly under the window in Bedroom 1.
		Southerly wind resulted in warm air emerging from the underfloor vents. There also appears to be a warmer band around the ground floor perimeter which extends around the whole dwelling, possibly due to a thermal bridge as the internal IR images also show the floor/wall junction to be cooler than expected. I don't know if a cavity tray was fitted preventing the blown insulation getting down below, but this resemble instances where I have observed this previously.
		
		
		NW Gable

		
		
		SE Gable Direct solar impinging on the SE gable, the front part is shown shaded but had direct solar within the last 2 hours.
Lounge – Under natural conditions		
		The warmer strip seen from outside at the ground floor perimeter can be observed as a colder area at the floor/wall junctions from inside the dwelling. Without any mixing of air inside the house there would be some natural temperature stratification internally, but this unlikely to

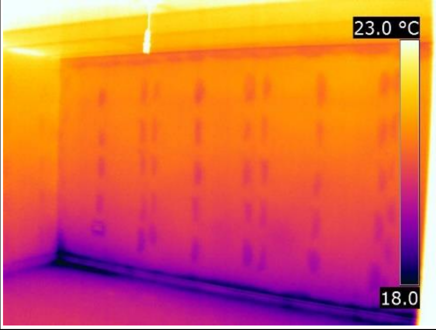
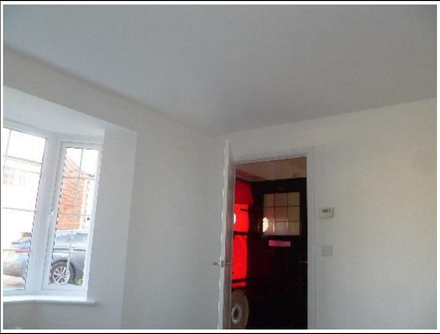
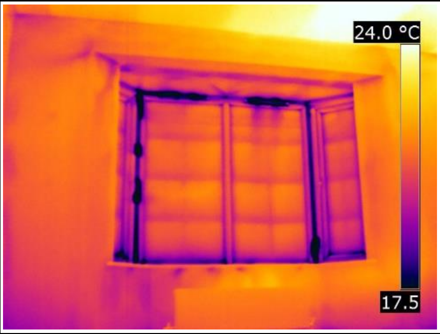
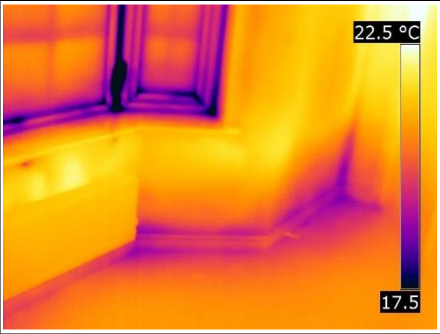


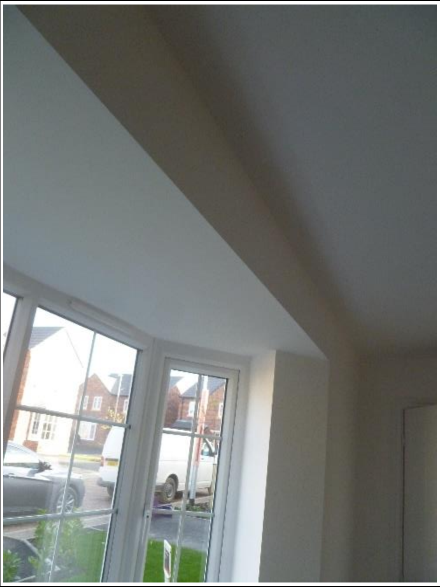


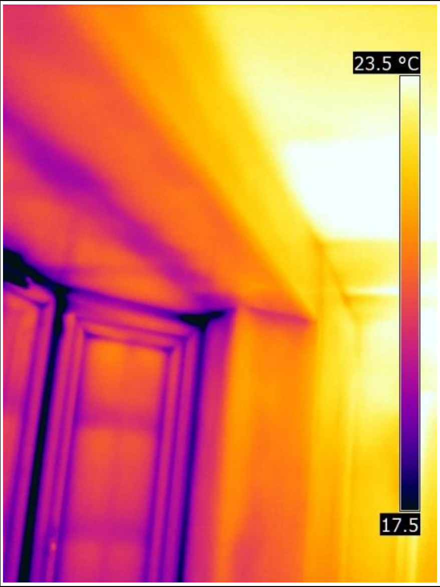
account for the significantly cooler surface temperatures at the base of the external walls. The temperature difference between the wall surface on and off the plasterboard adhesive dabs appears to reduce near the base of the wall.

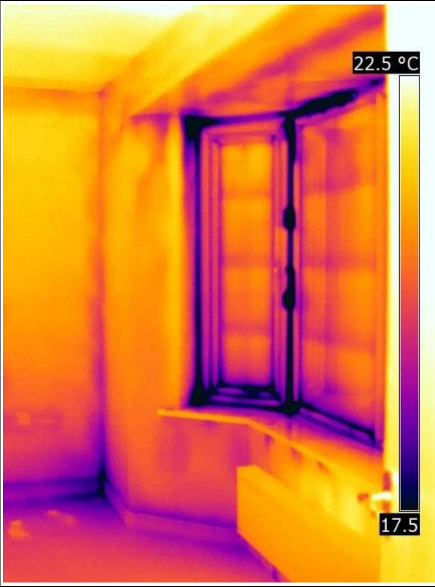
The internal surface of the bay roof appears cooler than the external elements around it, but due to cold air ingress at the trickle vents and reflection of the cooler windows it is difficult to analyse.

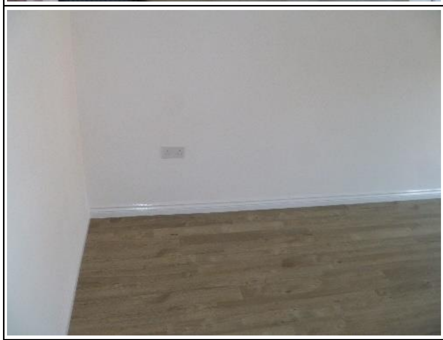
The bay window jambs appear to show no significant issues, an area where problems are commonplace.

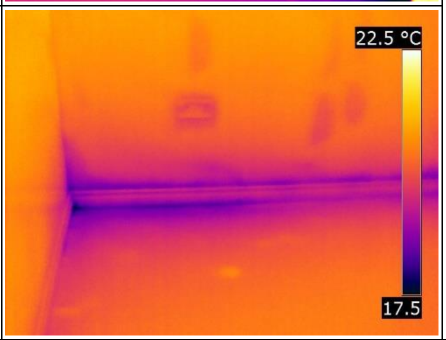
		
Lounge – Under depressurisation		
		Under depressurisation cooler air could be observed infiltration around the windows, with air entering through and around the closed trickle vents, at junctions between the lights and around the sill board. The thermal anomalies on the bay appear to worsen under depressurisation, where air movement is forced from cold external air to inside the structure, with a much clearer cold strip at the junction with the external wall above. This would indicate that gaps at interfaces play a part at this detail, whereas at the floor/wall junction the difference in IR images between natural and depressurised conditions is marginal suggesting that the increased heat loss at this junction is more likely due to conductive heat loss with discontinuities or disruptions of the insulation layer.
		
