Waterstone Design

Overheating Analysis

Bollo Lane,
Acton,
Plot 3A

waterstonedesign.co.uk

Issue and Revision Record

Revision	Date	Comments	Author	Checked
REV1	13/10/23	Updated Info	Joshua Collett	Ben Russell
REV2	08/12/23	TfL comments incorporated	Joshua Collett	Ben Russell

Table of Contents

1. Executive Summary

Waterstone Design have undertaken an overheating assessment of the proposed development for Plot 3A, Bollo Lane, Action ("the site") to identify whether any dwellings are at a significant risk of overheating as well demonstrating compliance with TM59 & Approved Document O. This report is also in support of a S96A application which seeks NMA to Planning Permission (201379OUT) to alter conditions to enable changes to the approved plans and elevations in response of new fire safety requirements and an improved overheating strategy for Plot 3A.

This report summaries the process undertaken and outlines the results of the thermal comfort analysis whilst describing any passive measures which may be required to ensure all spaces maintain acceptable levels of thermal comfort. The assessment uses profiles and schedules which are in line with CIBSE guidance TM52:2013 & TM59:2017. To achieve compliance, dwellings must pass both of the below criteria:

- *For living rooms, kitchens and bedrooms: the number of hours during which DT is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3 percent of occupied hours. (CIBSE TM52 Criterion 1: Hours of exceedance).*
- *For bedrooms only: to guarantee comfort during the sleeping hours the operative temperature in the bedroom from 10 pm to 7 am shall not exceed 26 °C for more than 1% of annual hours. (Note: 1% of the annual hours between 22:00 and 07:00 for bedrooms is 32 hours, so 33 or more hours above 26 °C will be recorded as a fail).*

Initial results have identified that using a specification of 0.63 g-value and restricted natural ventilation, many of the habitable rooms did not comply with the TM59 criteria. In addition to this, acoustic constraints stipulate that bedroom windows must remain closed however it should be noted that if openable windows are used in dwellings, the development can comply with applicable criterion.

Consequently, the following approaches (Option A & B) are proposed to satisfy acoustic constraints whilst both proposed options incorporate improved measures above the consented Energy Strategy:

- All residential glazing to benefit from a g-value of 0.37.
- The incorporation of passive design measures such as balconies, thermal mass (construction build ups) as well as increased internal and external reveals to reduce solar gains.
- An MVHR (Mechanical Ventilation with Heat Recovery) to each dwelling delivering 50 (l/s) extracting humid indoor air and providing fresh air to occupants.
- Natural ventilation has been provided to all 'KitchenLivingDining' areas through openable windows and balcony doors during occupied, daytime hours.
    - **Option A** - 'Hybrid Cooling System' which combines high levels of indoor air quality with the added benefit of summer cooling to mitigate overheating for bedroom areas.
    - **Option B** – A dedicated 'Purge Ventilation Unit' to bedroom areas allowing the rapid removal of stale, warm air from the dwelling to improve thermal comfort.

2. Introduction

To reduce the risk of overheating and reliance on cooling measures such as air conditioning, the development has been designed in accordance with new guidance released as part of Approved Document O (Overheating) 2021 edition due to transitional arrangements for the scheme to ensure the strategy for reducing overheating risk is acceptable. This is outlined below:

Limiting solar gains

Solar gains in summer should be limited by any of the following means.

a. Fixed shading devices, comprising any of the following.

   i. Shutters
   ii. External blinds
   iii. Overhangs
   iv. Awnings

b. Glazing design, involving any of the
   i. Size
   ii. Orientation
   iii. g-value
   iv. Depth of the window reveal.

c. Building design – for example, the placement of balconies.

d. Shading provided by adjacent permanent buildings, structures, or landscaping.

Although internal blinds and curtains provide some reduction in solar gains, they should not be taken into account when considering whether requirement O1 has been met.

Foliage, such as tree cover, can provide some reduction in solar gains. However, it should not be taken into account when considering whether requirement O1 has been met.

Removing excess heat

Excess heat should be removed from the residential building by any of the following means.

a. Opening windows (the effectiveness of this method is improved by cross-ventilation).
b. Ventilation louvres in external walls.
c. A mechanical ventilation system.
d. A mechanical cooling system

The building should be constructed to meet requirement O1 using passive means as far as reasonably practicable.

It should be demonstrated to the building control body that all practicable passive means of limiting unwanted solar gains and removing excess heat have been used first before adopting mechanical cooling.

Any mechanical cooling (air-conditioning) is expected to be used only where requirement O1 cannot be met using openings.

3. CIBSE TM52 Overheating Criteria – Adaptive Thermal Comfort

Historically, overheating in buildings has been quantified by the number of hours per year that the indoor temperature exceeds a particular temperature regardless of what the external temperature may be. However, studies have demonstrated that comfortable room temperatures vary subject to the external air temperature. Occupants are more likely to be 'comfortable' at higher room temperatures during periods of prolonged warmer weather. This is known as Adaptive Thermal Comfort.

In response to this CIBSE produced Technical Memorandum 52 (TM52) "The limits if thermal comfort: avoiding overheating in European buildings" which provides a methodology for assessment of Adaptive Thermal Comfort.

The TM52 assessment is based on the comparison of predicted room temperature with a maximum acceptable room temperature derived from the running mean of the outdoor temperature. The running mean used, places greater weight on the temperature for days closer to the present as these have more influence on a person's perceived comfort levels.

TM52 assesses thermal comfort based upon three criteria, with a 'pass' being dependent upon at least two of the three criteria being met. The three criteria are described below:

1. **Hours of Exceedance**

This criterion assesses the number of hours (He) during which the temperature difference (between actual operative temperature and maximum allowed temperature) is greater than or equal to one degree during the period of May to September inclusive shall not be more that 3% of occupied hours.

Threshold temperature exceeded by one degree ≤ 3% of occupied hours

2. **Daily Weighted Exceedance**

This criterion assesses the severity of overheating, the weighted exceedance (We) shall be less than or equal to 6 degree-hours in any one day.

Daily weighted exceedance (degree-hours) ≤ 6

3. **Upper Limit Temperature**

Criterion 3 sets an absolute maximum threshold for the indoor operative temperature for which the temperature difference between indoor operative temperature and maximum allowed temperature shall not exceed four degrees

Temperature ≤ upper limit

4. CIBSE TM59 Overheating Criteria - Adaptive Thermal Comfort

Homes that are predominantly naturally ventilated, including homes that have mechanical ventilation with heat recovery (MVHR), with good opportunities for natural ventilation in the summer should assess overheating using the adaptive method based on CIBSE TM52 (2013), as described in section 1 below.

In order to allow the occupants to 'adapt', each habitable room needs operable windows with a minimum free area that satisfies the purge ventilation criteria set in Part F of the Building Regulations, i.e. the window opening area should be at least 1/20th of the floor area of the room (different conditions exist for windows with restricted openings, and the same requirement applies for external doors). Control of overheating may require accessible, secure, quiet ventilation with a significant openable area.

Homes that are predominantly mechanically ventilated because they have either no opportunity or extremely limited opportunities for opening windows (e.g. due to noise levels or air quality) should be assessed for overheating using the fixed temperature method based on CIBSE Guide A (2015a), as described in section 2 below.

1. Criteria for homes predominantly naturally ventilated

Compliance is based on passing both of the following two criteria:

(a) *For living rooms, kitchens and bedrooms: the number of hours during which DT is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3 percent of occupied hours. (CIBSE TM52 Criterion 1: Hours of exceedance).*

(b) *For bedrooms only: to guarantee comfort during the sleeping hours the operative temperature in the bedroom from 10 pm to 7 am shall not exceed 26 °C for more than 1% of annual hours. (Note: 1% of the annual hours between 22:00 and 07:00 for bedrooms is 32 hours, so 33 or more hours above 26 °C will be recorded as a fail).*

Criteria 2 and 3 of CIBSE TM52 may fail to be met, but both (a) and (b) above must be passed for all relevant rooms.