		
		



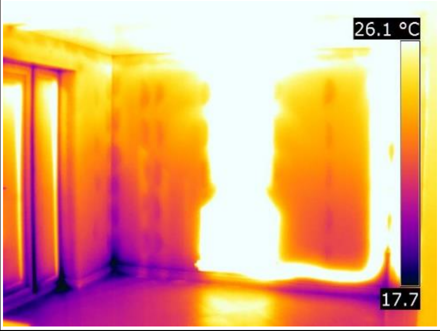
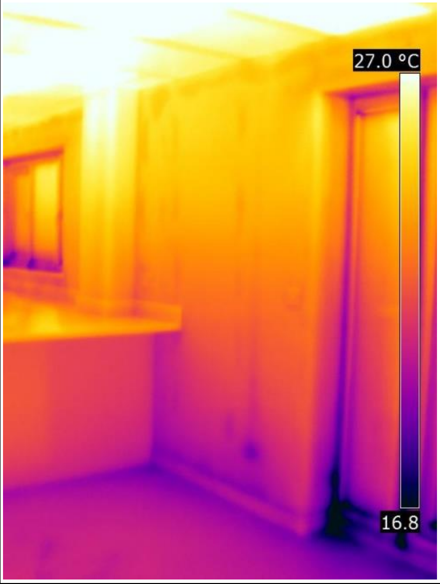
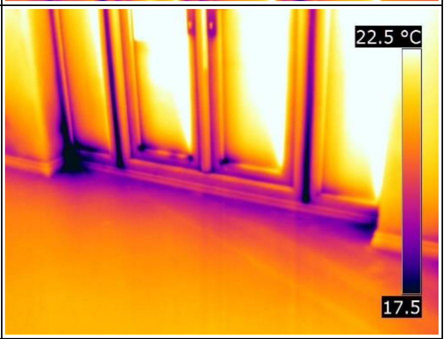








Dining / Kitchen – Under natural conditions

		The previously observed phenomena at the floor/wall junction was again apparent. Where the patio doors are positioned further out in the external wall the floor surface appears to get noticeably cooler, possibly due to greater thermal bridging.
		
		
		
		

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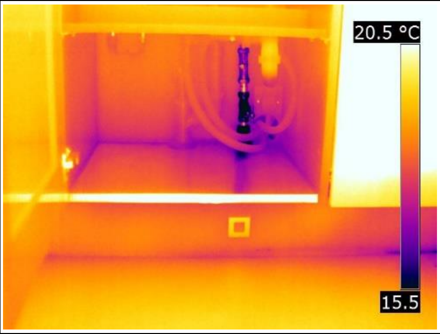
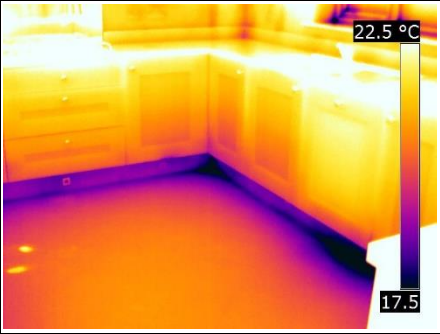
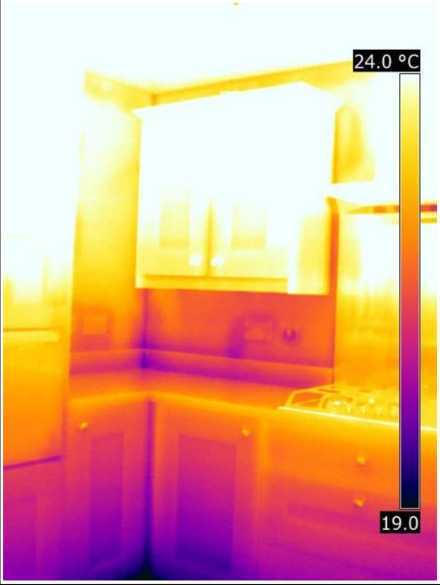
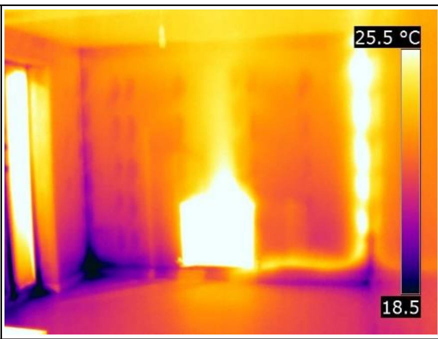
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="3">Dining / Kitchen – Under depressurisation</td></tr>
<tr><td></td><td></td><td></td></tr>
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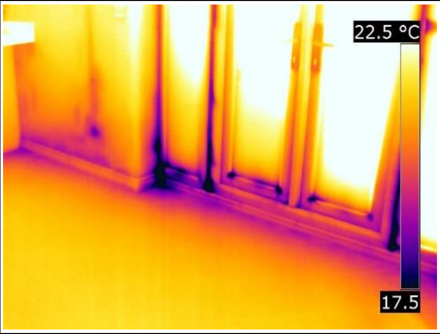
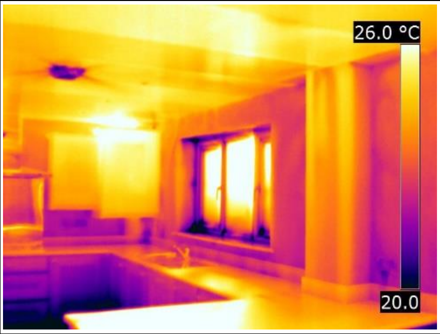
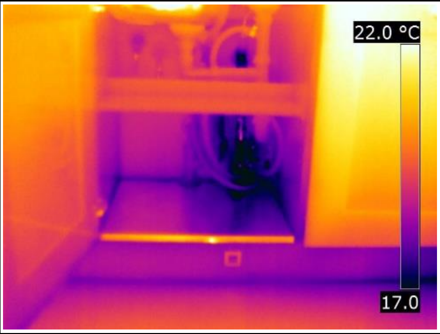
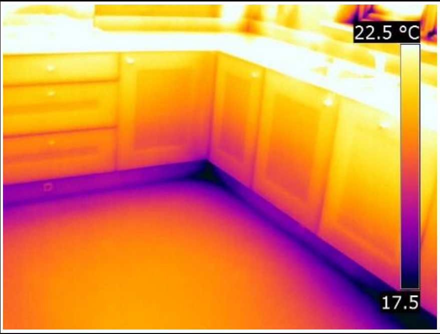


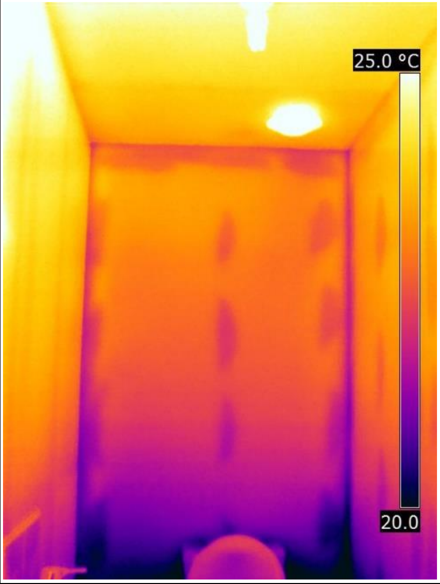
The floor surface at the patio doors does not change significantly under depressurisation, indicating again this is a bridging issue rather than to do with air movement.
Air infiltration is an issue, with both direct infiltration from outside around the windows and indirect air movement around service penetrations, into the boxed-in service riser and into the intermediate floor void.