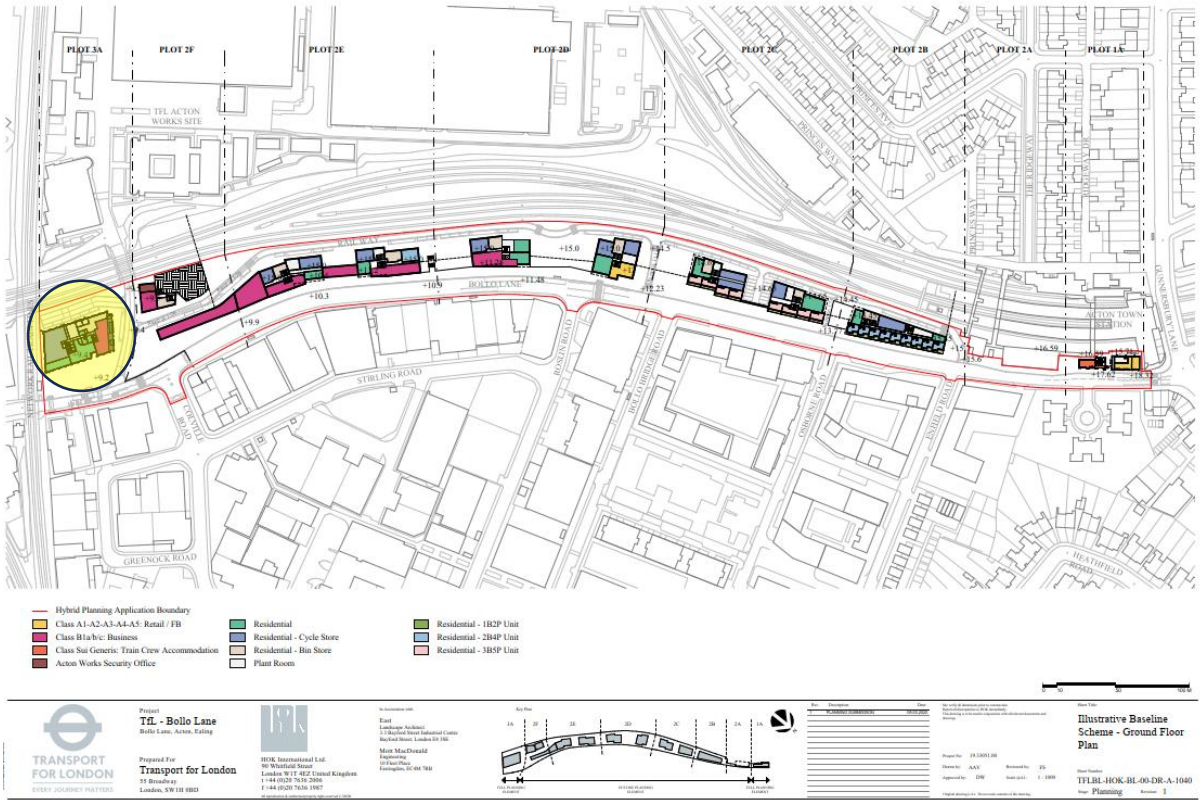
2. Criteria for homes predominantly mechanically ventilated

For homes with restricted window openings, the CIBSE fixed temperature test must be followed, i.e. all occupied rooms should not exceed an operative temperature of 26 ˚C for more than 3% of the annual occupied annual hours

5. Detailed Site Analysis

This application relates to a non-material amendment (NMA) application rather than the previously consented scheme.

- An NMA to Planning Permission Ref: 201379OUT to alter conditions to enable changes to the approved plans and elevations to respond to new fire safety requirements and an improved overheating strategy for Plot 3A. Alteration to various conditions for clarification purposes".
- The application is submitted to Ealing Council as the Local Planning Authority ("LPA").
- This Report should be read in conjunction with other technical documents submitted in support of the application for Plot 3A.



6. Modelling

The models for each dwelling have been created using Design Builder v7.2.0.32 which utilises the EnergyPlus simulation calculation engine. This software has been used as it allows the simulations to adopt *'Approved Document O rules'* which incorporates updated scripting to coincide with temperature variables listed in AD-O. The analysis was conducted by a qualified and competent person who has undertaken a relevant course to enable them to carry out assessments in the Design Builder software.

In terms of the modelling, a significant number of dwellings have been assessed which are deemed to be at risk of overheating due to factors such as acoustic restrictions, single aspect, have large areas of glazing or a combination of each of these. These have been represented using updated floor plans which can be seen below:

- Levels 05, 06 & 11

- Levels 13, 17 & 21

7. Development Features

7.1 Building Fabric

The following building elements have been assumed as per the Barratt fabric specification for Part L 2021. The U-Values, thermal mass and g-values have been modelled as follows.

Element	U-Value (W/m²K)	Kappa (kJ/m²K)
Ground Floor	0.12	76.720
External Wall	0.18 (SFS)	21.0475
Roofs	0.11	37.6544
Windows	1.2 (0.37 g-value)	N/A
Air Permeability	4 m3/hr.m2 @50Pa.	

7.2 Natural Ventilation

Natural ventilation is to be provided by means of openable windows where applicable which is an effective way to mitigate overheating as this delivers fresh air to the occupants. It should be noted that ventilation air change rates have been calculated by EnergyPlus utilising the detailed calculation, and wind speed/orientation data from the weather data files which allows calculation of air change rates for the given site location.

It has been scheduled that the occupants will be able to open any applicable windows during hot weather when internal temperatures are in line with Section 2 of Approved Document O:

a. When a room is occupied during the day (8am to 11pm), openings should be modelled to do all of the following.

   i. Start to open when the internal temperature exceeds 22°C.
   ii. Be fully open when the internal temperature exceeds 26°C.
   iii. Start to close when the internal temperature falls below 26°C.
   iv. Be fully closed when the internal temperature falls below 22°C.

b. At night (11pm to 8am), openings should be modelled as fully open if both of the following apply

   i. The opening is on the first floor or above and not easily accessible.
   ii. The internal temperature exceeds 23°C at 11pm.

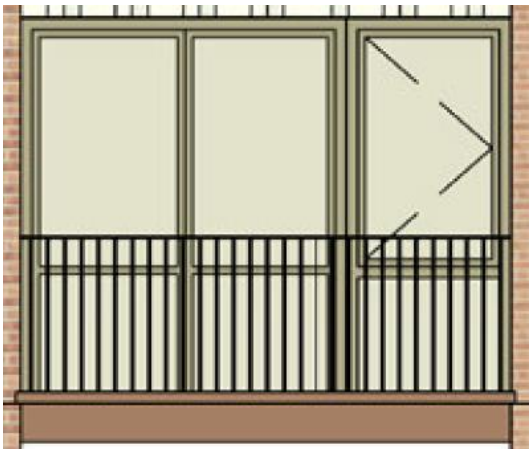
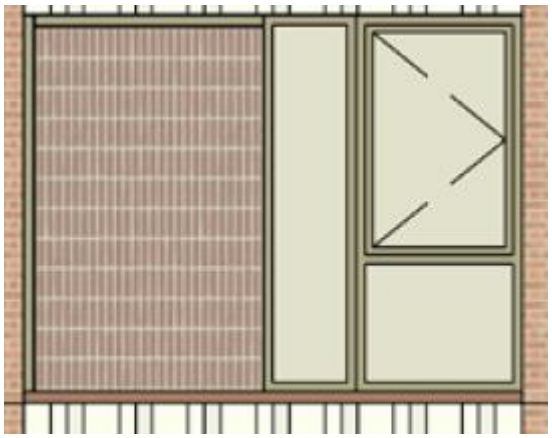
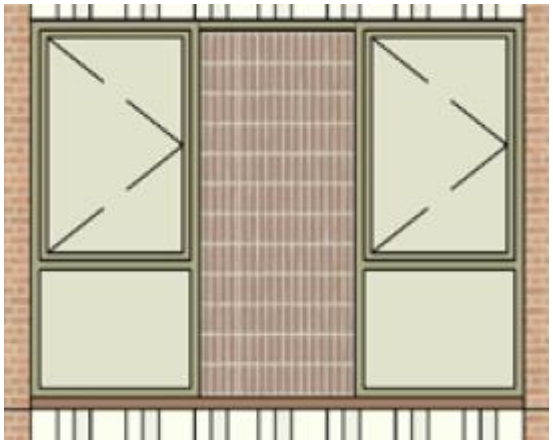
The free aperture of the windows has been calculated in accordance with the current elevational drawings. In order to calculate equivalent area, the discharge coefficient calculator as per Appendix D of Approved Document O has been utliised with further modelling undertaken to determine precise aperture alongside window opening angles which can be seen below.

It should be noted that the equivalent area calculations have been modelled to ensure the overheating mitigation strategy is usable to coincide with Section 3 of Approved Document O.

3.9 Openings that can be opened wider than 100mm may form part of the overheating mitigation strategy where they meet the follow condition:

a. Windows handles on windows the open outwards are not more than 650mm from the inside face of the wall when the window is at its maximum openable angle.

In accordance with the above, the assumptions made within the modelling have been outlined below. It should be noted that the scheme has initially been designed to demonstrate compliance with AD-O and TM59 using openable windows however, due to acoustic recommendations and constraints, bedroom windows have been assumed shut.

'KitchenLivingDining' - Balcony Areas Sliding Doors • Both doors assumed openable. • 85% equivalent area • Operation – Occupancy Schedule Side Hung Casement Window • 90° Inward Opening (1100m transom heights) • 88% equivalent area • Operation – Occupancy Schedule	
'KitchenLivingDining' Side Hung Casement Window • 90° Inward Opening (1100m transom heights) • 88% equivalent area • Operation – Occupancy Schedule	
'Bedrooms' Side Hung Casement Window Naturally Ventilated Compliance Option • 90° Inward Opening (1100m transom heights) • 88% equivalent area • Operation – Occupancy Schedule Acoustic Constraints Compliance Option • Shut – 24/7	

7.3 Mechanical Ventilation

Mechanical ventilation systems are to be installed in line with Part F regulations to all dwellings providing ventilation as well as extracting humid indoor air.

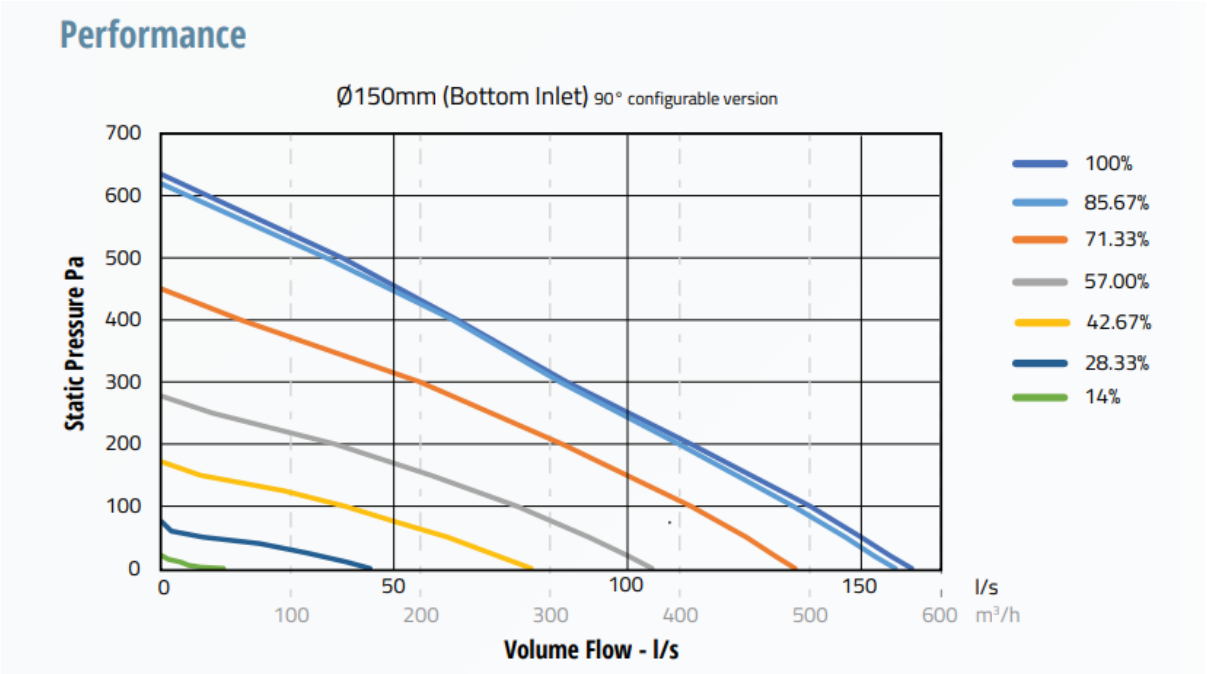
An MVHR (Mechanical Ventilation with Heat Recovery) unit has been modelled into all dwellings with a whole house ventilation rate of 50 l/s. It should be noted that occupants are still able to open applicable windows as per the natural ventilation assumptions in the diagram above.

Option A - Due to the acoustic constraints for bedroom areas, a cooling module can be added directly on-top-of, and operate in conjunction with, the already installed MVHR unit to create one packaged system. This added cooling significantly lowers the temperature of fresh air supplied into the dwelling, helping maintain comfortable internal temperature levels and mitigate overheating for residents. An example of modelling assumptions can be seen below which shows a flow rate of 50 l/s (from the MVHR unit) alongside 0.88 kW of cooling delivered at 14.3°C.

29°C EXTERNAL AIR TEMPERATURE

Conditions	Cooling (kW) / Airflow Rates (l/s)	50	60	70	80	90	100	110	120
23°C Internal	Combined kW	0.88	1.03	1.17	1.29	1.40	1.49	1.57	1.62
	Supply air °C	14.3	14.8	15.2	15.7	16.2	16.7	17.2	17.8
24°C Internal	Combined kW	0.82	0.98	1.12	1.24	1.34	1.43	1.49	1.53
	Supply air °C	15.0	15.4	15.9	16.3	16.8	17.3	17.8	18.4
25°C Internal	Combined kW	0.80	0.95	1.07	1.18	1.27	1.34	1.39	1.43
	Supply air °C	15.5	15.9	16.4	16.9	17.4	18.0	18.5	19.1
26°C Internal	Combined kW	0.78	0.91	1.02	1.11	1.19	1.25	1.30	1.33
	Supply air °C	15.9	16.4	17.0	17.5	18.1	18.6	19.2	19.8

Option B – In addition to the MVHR (50 l/s), a dedicated Purge Ventilation Unit mechanically extracting an additional 50l/s within the bedroom areas during sleeping hours to improve thermal comfort for occupants. This amount of air can be extracted at an estimated 40% fan speed as per the performance graph below.



7.4 Internal Doors

Internal doors have been included and left open in the model in the daytime but are assumed to be closed when the occupants are sleeping as per TM59 assumptions.

7.5 Assumed Occupancy

Occupancy levels have been defined by schedules within the software, which have been written in line with the values set out in Figure 1 within CIBSE TM59. This table is attached as Appendix A at the end of this document.

7.6 Corridors

Any corridors have been modelled throughout apartment buildings to allow us to assess what temperatures they reach throughout the year. Communal corridor heat gains have been modelled based on calculated losses from pipework using the simplified method provided in Table 5 of the Domestic Building Services Compliance Guide (HMG,2013) - for these calculations, 28mm outside pipe diameter has been used