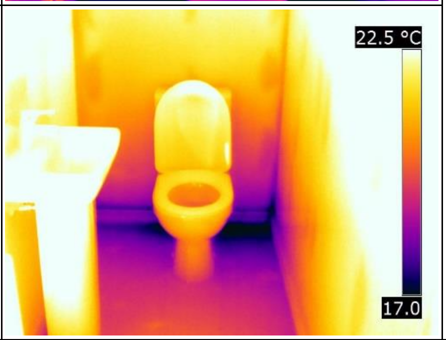



Ground Floor WC – Under natural conditions





Ground Floor WC – Under depressurisation

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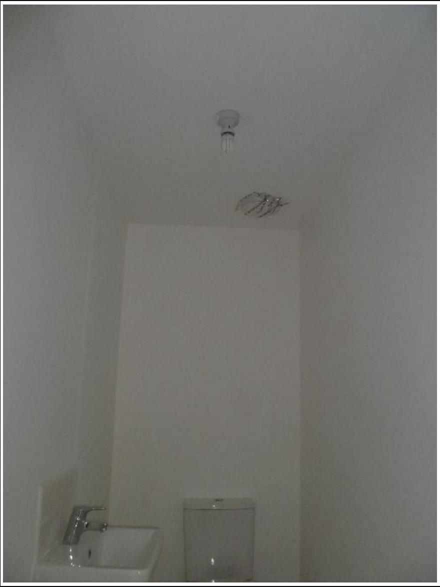
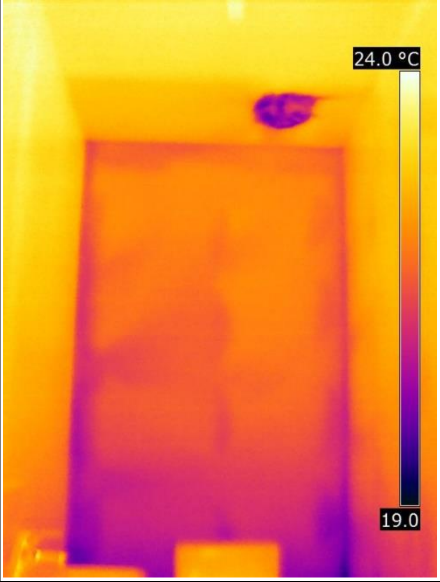
<td></td>
<td>
</td>
<td rowspan="2">Some air movement behind the plasterboard dry lining observed, it is unclear of the source and direction of movement but tends to look as if the air is coming from the adjacent study.</td>
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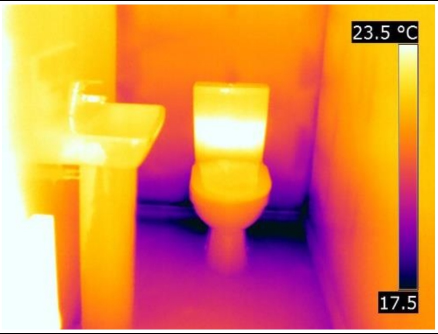
<td>
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<tr>
<td colspan="3">Study – Under natural conditions</td>
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<td rowspan="2">Plasterboard adhesive dabs appear coolest where the utilities meter boxes are situated on the external walls.
Some temperature stratification across the intermediate floor void can be observed, but it is unclear whether this is heat from the heating system pipework spreading toward the outside or cooler air from the gable wall junctions spreading inside.</td>
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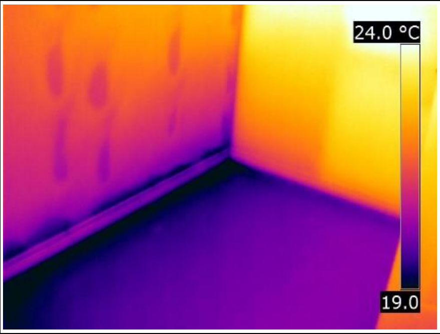
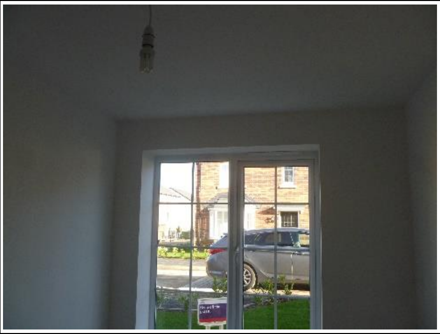
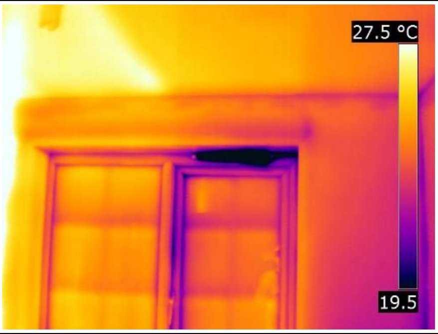
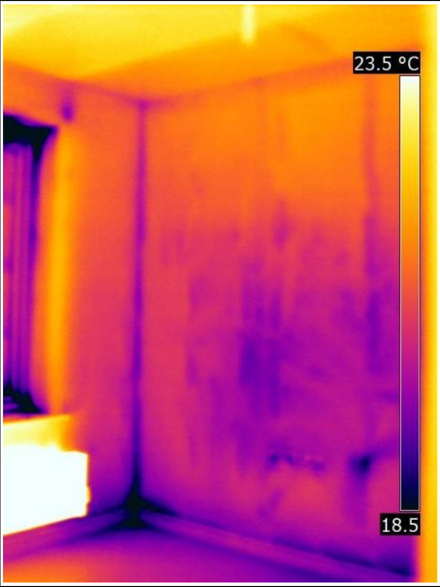
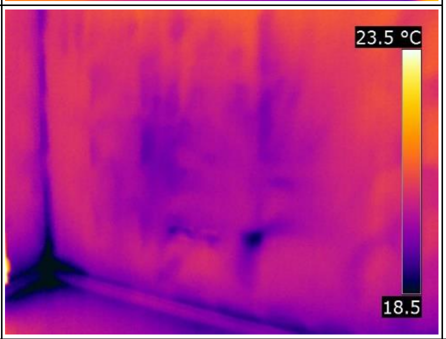
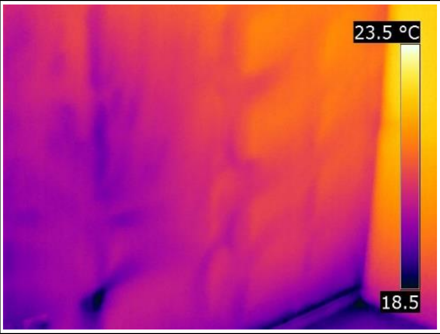
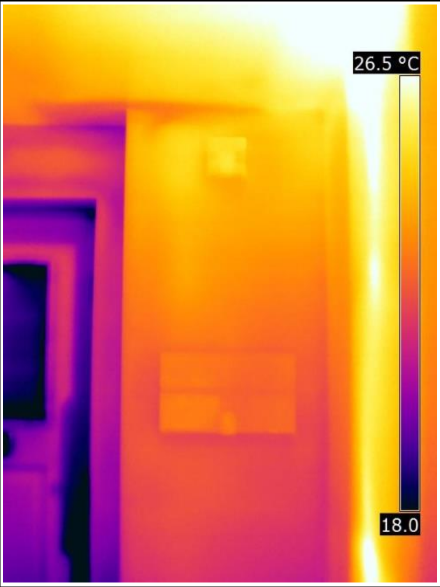
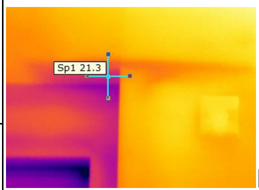
		
		
Study – Under depressurisation		
		SE Gable, position of electricity and gas meter boxes are more apparent under depressurisation, it is difficult to determine how much of the additional heat loss in this area is due to reduced insulation and how much is due to infiltration into the void behind the plasterboard dry lining. However, as air movement in this void may be continuing into the adjacent downstairs WC, it could be the major factor.
		

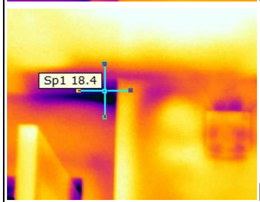
		
		
		
Hall – Under natural conditions		
		A colder area at the junction of the external wall with the intermediate floor and boxed void was not observed from the external IR images.