In line with CIBSE TM59, there are no pass or fail criteria, but it is to be noted within the report if the temperature exceeds 28˚C for more than 3% of the total annual hours.
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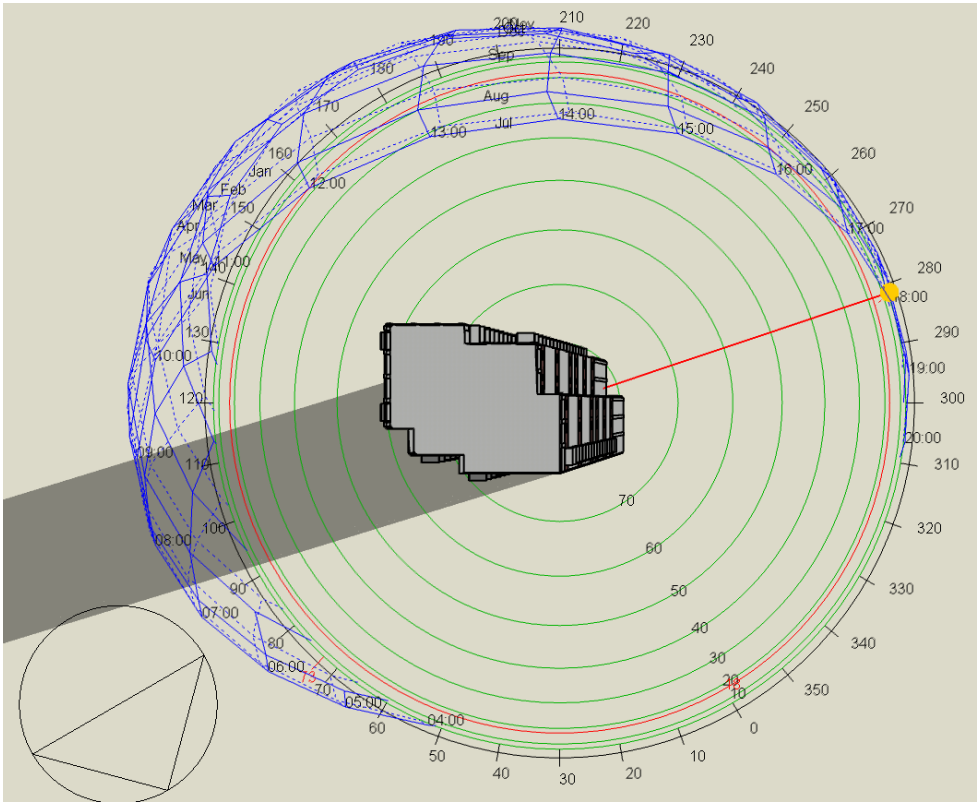
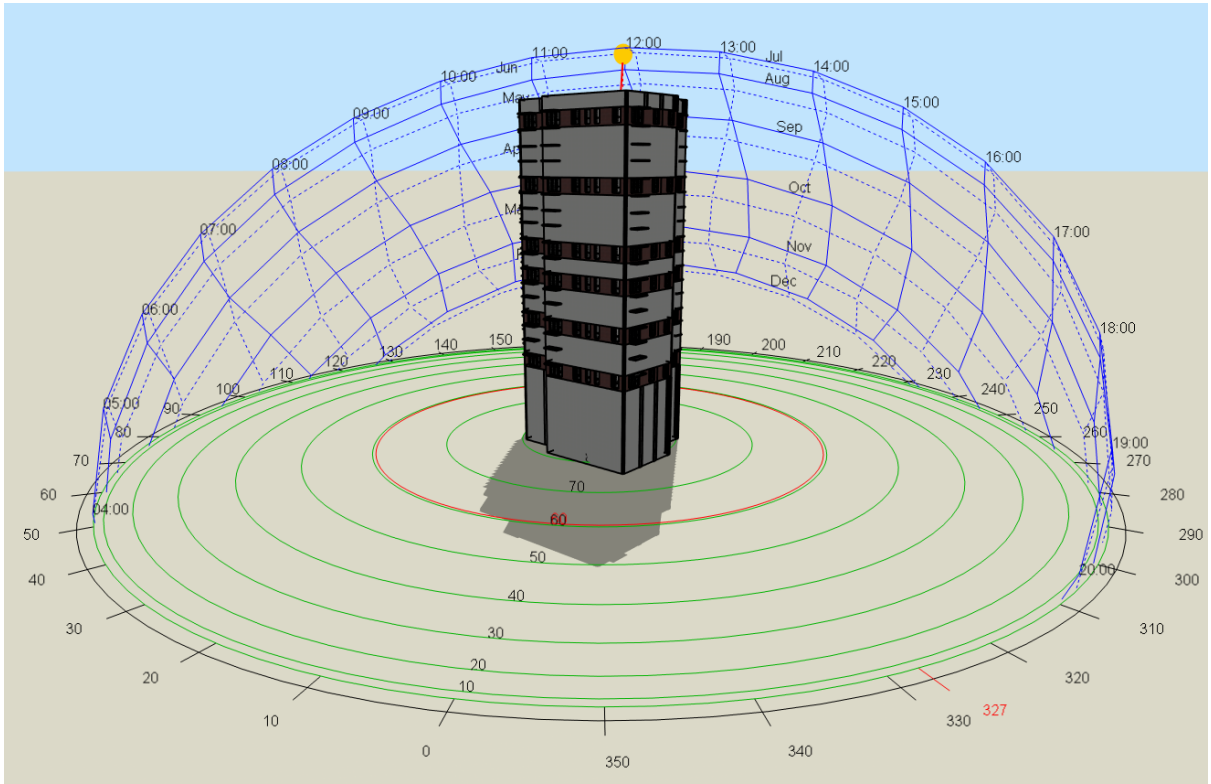
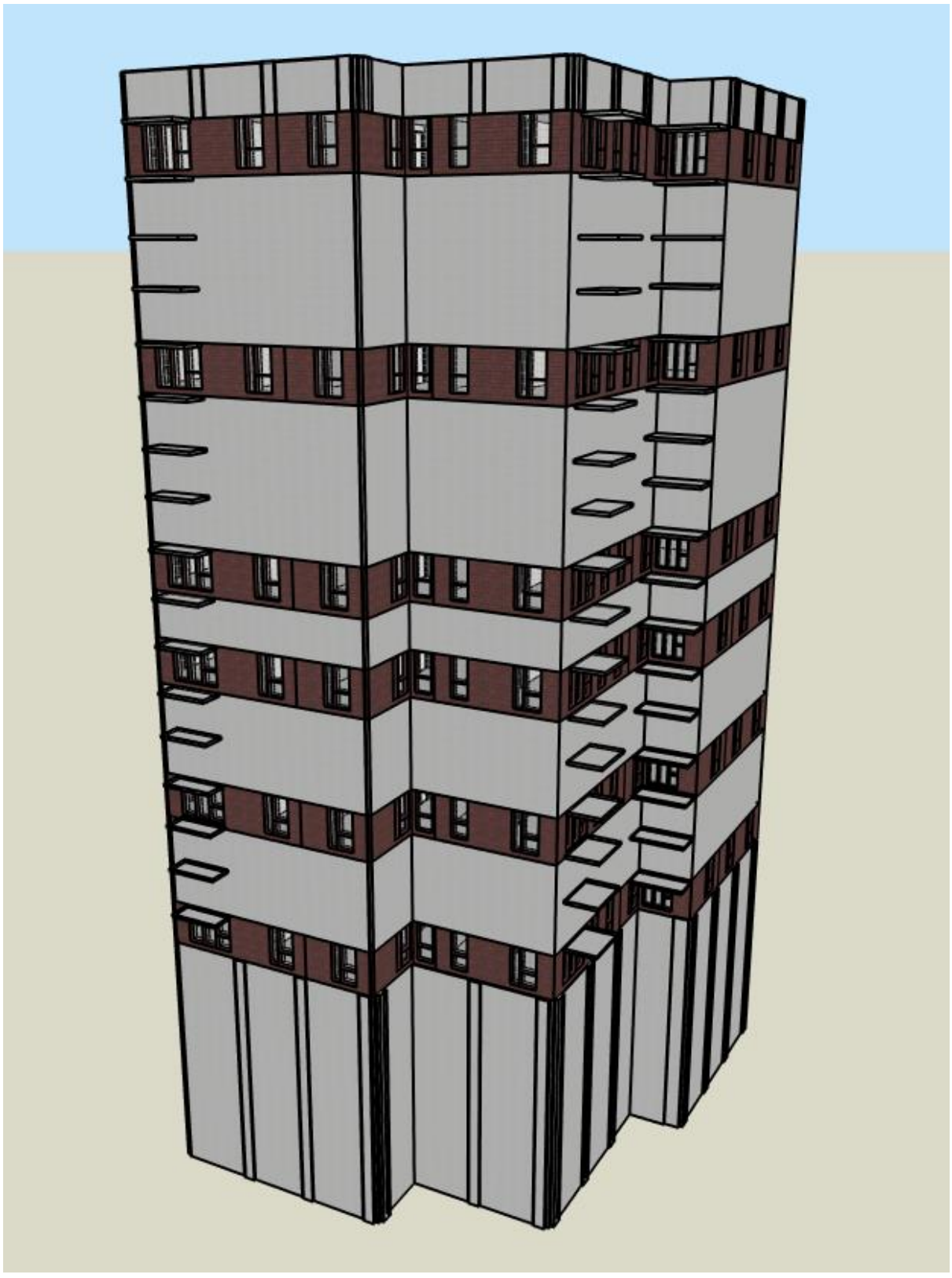
Table 1 Default heat losses from pipework (HMG, 2013; Table 5)

Outside diameter of pipe (mm)	Maximum heat loss per metre run of pipe (W/m)
8	7.06
10	7.23
12	7.35
15	7.89
22	9.12
28	10.07
35	11.08
42	12.19
54	14.12

8. 3D Visualisation







9. Results & Recommendations

The following results demonstrates a summary of for all assessed habitable rooms against the criteria of CIBSE TM59. Based on a notional specification, methodology and assumptions outlined within this report, the initial results demonstrated that many of the habitable living spaces were exceeding the stipulated level of thermal comfort as defined by TM59.

In order to address this, measures to reduce the level of overheating have been recommended as follows alongside two separate approaches:

- Natural ventilation has been provided to all dwellings through applicable openable windows (KitchenLivingAreas) but only operational during daytime hours and once the internal air temperature exceeds 22°C – a table has been provided previously to outline openable areas within dwellings.
- All residential glazing to benefit from a 0.37 g-value.
- The incorporation of passive design measures such as balconies, thermal mass (construction build ups) and large internal/external reveals to reduce solar gain.
    - **Natural Ventilation –** As previously mentioned, if utilising openable windows in all areas, then the development can be compliant with TM59 and AD-O criterion however due to acoustic constraints the below M&E solution has been introduced to mitigation overheating due to restricted ventilation.
    - **Option A** - Singular packaged 'Hybrid Cooling System' which combines an MVHR unit providing heat exchanger coolth recovery with DX cooling due to unopenable windows in bedroom areas.
    - **Option B** - A dedicated 'Purge Ventilation Unit' to bedroom areas allowing the rapid removal of stale, warm air from the dwelling to improve thermal comfort.

9.1 Natural Ventilation

Criteria for predominantly naturally ventilated homes

Block	Zone	Criterion A (%)	Criterion B (hr)	Pass/Fail
L11X1B2PX50X50M210	DOUBLEBEDROOM	0	21.17	Pass
L11X1B2PX50X50M210	LIVINGKITCHENDINING	0.08	N/A	Pass
L11X1B2PX50X50M211	DOUBLEBEDROOM	0	20.17	Pass
L11X1B2PX50X50M211	LIVINGKITCHENDINING	0.09	N/A	Pass
L11X1B2PX50X50M26	DOUBLEBEDROOM	0	21.5	Pass
L11X1B2PX50X50M26	LIVINGKITCHENDINING	0.03	N/A	Pass
L11X1B2PX50X50M27	DOUBLEBEDROOM	0	21.17	Pass
L11X1B2PX50X50M27	LIVINGKITCHENDINING	0.03	N/A	Pass
L11X1B2PX50X50M28	DOUBLEBEDROOM	0	21.33	Pass
L11X1B2PX50X50M28	LIVINGKITCHENDINING	0.08	N/A	Pass
L11X1B2PX50X50M29	DOUBLEBEDROOM	0	21.67	Pass
L11X1B2PX50X50M29	LIVINGKITCHENDINING	0.08	N/A	Pass

L11X1B2PX53X6M210	DOUBLEBEDROOM	0	24.5	Pass
L11X1B2PX53X6M210	KITCHENLIVINGDINING	0.39	N/A	Pass
L11X1B2PX53X6M211	DOUBLEBEDROOM	0	24	Pass
L11X1B2PX53X6M211	KITCHENLIVINGDINING	0.39	N/A	Pass
L11X1B2PX53X6M26	DOUBLEBEDROOM	0	25.5	Pass
L11X1B2PX53X6M26	KITCHENLIVINGDINING	0.47	N/A	Pass
L11X1B2PX53X6M27	DOUBLEBEDROOM	0	25.17	Pass
L11X1B2PX53X6M27	KITCHENLIVINGDINING	0.45	N/A	Pass
L11X1B2PX53X6M28	DOUBLEBEDROOM	0	25.17	Pass
L11X1B2PX53X6M28	KITCHENLIVINGDINING	0.44	N/A	Pass
L11X1B2PX53X6M29	DOUBLEBEDROOM	0	25	Pass
L11X1B2PX53X6M29	KITCHENLIVINGDINING	0.43	N/A	Pass
L11X2B3PX62X2M210	DOUBLEBEDROOM	0.03	24.67	Pass
L11X2B3PX62X2M210	KITCHENLIVINGDINING	0.45	N/A	Pass
L11X2B3PX62X2M210	SINGLEBEDROOM	0.17	27	Pass
L11X2B3PX62X2M211	DOUBLEBEDROOM	0.02	24.17	Pass
L11X2B3PX62X2M211	KITCHENLIVINGDINING	0.44	N/A	Pass
L11X2B3PX62X2M211	SINGLEBEDROOM	0.16	25.33	Pass
L11X2B3PX62X2M26	DOUBLEBEDROOM	0	25.83	Pass
L11X2B3PX62X2M26	KITCHENLIVINGDINING	0.49	N/A	Pass
L11X2B3PX62X2M26	SINGLEBEDROOM	0.17	29.17	Pass
L11X2B3PX62X2M27	DOUBLEBEDROOM	0	25	Pass
L11X2B3PX62X2M27	KITCHENLIVINGDINING	0.46	N/A	Pass
L11X2B3PX62X2M27	SINGLEBEDROOM	0.16	27.83	Pass
L11X2B3PX62X2M28	DOUBLEBEDROOM	0.02	25	Pass
L11X2B3PX62X2M28	KITCHENLIVINGDINING	0.45	N/A	Pass
L11X2B3PX62X2M28	SINGLEBEDROOM	0.15	27	Pass
L11X2B3PX62X2M29	DOUBLEBEDROOM	0.03	25.5	Pass
L11X2B3PX62X2M29	KITCHENLIVINGDINING	0.46	N/A	Pass
L11X2B3PX62X2M29	SINGLEBEDROOM	0.15	27.5	Pass
L11X3B4PX86X0M210	DOUBLEBEDROOM	0.13	25.17	Pass
L11X3B4PX86X0M210	DOUBLEBEDROOM1	0.1	25.67	Pass
L11X3B4PX86X0M210	KITCHENLIVINGDINING	0.45	N/A	Pass
L11X3B4PX86X0M210	SINGLEBEDROOM	0.22	24	Pass
L11X3B4PX86X0M211	DOUBLEBEDROOM	0.13	25.33	Pass
L11X3B4PX86X0M211	DOUBLEBEDROOM1	0.1	24.83	Pass
L11X3B4PX86X0M211	KITCHENLIVINGDINING	0.41	N/A	Pass
L11X3B4PX86X0M211	SINGLEBEDROOM	0.22	23.67	Pass
L11X3B4PX86X0M26	DOUBLEBEDROOM	0.13	28.5	Pass
L11X3B4PX86X0M26	DOUBLEBEDROOM1	0.07	26.33	Pass
L11X3B4PX86X0M26	KITCHENLIVINGDINING	0.33	N/A	Pass
L11X3B4PX86X0M26	SINGLEBEDROOM	0.22	26.33	Pass
L11X3B4PX86X0M27	DOUBLEBEDROOM	0.13	27.67	Pass
L11X3B4PX86X0M27	DOUBLEBEDROOM1	0.08	25.17	Pass
L11X3B4PX86X0M27	KITCHENLIVINGDINING	0.39	N/A	Pass
L11X3B4PX86X0M27	SINGLEBEDROOM	0.21	25.33	Pass

L11X3B4PX86X0M28	DOUBLEBEDROOM	0.13	26.67	Pass
L11X3B4PX86X0M28	DOUBLEBEDROOM1	0.1	25.83	Pass
L11X3B4PX86X0M28	KITCHENLIVINGDINING	0.47	N/A	Pass
L11X3B4PX86X0M28	SINGLEBEDROOM	0.24	25.33	Pass
L11X3B4PX86X0M29	DOUBLEBEDROOM	0.13	26.17	Pass
L11X3B4PX86X0M29	DOUBLEBEDROOM1	0.1	26.33	Pass
L11X3B4PX86X0M29	KITCHENLIVINGDINING	0.48	N/A	Pass
L11X3B4PX86X0M29	SINGLEBEDROOM	0.24	25	Pass
L11XPLOT1X1B2P10	DOUBLEBEDROOM	0	24	Pass
L11XPLOT1X1B2P10	KITCHENLIVINGDINING	0.28	N/A	Pass
L11XPLOT1X1B2P11	DOUBLEBEDROOM	0	23.5	Pass
L11XPLOT1X1B2P11	KITCHENLIVINGDINING	0.27	N/A	Pass
L11XPLOT1X1B2P6	DOUBLEBEDROOM	0	24.5	Pass
L11XPLOT1X1B2P6	KITCHENLIVINGDINING	0.33	N/A	Pass
L11XPLOT1X1B2P7	DOUBLEBEDROOM	0	24.33	Pass
L11XPLOT1X1B2P7	KITCHENLIVINGDINING	0.31	N/A	Pass
L11XPLOT1X1B2P8	DOUBLEBEDROOM	0	23.83	Pass
L11XPLOT1X1B2P8	KITCHENLIVINGDINING	0.31	N/A	Pass
L11XPLOT1X1B2P9	DOUBLEBEDROOM	0	24	Pass
L11XPLOT1X1B2P9	KITCHENLIVINGDINING	0.31	N/A	Pass
L11XPLOT2X2B4P10	DOUBLEBEDROOM1	0	24.5	Pass
L11XPLOT2X2B4P10	DOUBLEBEDROOM2	0.03	26.17	Pass
L11XPLOT2X2B4P10	KITCHENLIVINGDINING	0.28	N/A	Pass
L11XPLOT2X2B4P11	DOUBLEBEDROOM1	0	23.67	Pass
L11XPLOT2X2B4P11	DOUBLEBEDROOM2	0.03	25.83	Pass
L11XPLOT2X2B4P11	KITCHENLIVINGDINING	0.27	N/A	Pass
L11XPLOT2X2B4P6	DOUBLEBEDROOM1	0	24.67	Pass
L11XPLOT2X2B4P6	DOUBLEBEDROOM2	0	26.17	Pass
L11XPLOT2X2B4P6	KITCHENLIVINGDINING	0.28	N/A	Pass
L11XPLOT2X2B4P7	DOUBLEBEDROOM1	0	25	Pass
L11XPLOT2X2B4P7	DOUBLEBEDROOM2	0.02	26.33	Pass
L11XPLOT2X2B4P7	KITCHENLIVINGDINING	0.28	N/A	Pass
L11XPLOT2X2B4P8	DOUBLEBEDROOM1	0	25.33	Pass
L11XPLOT2X2B4P8	DOUBLEBEDROOM2	0.03	26.83	Pass
L11XPLOT2X2B4P8	KITCHENLIVINGDINING	0.3	N/A	Pass
L11XPLOT2X2B4P9	DOUBLEBEDROOM1	0	25.33	Pass
L11XPLOT2X2B4P9	DOUBLEBEDROOM2	0.03	26.67	Pass
L11XPLOT2X2B4P9	KITCHENLIVINGDINING	0.3	N/A	Pass
L11XPLOT3X2B3PW10	DOUBLEBEDROOM	0.18	31.33	Pass
L11XPLOT3X2B3PW10	KITCHENLIVINGDINING	0.59	N/A	Pass
L11XPLOT3X2B3PW10	SINGLEBEDROOM	0.1	24	Pass
L11XPLOT3X2B3PW11	DOUBLEBEDROOM	0.16	31.33	Pass
L11XPLOT3X2B3PW11	KITCHENLIVINGDINING	0.55	N/A	Pass
L11XPLOT3X2B3PW11	SINGLEBEDROOM	0.1	23.5	Pass
L11XPLOT3X2B3PW6	DOUBLEBEDROOM	0.11	31.5	Pass
L11XPLOT3X2B3PW6	KITCHENLIVINGDINING	0.59	N/A	Pass