Hall – Under depressurisation

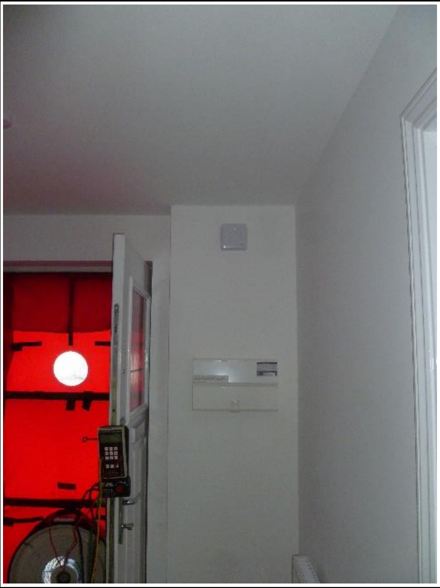
The indirect infiltration by the external wall junction with the lounge wall appears to be due to the penetration for the outside light.
The colder area at the junction of the external wall with the intermediate floor and boxed void appeared to worsen under depressurisation, this is deemed due to increased air movement which can be seen extending down the service void.

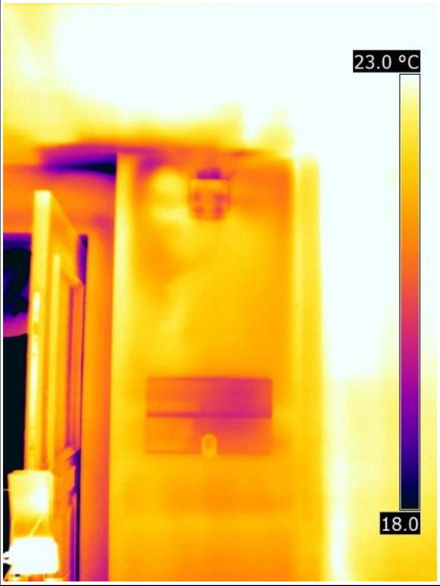


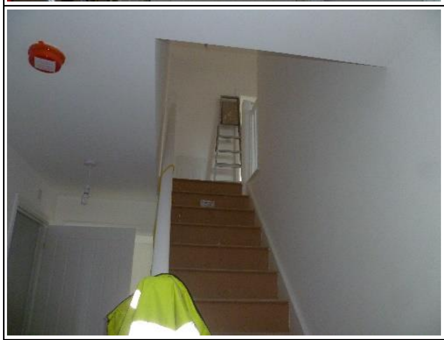
Natural



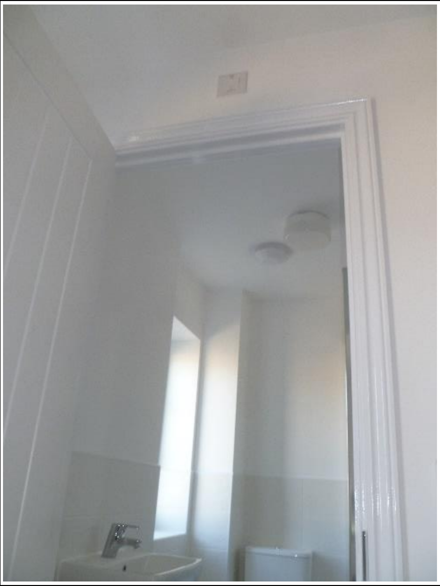
Depressurised

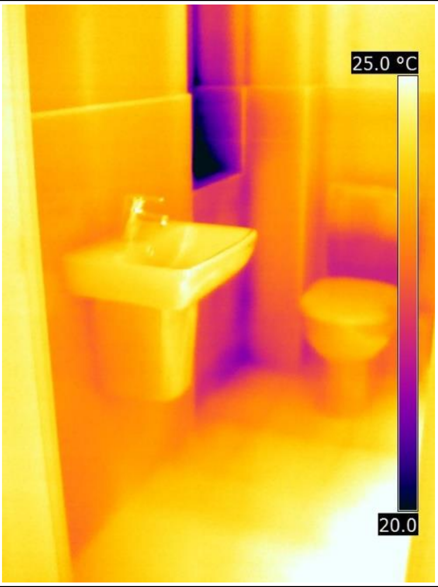




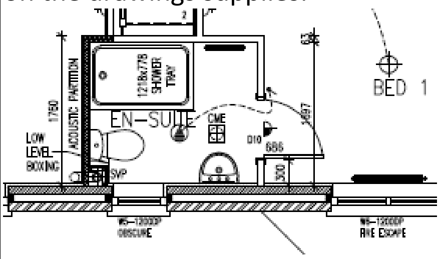


En-Suite – Under natural conditions



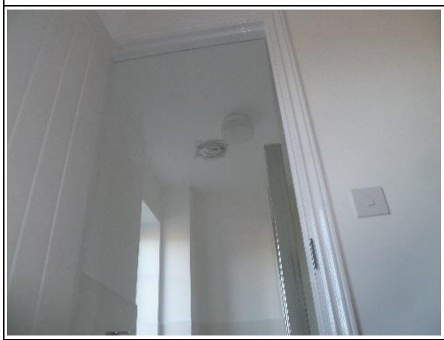


Colder areas are visible at the junction of the ceiling and external wall, extending down the service void to the right of the window. The service void to the left of the window show warmer timbers than the air voids behind but no distinct thermal gradient beyond the natural temperature stratification in the room. This void was not present on the drawings supplies:



Additionally, there appears to be some dislocation of the loft insulation around ceiling penetrations.

En-Suite – Under depressurisation



Air being drawn in from the loft space was observed into the service voids, around ceiling penetrations and into the internal partition wall by the shower cubicle.