L11XPLOT3X2B3PW6	SINGLEBEDROOM	0.09	27.33	Pass
L11XPLOT3X2B3PW7	DOUBLEBEDROOM	0.12	31.17	Pass
L11XPLOT3X2B3PW7	KITCHENLIVINGDINING	0.59	N/A	Pass
L11XPLOT3X2B3PW7	SINGLEBEDROOM	0.1	26.33	Pass
L11XPLOT3X2B3PW8	DOUBLEBEDROOM	0.14	31.67	Pass
L11XPLOT3X2B3PW8	KITCHENLIVINGDINING	0.59	N/A	Pass
L11XPLOT3X2B3PW8	SINGLEBEDROOM	0.11	25.5	Pass
L11XPLOT3X2B3PW9	DOUBLEBEDROOM	0.18	31.55	Pass
L11XPLOT3X2B3PW9	KITCHENLIVINGDINING	0.59	N/A	Pass
L11XPLOT3X2B3PW9	SINGLEBEDROOM	0.11	25.17	Pass
L11XPLOT4X1B2P10	DOUBLEBEDROOM	0	19.83	Pass
L11XPLOT4X1B2P10	KITCHENLIVINGDINING	0	N/A	Pass
L11XPLOT4X1B2P11	DOUBLEBEDROOM	0	19.5	Pass
L11XPLOT4X1B2P11	KITCHENLIVINGDINING	0	N/A	Pass
L11XPLOT4X1B2P6	DOUBLEBEDROOM	0	22.67	Pass
L11XPLOT4X1B2P6	KITCHENLIVINGDINING	0.03	N/A	Pass
L11XPLOT4X1B2P7	DOUBLEBEDROOM	0	21.67	Pass
L11XPLOT4X1B2P7	KITCHENLIVINGDINING	0	N/A	Pass
L11XPLOT4X1B2P8	DOUBLEBEDROOM	0	21.33	Pass
L11XPLOT4X1B2P8	KITCHENLIVINGDINING	0	N/A	Pass
L11XPLOT4X1B2P9	DOUBLEBEDROOM	0	20.5	Pass
L11XPLOT4X1B2P9	KITCHENLIVINGDINING	0	N/A	Pass

9.2 Option A – Hybrid Cooling System

Criteria for predominantly naturally ventilated homes

Block	Zone	Criterion A (%)	Criterion B (hr)	Pass/Fail
L11X1B2PX50X50M210	LIVINGKITCHENDINING	0	N/A	Pass
L11X1B2PX50X50M211	LIVINGKITCHENDINING	0	N/A	Pass
L11X1B2PX50X50M26	LIVINGKITCHENDINING	0	N/A	Pass
L11X1B2PX50X50M27	LIVINGKITCHENDINING	0	N/A	Pass
L11X1B2PX50X50M28	LIVINGKITCHENDINING	0	N/A	Pass
L11X1B2PX50X50M29	LIVINGKITCHENDINING	0	N/A	Pass
L11X1B2PX53X6M210	KITCHENLIVINGDINING	0.37	N/A	Pass
L11X1B2PX53X6M211	KITCHENLIVINGDINING	0.37	N/A	Pass
L11X1B2PX53X6M26	KITCHENLIVINGDINING	0.42	N/A	Pass
L11X1B2PX53X6M27	KITCHENLIVINGDINING	0.42	N/A	Pass
L11X1B2PX53X6M28	KITCHENLIVINGDINING	0.4	N/A	Pass
L11X1B2PX53X6M29	KITCHENLIVINGDINING	0.39	N/A	Pass
L11X2B3PX62X2M210	KITCHENLIVINGDINING	0.28	N/A	Pass
L11X2B3PX62X2M211	KITCHENLIVINGDINING	0.27	N/A	Pass
L11X2B3PX62X2M26	KITCHENLIVINGDINING	0.11	N/A	Pass
L11X2B3PX62X2M27	KITCHENLIVINGDINING	0.3	N/A	Pass
L11X2B3PX62X2M28	KITCHENLIVINGDINING	0.28	N/A	Pass
L11X2B3PX62X2M29	KITCHENLIVINGDINING	0.3	N/A	Pass
L11X3B4PX86X0M210	KITCHENLIVINGDINING	0.34	N/A	Pass
L11X3B4PX86X0M211	KITCHENLIVINGDINING	0.28	N/A	Pass
L11X3B4PX86X0M26	KITCHENLIVINGDINING	0.26	N/A	Pass
L11X3B4PX86X0M27	KITCHENLIVINGDINING	0.27	N/A	Pass
L11X3B4PX86X0M28	KITCHENLIVINGDINING	0.34	N/A	Pass
L11X3B4PX86X0M29	KITCHENLIVINGDINING	0.37	N/A	Pass
L11XPLOT1X1B2P10	KITCHENLIVINGDINING	0.23	N/A	Pass
L11XPLOT1X1B2P11	KITCHENLIVINGDINING	0.23	N/A	Pass
L11XPLOT1X1B2P6	KITCHENLIVINGDINING	0.27	N/A	Pass
L11XPLOT1X1B2P7	KITCHENLIVINGDINING	0.27	N/A	Pass
L11XPLOT1X1B2P8	KITCHENLIVINGDINING	0.27	N/A	Pass
L11XPLOT1X1B2P9	KITCHENLIVINGDINING	0.26	N/A	Pass
L11XPLOT2X2B4P10	KITCHENLIVINGDINING	0.35	N/A	Pass
L11XPLOT2X2B4P11	KITCHENLIVINGDINING	0.34	N/A	Pass
L11XPLOT2X2B4P6	KITCHENLIVINGDINING	0.38	N/A	Pass
L11XPLOT2X2B4P7	KITCHENLIVINGDINING	0.39	N/A	Pass
L11XPLOT2X2B4P8	KITCHENLIVINGDINING	0.39	N/A	Pass
L11XPLOT2X2B4P9	KITCHENLIVINGDINING	0.39	N/A	Pass
L11XPLOT3X2B3PW10	KITCHENLIVINGDINING	0.59	N/A	Pass
L11XPLOT3X2B3PW11	KITCHENLIVINGDINING	0.56	N/A	Pass
L11XPLOT3X2B3PW6	KITCHENLIVINGDINING	0.59	N/A	Pass
L11XPLOT3X2B3PW7	KITCHENLIVINGDINING	0.59	N/A	Pass
L11XPLOT3X2B3PW8	KITCHENLIVINGDINING	0.6	N/A	Pass

L11XPLOT3X2B3PW9	KITCHENLIVINGDINING	0.6	N/A	Pass
L11XPLOT4X1B2P10	KITCHENLIVINGDINING	0	N/A	Pass
L11XPLOT4X1B2P11	KITCHENLIVINGDINING	0	N/A	Pass
L11XPLOT4X1B2P6	KITCHENLIVINGDINING	0	N/A	Pass
L11XPLOT4X1B2P7	KITCHENLIVINGDINING	0	N/A	Pass
L11XPLOT4X1B2P8	KITCHENLIVINGDINING	0	N/A	Pass
L11XPLOT4X1B2P9	KITCHENLIVINGDINING	0	N/A	Pass

Criteria for predominantly mechanically ventilated homes

Block	Zone	% Hours Exceeded	Pass/Fail
L11X1B2PX50X50M210	DOUBLEBEDROOM	1	Pass
L11X1B2PX50X50M211	DOUBLEBEDROOM	1.01	Pass
L11X1B2PX50X50M26	DOUBLEBEDROOM	0.87	Pass
L11X1B2PX50X50M27	DOUBLEBEDROOM	0.9	Pass
L11X1B2PX50X50M28	DOUBLEBEDROOM	0.96	Pass
L11X1B2PX50X50M29	DOUBLEBEDROOM	1.02	Pass
L11X1B2PX53X6M210	DOUBLEBEDROOM	1.35	Pass
L11X1B2PX53X6M211	DOUBLEBEDROOM	1.35	Pass
L11X1B2PX53X6M26	DOUBLEBEDROOM	1.37	Pass
L11X1B2PX53X6M27	DOUBLEBEDROOM	1.39	Pass
L11X1B2PX53X6M28	DOUBLEBEDROOM	1.38	Pass
L11X1B2PX53X6M29	DOUBLEBEDROOM	1.37	Pass
L11X2B3PX62X2M210	DOUBLEBEDROOM	1.15	Pass
L11X2B3PX62X2M210	SINGLEBEDROOM	2.87	Pass
L11X2B3PX62X2M211	DOUBLEBEDROOM	1.14	Pass
L11X2B3PX62X2M211	SINGLEBEDROOM	2.71	Pass
L11X2B3PX62X2M26	DOUBLEBEDROOM	0.74	Pass
L11X2B3PX62X2M26	SINGLEBEDROOM	1.95	Pass
L11X2B3PX62X2M27	DOUBLEBEDROOM	1.03	Pass
L11X2B3PX62X2M27	SINGLEBEDROOM	2.94	Pass
L11X2B3PX62X2M28	DOUBLEBEDROOM	1.1	Pass
L11X2B3PX62X2M28	SINGLEBEDROOM	2.89	Pass
L11X2B3PX62X2M29	DOUBLEBEDROOM	1.16	Pass
L11X2B3PX62X2M29	SINGLEBEDROOM	2.86	Pass
L11X3B4PX86X0M210	DOUBLEBEDROOM	1.32	Pass
L11X3B4PX86X0M210	DOUBLEBEDROOM1	1.89	Pass
L11X3B4PX86X0M210	SINGLEBEDROOM	2.89	Pass
L11X3B4PX86X0M211	DOUBLEBEDROOM	1.3	Pass
L11X3B4PX86X0M211	DOUBLEBEDROOM1	1.88	Pass
L11X3B4PX86X0M211	SINGLEBEDROOM	2.84	Pass
L11X3B4PX86X0M26	DOUBLEBEDROOM	1.32	Pass
L11X3B4PX86X0M26	DOUBLEBEDROOM1	1.34	Pass
L11X3B4PX86X0M26	SINGLEBEDROOM	2.9	Pass
L11X3B4PX86X0M27	DOUBLEBEDROOM	1.32	Pass
L11X3B4PX86X0M27	DOUBLEBEDROOM1	1.46	Pass