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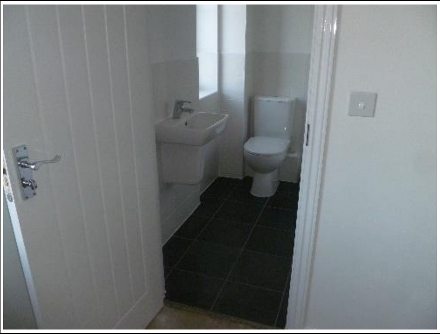
<tr><td></td><td>
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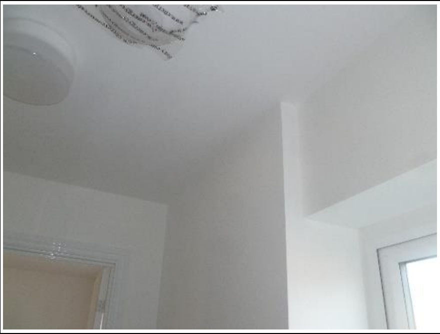
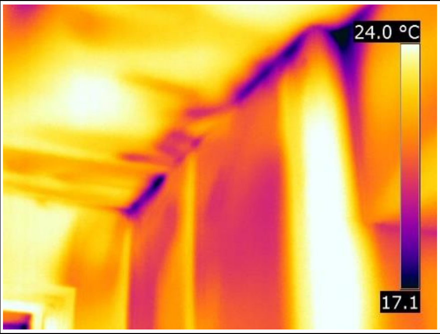
<tr><td></td><td>
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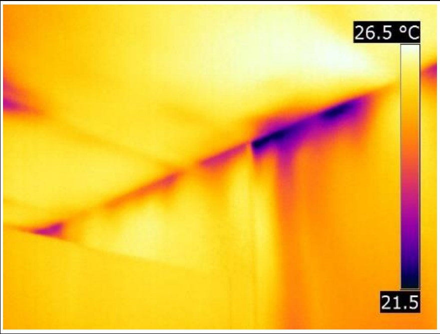
<tr><td></td><td>
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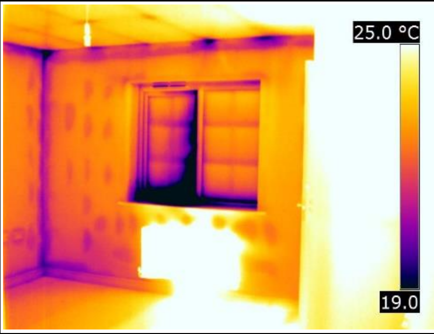
<tr><td colspan="3">Bedroom 1 – Under natural conditions</td></tr>
<tr><td></td><td>
</td><td rowspan="2">At ceiling level, under natural conditions, air would be expected to be leaving the building. This warmed air moving from behind the plasterboard to the loft space would be expected to make the tops of the external wall perimeter appear warmer, but there is still a clear colder section of wall at this junction at the wall plate and directly beneath the gable wall spandrel panels, raising questions about potential thermal bridging at these junctions.
The cooler areas of ceiling where addition timbers between the trusses dislodge the loft insulation</td></tr>
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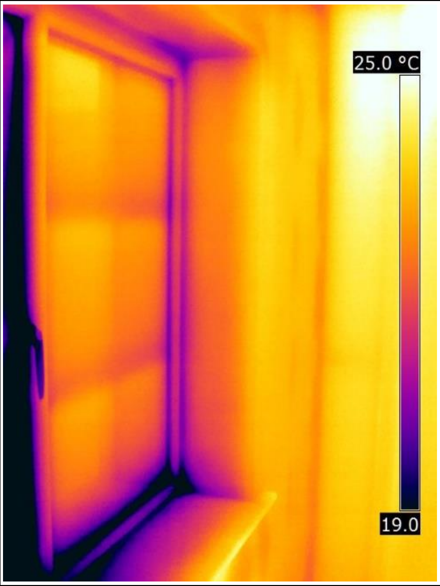
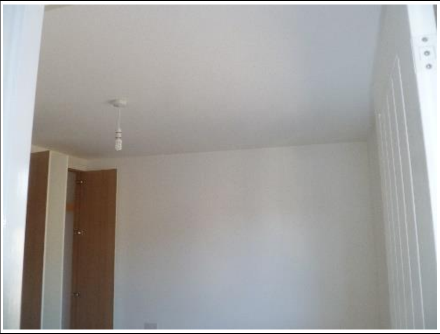
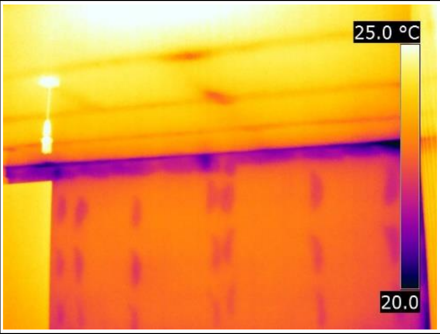
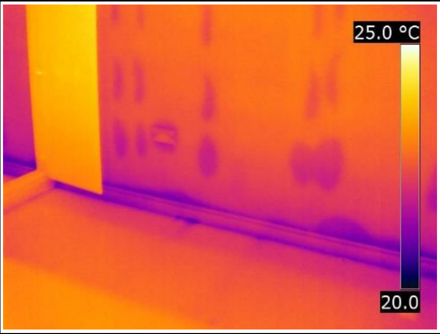
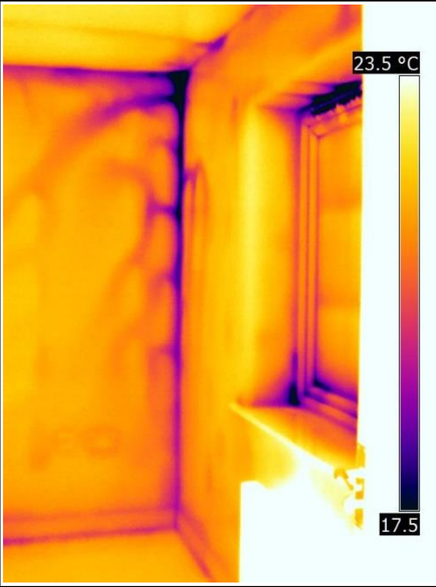
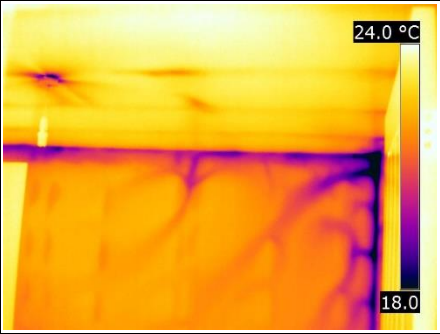
		from direct contact with the ceiling are not excessive. The stratification of temperatures of the intermediate floor void visible from below is also clear from above. Thermal bridging at jambs/head/sill is also apparent but not excessive.
		
		
		
		

<table>
<tr><td colspan="3">Bedroom 1 – Under depressurisation</td></tr>
<tr><td></td><td></td><td rowspan="4">Under depressurisation colder air can be seen being drawn in from the loft through ceiling penetrations, into the void behind the plasterboard dry lining and into some partition wall voids and emerging at places at the intermediate floor perimeter.
The external wall at the ceiling perimeter, in particular, looks significantly colder than under natural conditions due to the change in air movement direction suggesting that air movement has a greater effect here than any thermal bridging or insulation discontinuity issues.</td></tr>
<tr><td></td><td></td></tr>
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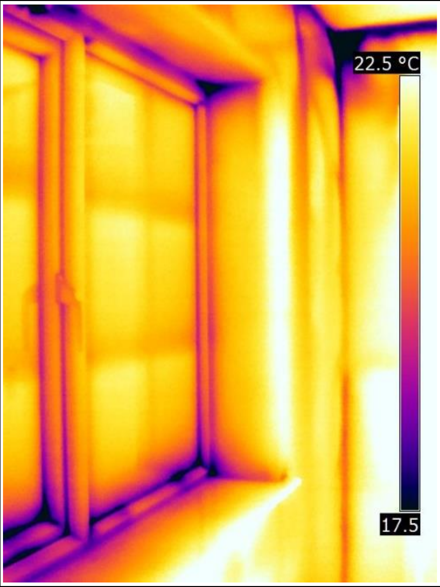
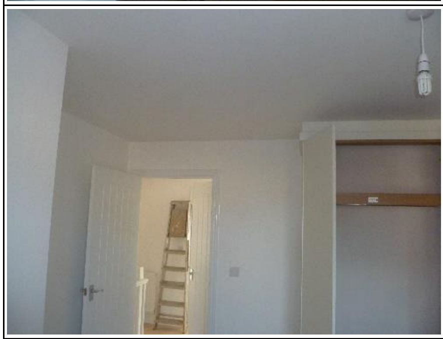
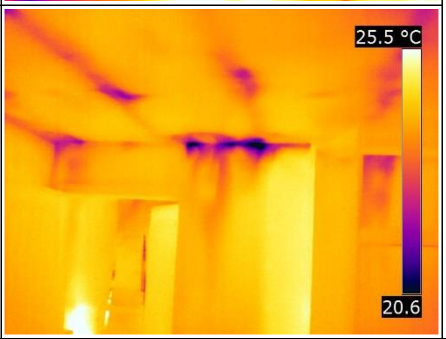
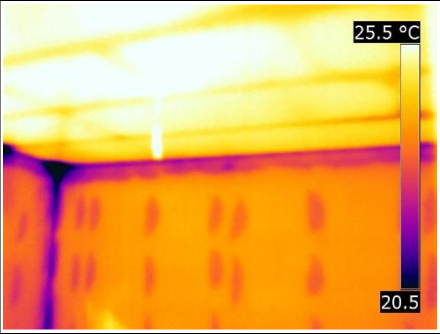
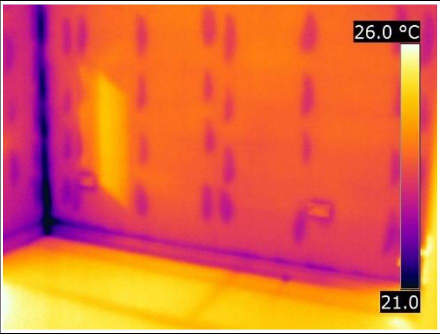