L11X3B4PX86X0M27	SINGLEBEDROOM	2.91	Pass
L11X3B4PX86X0M28	DOUBLEBEDROOM	1.33	Pass
L11X3B4PX86X0M28	DOUBLEBEDROOM1	1.69	Pass
L11X3B4PX86X0M28	SINGLEBEDROOM	2.93	Pass
L11X3B4PX86X0M29	DOUBLEBEDROOM	1.34	Pass
L11X3B4PX86X0M29	DOUBLEBEDROOM1	1.9	Pass
L11X3B4PX86X0M29	SINGLEBEDROOM	2.94	Pass
L11XPLOT1X1B2P10	DOUBLEBEDROOM	1.26	Pass
L11XPLOT1X1B2P11	DOUBLEBEDROOM	1.25	Pass
L11XPLOT1X1B2P6	DOUBLEBEDROOM	1.33	Pass
L11XPLOT1X1B2P7	DOUBLEBEDROOM	1.31	Pass
L11XPLOT1X1B2P8	DOUBLEBEDROOM	1.31	Pass
L11XPLOT1X1B2P9	DOUBLEBEDROOM	1.3	Pass
L11XPLOT2X2B4P10	DOUBLEBEDROOM1	1.37	Pass
L11XPLOT2X2B4P10	DOUBLEBEDROOM2	2.25	Pass
L11XPLOT2X2B4P11	DOUBLEBEDROOM1	1.34	Pass
L11XPLOT2X2B4P11	DOUBLEBEDROOM2	2.21	Pass
L11XPLOT2X2B4P6	DOUBLEBEDROOM1	1.15	Pass
L11XPLOT2X2B4P6	DOUBLEBEDROOM2	1.83	Pass
L11XPLOT2X2B4P7	DOUBLEBEDROOM1	1.25	Pass
L11XPLOT2X2B4P7	DOUBLEBEDROOM2	2.05	Pass
L11XPLOT2X2B4P8	DOUBLEBEDROOM1	1.32	Pass
L11XPLOT2X2B4P8	DOUBLEBEDROOM2	2.19	Pass
L11XPLOT2X2B4P9	DOUBLEBEDROOM1	1.36	Pass
L11XPLOT2X2B4P9	DOUBLEBEDROOM2	2.26	Pass
L11XPLOT3X2B3PW10	DOUBLEBEDROOM	2.67	Pass
L11XPLOT3X2B3PW10	SINGLEBEDROOM	2.45	Pass
L11XPLOT3X2B3PW11	DOUBLEBEDROOM	2.59	Pass
L11XPLOT3X2B3PW11	SINGLEBEDROOM	2.4	Pass
L11XPLOT3X2B3PW6	DOUBLEBEDROOM	2.05	Pass
L11XPLOT3X2B3PW6	SINGLEBEDROOM	2.31	Pass
L11XPLOT3X2B3PW7	DOUBLEBEDROOM	2.42	Pass
L11XPLOT3X2B3PW7	SINGLEBEDROOM	2.48	Pass
L11XPLOT3X2B3PW8	DOUBLEBEDROOM	2.56	Pass
L11XPLOT3X2B3PW8	SINGLEBEDROOM	2.48	Pass
L11XPLOT3X2B3PW9	DOUBLEBEDROOM	2.65	Pass
L11XPLOT3X2B3PW9	SINGLEBEDROOM	2.48	Pass
L11XPLOT4X1B2P10	DOUBLEBEDROOM	1.19	Pass
L11XPLOT4X1B2P11	DOUBLEBEDROOM	1.17	Pass
L11XPLOT4X1B2P6	DOUBLEBEDROOM	0.78	Pass
L11XPLOT4X1B2P7	DOUBLEBEDROOM	1.32	Pass
L11XPLOT4X1B2P8	DOUBLEBEDROOM	1.29	Pass
L11XPLOT4X1B2P9	DOUBLEBEDROOM	1.19	Pass

9.3 Option B – Purge Ventilation Unit

Criteria for predominantly naturally ventilated homes

Block	Zone	Criterion A (%)	Criterion B (hr)	Pass/Fail
L11X1B2PX50X50M210	LIVINGKITCHENDINING	0	N/A	Pass
L11X1B2PX50X50M26	LIVINGKITCHENDINING	0	N/A	Pass
L11X1B2PX50X50M27	LIVINGKITCHENDINING	0	N/A	Pass
L11X1B2PX50X50M28	LIVINGKITCHENDINING	0	N/A	Pass
L11X1B2PX50X50M29	LIVINGKITCHENDINING	0	N/A	Pass
L11X1B2PX53X6M210	KITCHENLIVINGDINING	0.38	N/A	Pass
L11X1B2PX53X6M26	KITCHENLIVINGDINING	0.44	N/A	Pass
L11X1B2PX53X6M27	KITCHENLIVINGDINING	0.44	N/A	Pass
L11X1B2PX53X6M28	KITCHENLIVINGDINING	0.43	N/A	Pass
L11X1B2PX53X6M29	KITCHENLIVINGDINING	0.57	N/A	Pass
L11X2B3PX62X2M210	KITCHENLIVINGDINING	0.08	N/A	Pass
L11X2B3PX62X2M26	KITCHENLIVINGDINING	0.09	N/A	Pass
L11X2B3PX62X2M27	KITCHENLIVINGDINING	0.42	N/A	Pass
L11X2B3PX62X2M28	KITCHENLIVINGDINING	0.39	N/A	Pass
L11X2B3PX62X2M29	KITCHENLIVINGDINING	0.36	N/A	Pass
L11X3B4PX86X0M210	KITCHENLIVINGDINING	0.78	N/A	Pass
L11X3B4PX86X0M26	KITCHENLIVINGDINING	0.28	N/A	Pass
L11X3B4PX86X0M27	KITCHENLIVINGDINING	0.32	N/A	Pass
L11X3B4PX86X0M28	KITCHENLIVINGDINING	0.33	N/A	Pass
L11X3B4PX86X0M29	KITCHENLIVINGDINING	0.23	N/A	Pass
L11XPLOT1X1B2P10	KITCHENLIVINGDINING	0.26	N/A	Pass
L11XPLOT1X1B2P6	KITCHENLIVINGDINING	0.28	N/A	Pass
L11XPLOT1X1B2P7	KITCHENLIVINGDINING	0.33	N/A	Pass
L11XPLOT1X1B2P8	KITCHENLIVINGDINING	0.33	N/A	Pass
L11XPLOT1X1B2P9	KITCHENLIVINGDINING	0.28	N/A	Pass
L11XPLOT2X2B4P10	KITCHENLIVINGDINING	0.16	N/A	Pass
L11XPLOT2X2B4P6	KITCHENLIVINGDINING	0.39	N/A	Pass
L11XPLOT2X2B4P7	KITCHENLIVINGDINING	0.41	N/A	Pass
L11XPLOT2X2B4P8	KITCHENLIVINGDINING	0.41	N/A	Pass
L11XPLOT2X2B4P9	KITCHENLIVINGDINING	0.55	N/A	Pass
L11XPLOT3X2B3PW10	KITCHENLIVINGDINING	0.38	N/A	Pass
L11XPLOT3X2B3PW6	KITCHENLIVINGDINING	0.59	N/A	Pass
L11XPLOT3X2B3PW7	KITCHENLIVINGDINING	0.58	N/A	Pass
L11XPLOT3X2B3PW8	KITCHENLIVINGDINING	0.59	N/A	Pass
L11XPLOT3X2B3PW9	KITCHENLIVINGDINING	1.22	N/A	Pass
L11XPLOT4X1B2P10	KITCHENLIVINGDINING	0	N/A	Pass
L11XPLOT4X1B2P6	KITCHENLIVINGDINING	0	N/A	Pass
L11XPLOT4X1B2P7	KITCHENLIVINGDINING	0	N/A	Pass
L11XPLOT4X1B2P8	KITCHENLIVINGDINING	0	N/A	Pass
L11XPLOT4X1B2P9	KITCHENLIVINGDINING	0	N/A	Pass