Bedroom 4 – Under natural conditions

<table>
<tr><td></td><td>
</td><td rowspan="3">Repeat of the observations for Bedroom 1.</td></tr>
<tr><td></td><td>
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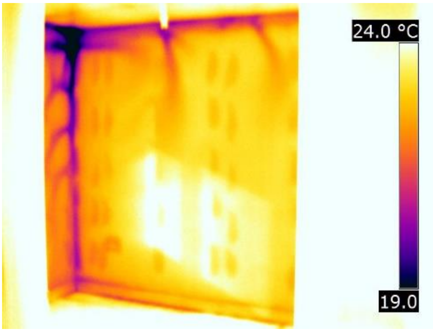
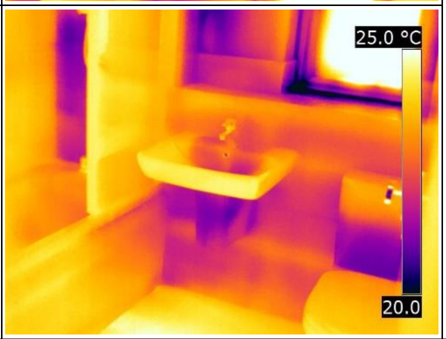
<tr><td colspan="3">Bedroom 4 – Under depressurisation</td></tr>
<tr><td></td><td>
</td><td rowspan="2">Repeat of the observations for Bedroom 1.</td></tr>
<tr><td></td><td>
</td></tr>
</table>

		
Bathroom – Under natural conditions		
		As previously observed in the bedroom, with the cold strip at the wall plate more obvious in comparison to the boxed-in service void next to it.
		
Bathroom – Under depressurisation		
		As in the En-suite, cold air is drawn in around ceiling penetration, into the void behind the dry lining and into the boxed-in void.
		
Bedroom 3 – Under natural conditions		

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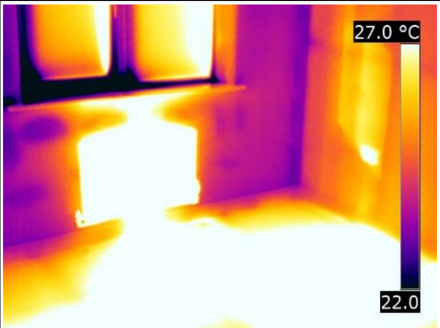
</td><td rowspan="5">As previous bedrooms.</td></tr>
<tr><td></td><td>
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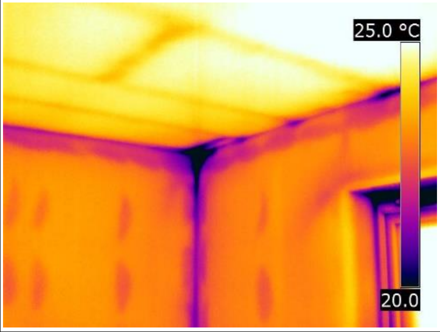
<tr><td></td><td>
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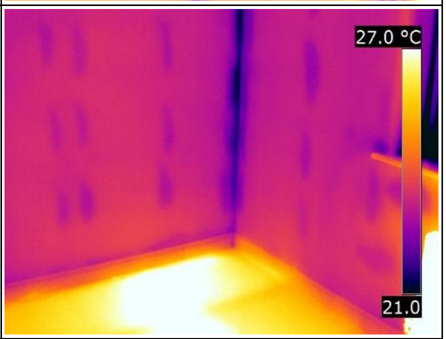
<tr><td></td><td>
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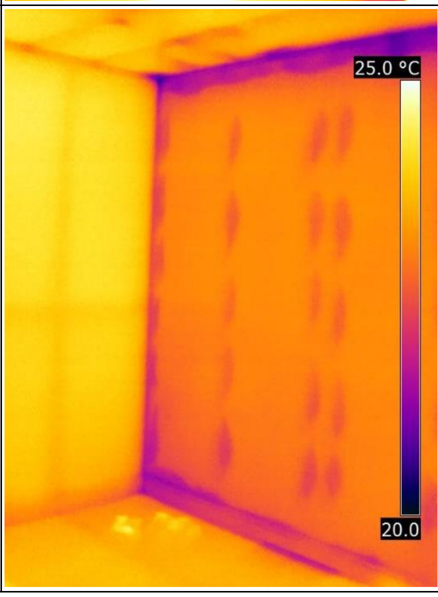
<tr><td></td><td>
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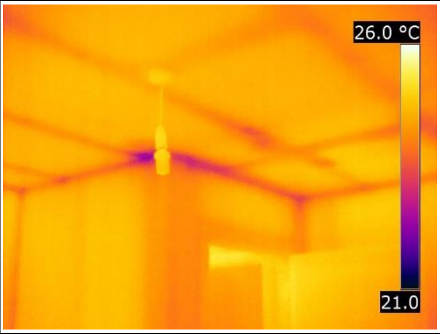
<tr><td></td><td>
</td><td></td></tr>
<tr><td colspan="3">Bedroom 3 – Under depressurisation</td></tr>
<tr><td></td><td>
</td><td rowspan="3">As previous bedrooms.</td></tr>
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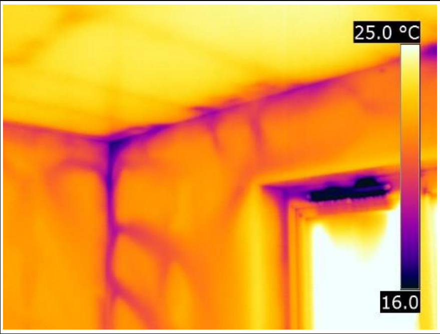
</td></tr>
<tr><td></td><td>
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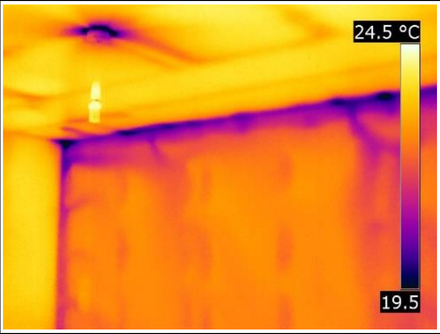
<tr><td></td><td>
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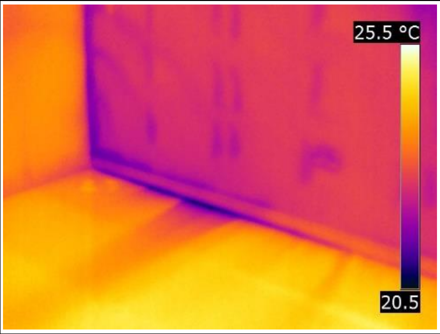
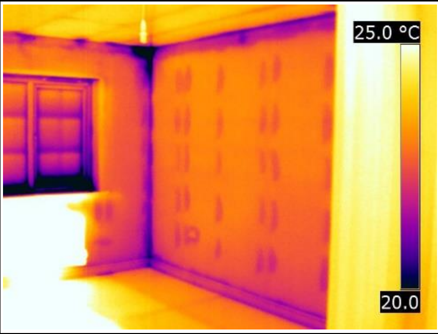
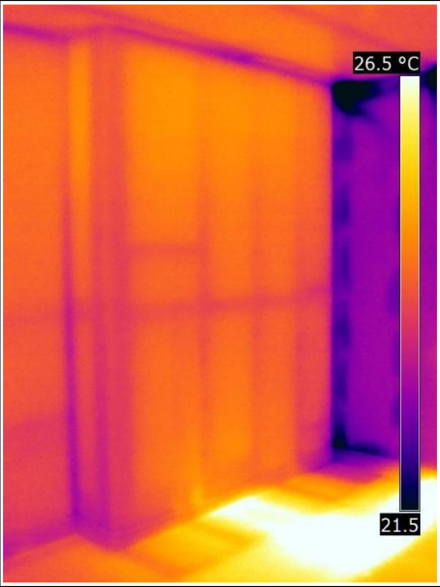
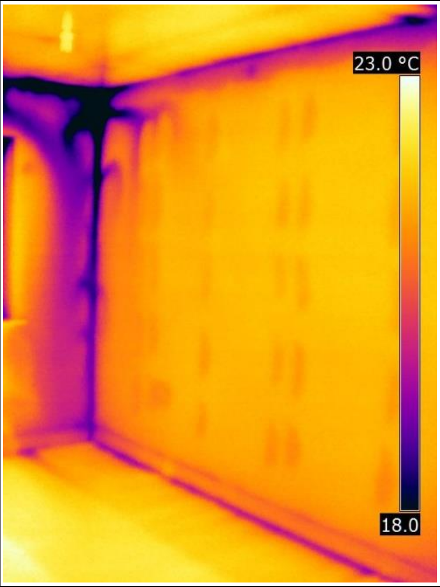
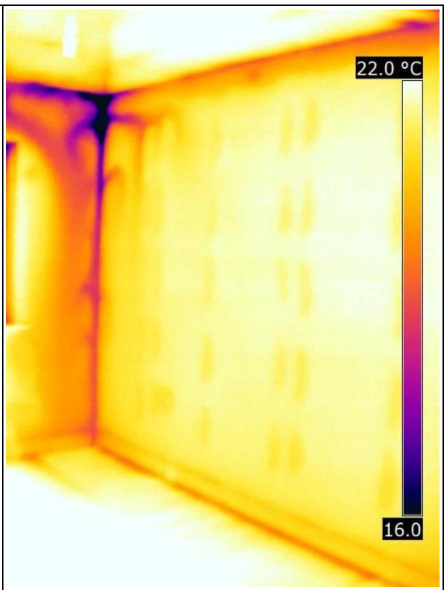
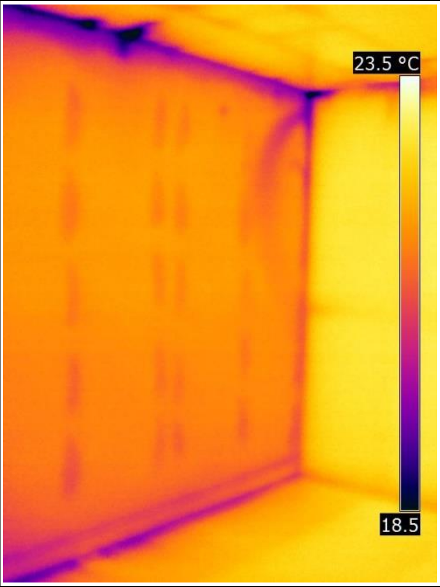
<tr><td></td><td>
</td><td></td></tr>
<tr><td colspan="3">Bedroom 2 – Under natural conditions</td></tr>
<tr><td></td><td>
</td><td>As previous bedrooms.
The junction of the partition wall with the external wall backing on to the service void in the En-suite looks slightly cooler in places.</td></tr>
</table>

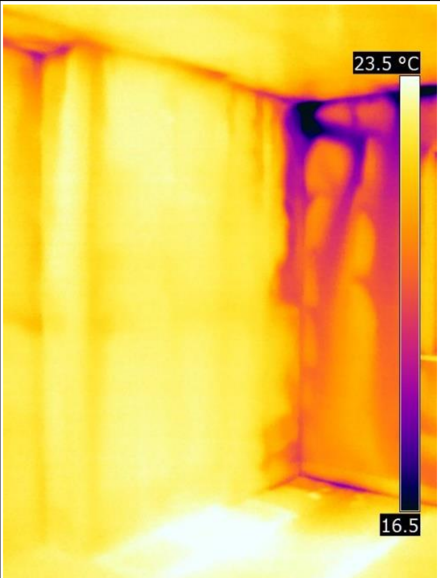
		
		
Bedroom 2 – Under depressurisation		
		As previously observed in other bedrooms.

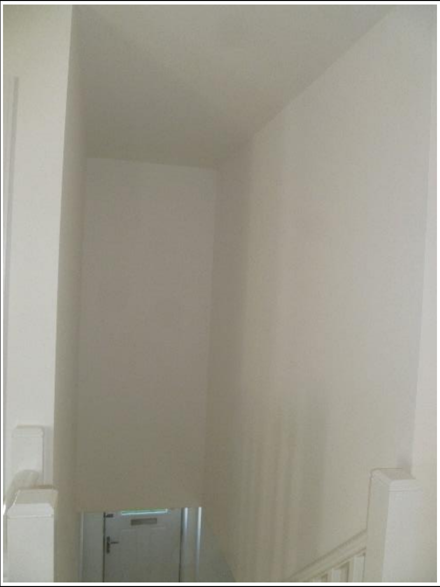
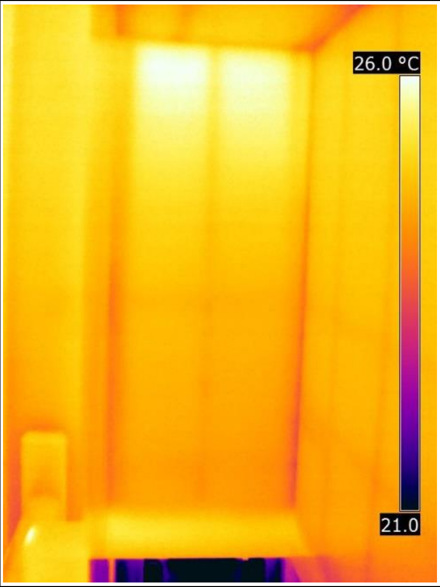
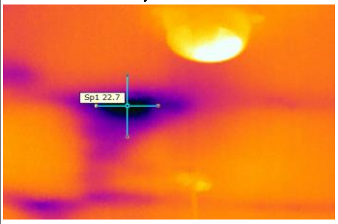


Air can also clearly be observed being drawn down the junction of the partition wall with the external wall backing on to the service void in the En-suite, this void appear to link to the void behind the plasterboard on the external wall.

Landing – Under natural conditions

<table>
<tr>
<td></td>
<td></td>
<td rowspan="3">Some areas of dislodged loft insulation appear, the level and span of the thermal image makes some of these appear worse than they are (e.g. the minimum temperature of 22.7 °C in the adjacent image) due to the nearby hot water cylinder.
</td>
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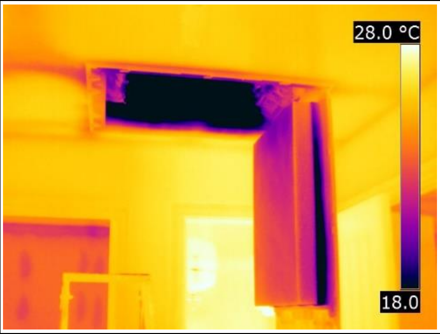
<td></td>
</tr>
<tr>
<td colspan="3">Landing – Under depressurisation</td>
</tr>
<tr>
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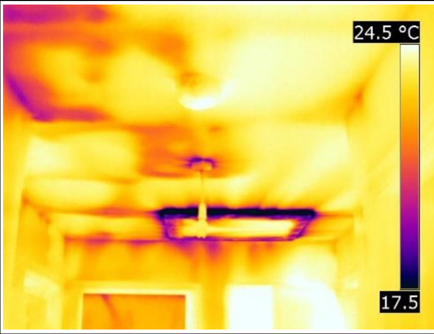
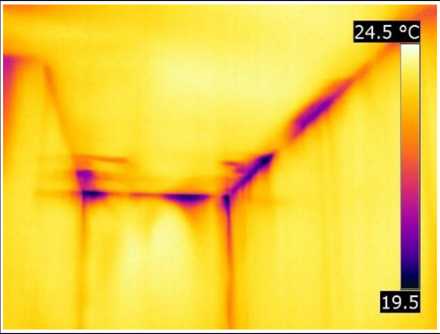
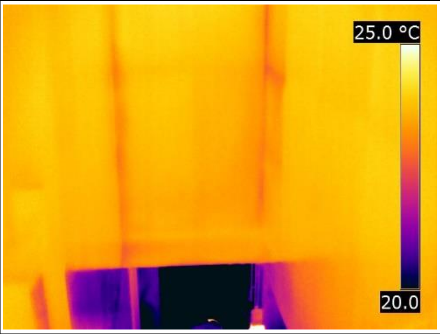
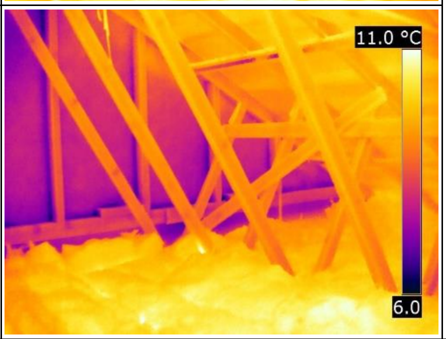
<td></td>
<td>Under depressurisation air could be seen infiltrating directly around ceiling penetrations, most significantly around the loft hatch door. Air could also be seen entering the internal partition wall voids.</td>
</tr>
</table>

		
		
		
Loft – Under natural conditions		
		The NW gable showed no signs of significant thermal bridging beneath the spandrel panel, suggesting that the cooler strip at the ceiling perimeter observed in the bedrooms below is unlikely to be due to thermal bridging.
		

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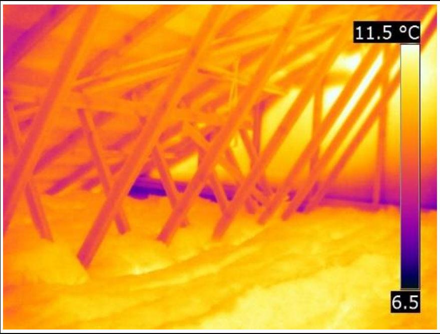
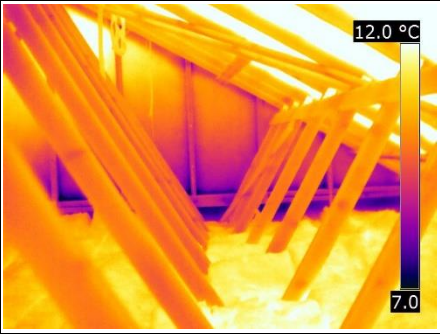
<tr><td></td><td>
</td><td rowspan="2">Direct solar on the SE gable hampered thermal imaging, but again no excessive thermal bridging beneath the spandrel panel was observed.</td></tr>
<tr><td></td><td>
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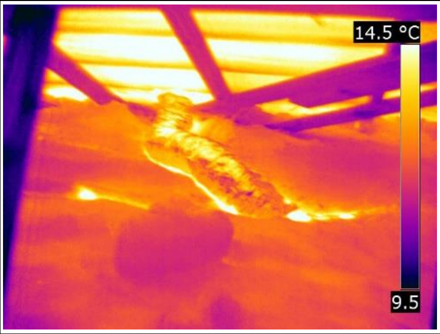
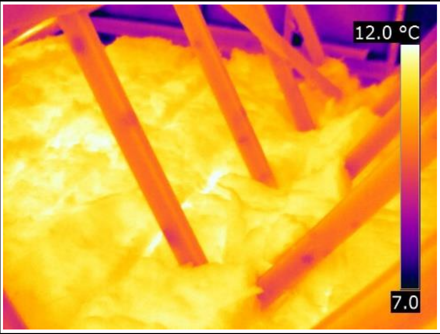
<tr><td></td><td>
</td><td rowspan="2">The loft insulation itself appeared from above to be laid particularly diligently; many commonly observed errors had been avoided, with insulation inserted into the small gaps and well placed around awkward truss angles and penetrations.</td></tr>
<tr><td></td><td>
</td></tr>
</table>

Pressure Test Spreadsheet:

LEEDS BECKETT UNIVERSITY

Leeds Sustainability Institute

MINNEAPOLIS BLOWER DOOR DATA INPUT AND CALCULATION

date:	08/11/2017		Version 16d	19 June 2017	
test house address:	Plot 288 - St James Way, Crigglestone, Wakefield, WF4 3HY				
company:	Knauf Insulation - Taylor Wimpey				
house type:	Shelford				
tester:	DMS				
test reference number:			Blower Door & Gauge Used	Model 3 with DG700	
outdoor temp (°C)	8.2	°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)	20.8	°C			
outdoor humidity (%rh)	62.2	%RH			
indoor humidity (%rh)	51	%RH			
outdoor barometric pressure	1016.6	mbar or hPa	Calculated Outdoor Air Density	1.26	kg/m^3
indoor barometric pressure	1016.5	mbar or hPa	Calculated Indoor Air Density	1.20	kg/m^3
temperature corr. fact. depress.	0.957	WARNING!!	description of main construction details:		
temperature corr. fact. press.	1.045	Extreme Test	New build, masonry, blown full-fill, detached		
wind speed (m/s):	0.2	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 =	1386.27	m^3/h			
Mean Air Leakage at 50Pa =	4.37	h^{-1}			
Mean Air Permeability at 50 Pa =	4.81	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	53.3	1427	1362.8	OK	53.3	3.976	7.217	1339.21	4.65	4.22
Approx 57 Pa	b	45.6	1311	1252.0	OK	45.6	3.820	7.132	r^2	0.999	
Approx 49 Pa	b	39	1177	1124.0	OK	39	3.664	7.025	C_{env}	97.808	$m^3/h.Pa^n$
Approx 41 Pa	b	34.2	1066	1018.0	OK	34.2	3.532	6.926	n	0.665	
Approx 33 Pa	b	27.7	940	897.7	OK	27.7	3.321	6.800			
Approx 25 Pa	b	21.2	776	741.1	OK	21.2	3.054	6.608	C_L (corrected)	99.303	$m^3/h.Pa^n$
Approx 20 Pa	b	17.3	682	651.3	OK	17.3	2.851	6.479			

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	54.9	1442	1510.0	OK	54.9	4.006	7.320	1433.33	4.98	4.51
Approx 57 Pa	b	46.7	1314	1375.9	OK	46.7	3.844	7.227	r^2	1.000	
Approx 49 Pa	b	40.2	1197	1253.4	OK	40.2	3.694	7.134	C_{env}	116.838	$m^3/h.Pa^n$
Approx 41 Pa	b	34	1070	1120.4	OK	34	3.526	7.021	n	0.641	
Approx 33 Pa	b	27	925	968.6	OK	27	3.296	6.876			
Approx 25 Pa	b	21.4	795	832.5	OK	21.4	3.063	6.724	C_L (corrected)	116.805	$m^3/h.Pa^n$
Approx 20 Pa	b	14.9	628	657.6	OK	14.9	2.701	6.489