Criteria for predominantly mechanically ventilated homes

Block	Zone	% Hours Exceeded	Pass/Fail
L11X1B2PX50X50M210	DOUBLEBEDROOM	1.05	Pass
L11X1B2PX50X50M26	DOUBLEBEDROOM	1.58	Pass
L11X1B2PX50X50M27	DOUBLEBEDROOM	1.27	Pass
L11X1B2PX50X50M28	DOUBLEBEDROOM	1.3	Pass
L11X1B2PX50X50M29	DOUBLEBEDROOM	1.25	Pass
L11X1B2PX53X6M210	DOUBLEBEDROOM	2.23	Pass
L11X1B2PX53X6M26	DOUBLEBEDROOM	2.17	Pass
L11X1B2PX53X6M27	DOUBLEBEDROOM	1.46	Pass
L11X1B2PX53X6M28	DOUBLEBEDROOM	1.45	Pass
L11X1B2PX53X6M29	DOUBLEBEDROOM	2.02	Pass
L11X2B3PX62X2M210	DOUBLEBEDROOM	1.12	Pass
L11X2B3PX62X2M210	SINGLEBEDROOM	1.86	Pass
L11X2B3PX62X2M26	DOUBLEBEDROOM	1.1	Pass
L11X2B3PX62X2M26	SINGLEBEDROOM	2.1	Pass
L11X2B3PX62X2M27	DOUBLEBEDROOM	1.28	Pass
L11X2B3PX62X2M27	SINGLEBEDROOM	2.67	Pass
L11X2B3PX62X2M28	DOUBLEBEDROOM	1.29	Pass
L11X2B3PX62X2M28	SINGLEBEDROOM	2.59	Pass
L11X2B3PX62X2M29	DOUBLEBEDROOM	1.25	Pass
L11X2B3PX62X2M29	SINGLEBEDROOM	2.48	Pass
L11X3B4PX86X0M210	DOUBLEBEDROOM	1.96	Pass
L11X3B4PX86X0M210	DOUBLEBEDROOM1	2.15	Pass
L11X3B4PX86X0M210	SINGLEBEDROOM	2.66	Pass
L11X3B4PX86X0M26	DOUBLEBEDROOM	1.95	Pass
L11X3B4PX86X0M26	DOUBLEBEDROOM1	1.83	Pass
L11X3B4PX86X0M26	SINGLEBEDROOM	2.7	Pass
L11X3B4PX86X0M27	DOUBLEBEDROOM	1.31	Pass
L11X3B4PX86X0M27	DOUBLEBEDROOM1	1.28	Pass
L11X3B4PX86X0M27	SINGLEBEDROOM	1.5	Pass
L11X3B4PX86X0M28	DOUBLEBEDROOM	1.3	Pass
L11X3B4PX86X0M28	DOUBLEBEDROOM1	1.3	Pass
L11X3B4PX86X0M28	SINGLEBEDROOM	1.48	Pass
L11X3B4PX86X0M29	DOUBLEBEDROOM	1.27	Pass
L11X3B4PX86X0M29	DOUBLEBEDROOM1	1.3	Pass
L11X3B4PX86X0M29	SINGLEBEDROOM	1.41	Pass
L11XPLOT1X1B2P10	DOUBLEBEDROOM	2.13	Pass
L11XPLOT1X1B2P6	DOUBLEBEDROOM	2.2	Pass
L11XPLOT1X1B2P7	DOUBLEBEDROOM	1.51	Pass
L11XPLOT1X1B2P8	DOUBLEBEDROOM	1.49	Pass
L11XPLOT1X1B2P9	DOUBLEBEDROOM	1.46	Pass
L11XPLOT2X2B4P10	DOUBLEBEDROOM1	1.23	Pass
L11XPLOT2X2B4P10	DOUBLEBEDROOM2	1.39	Pass
L11XPLOT2X2B4P6	DOUBLEBEDROOM1	1.92	Pass
L11XPLOT2X2B4P6	DOUBLEBEDROOM2	2.53	Pass

L11XPLOT2X2B4P7	DOUBLEBEDROOM1	1.43	Pass
L11XPLOT2X2B4P7	DOUBLEBEDROOM2	1.52	Pass
L11XPLOT2X2B4P8	DOUBLEBEDROOM1	1.45	Pass
L11XPLOT2X2B4P8	DOUBLEBEDROOM2	1.54	Pass
L11XPLOT2X2B4P9	DOUBLEBEDROOM1	2.39	Pass
L11XPLOT2X2B4P9	DOUBLEBEDROOM2	2.85	Pass
L11XPLOT3X2B3PW10	DOUBLEBEDROOM	1.48	Pass
L11XPLOT3X2B3PW10	SINGLEBEDROOM	1.4	Pass
L11XPLOT3X2B3PW6	DOUBLEBEDROOM	2.72	Pass
L11XPLOT3X2B3PW6	SINGLEBEDROOM	2.69	Pass
L11XPLOT3X2B3PW7	DOUBLEBEDROOM	1.58	Pass
L11XPLOT3X2B3PW7	SINGLEBEDROOM	1.59	Pass
L11XPLOT3X2B3PW8	DOUBLEBEDROOM	1.58	Pass
L11XPLOT3X2B3PW8	SINGLEBEDROOM	1.59	Pass
L11XPLOT3X2B3PW9	DOUBLEBEDROOM	2.94	Pass
L11XPLOT3X2B3PW9	SINGLEBEDROOM	2.75	Pass
L11XPLOT4X1B2P10	DOUBLEBEDROOM	1.13	Pass
L11XPLOT4X1B2P6	DOUBLEBEDROOM	1.21	Pass
L11XPLOT4X1B2P7	DOUBLEBEDROOM	1.31	Pass
L11XPLOT4X1B2P8	DOUBLEBEDROOM	1.28	Pass
L11XPLOT4X1B2P9	DOUBLEBEDROOM	1.88	Pass

9.4 Corridor Results

	Criteria for corridors	
Zone	**% Hours Exceeded**	**Pass/Fail**
ZONE1	0.5	Pass
ZONE1	0.51	Pass
ZONE1	0.72	Pass
ZONE1	0.73	Pass
ZONE1	0.75	Pass
ZONE1	0.61	Pass
ZONE1	0.67	Pass
ZONE1	0.58	Pass
ZONE1	0.54	Pass
ZONE1	0.54	Pass
ZONE1	0.54	Pass
ZONE1	0.54	Pass
ZONE1	0.53	Pass
ZONE1	0.54	Pass
ZONE1	0.54	Pass
ZONE1	0.53	Pass
ZONE1	0.58	Pass

10. Conclusion

- The results have represented a significant number of dwellings in Plot 3A at Bollo Lane, Acton which provides a thorough analysis of overheating and the measures implemented to alleviate this issue.
- This assessment has been undertaken in accordance with CIBSE TM59 methodology which aligns with room profiles, equipment, lighting, and occupancy gains.
- The modelling has been conducted using weather data for London Heathrow (LHR) – Design Summer Year 1 (DSY1 – 2020, high emission, 50% percentile scenario).
- The results of the initial modelling indicated that during peak summertime conditions some dwellings failed to maintain acceptable levels of thermal comfort, with many zones failing to meet more than one of the CIBSE TM59 criteria.
- To address this, the following improvement measures have been implemented to demonstrate compliance for each dwelling utilising both TM59 Compliance Criterion as previously discussed to maintain acceptable levels of thermal comfort.
    - All residential glazing to benefit from a 0.37 g-value
    - Incorporation of passive design measures throughout the building such as balconies, thermal mass (construction build ups) and large internal/external reveals.
    - Natural ventilation has been provided to all 'KitchenLivingDining' areas through openable windows during occupied, daytime hours which demonstrates compliance with '***Criteria for homes predominantly naturally ventilated'*** for these areas.
        - *For living rooms, kitchens and bedrooms: the number of hours during which DT is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3 percent of occupied hours. (CIBSE TM52 Criterion 1: Hours of exceedance).*
        - *For bedrooms only: to guarantee comfort during the sleeping hours the operative temperature in the bedroom from 10 pm to 7 am shall not exceed 26 °C for more than 1% of annual hours. (Note: 1% of the annual hours between 22:00 and 07:00 for bedrooms is 32 hours, so 33 or more hours above 26 °C will be recorded as a fail).*
    - Both '**Option A'** and '**Option B**' have been assessed against '***Criteria for homes predominantly mechanically ventilated'***. as acoustic constraints do not allow for openable windows in bedroom areas. Both proposed options incorporate improved measures above the consented Energy Strategy:
        - *For homes with restricted window openings, the CIBSE fixed temperature test must be followed, i.e. all occupied rooms should not exceed an operative temperature of 26 ˚C for more than 3% of the annual occupied annual hours (CIBSE Guide A (2015a))*
        - **Option A** - 'Hybrid Cooling System' which allows summer cooling to mitigate overheating.
        - **Option B** - 'Purge Ventilation Unit' that allows the rapid removal of stale, warm air from the bedroom areas during sleeping hours.

Appendix A – CIBSE TM59 Occupancy Patterns

Figure 1 Heat gain profile

Number of people	Description	Peak load (W)		Period																							
		Sensible	Latent	00–01	01–02	02–03	03–04	04–05	05–06	06–07	07–08	08–09	09–10	10–11	11–12	12–13	13–14	14–15	15–16	16–17	17–18	18–19	19–20	20–21	21–22	22–23	23–24
				Hour ending																							
				1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00
1	Single bedroom occupancy	75	55	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.7
2	Double bedroom cccupancy	150	110	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.7
2	Studio occupancy	150	110	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.7
1	1-bedroom living/kitchen occupancy	75	55	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
1	1-bedroom living occupancy	75	55	0	0	0	0	0	0	0	0	0	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0	0
1	1-bedroom kitchen occupancy	75	55	0	0	0	0	0	0	0	0	0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0
2	2-bedroom living/kitchen occupancy	150	110	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
2	2-bedroom living occupancy	150	110	0	0	0	0	0	0	0	0	0	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0	0
2	2-bedroom kitchen occupancy	150	110	0	0	0	0	0	0	0	0	0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0
3	3-bedroom living/kitchen occupancy	225	165	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
3	3-bedroom living occupancy	225	165	0	0	0	0	0	0	0	0	0	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0	0
3	3-bedroom kitchen occupancy	225	165	0	0	0	0	0	0	0	0	0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0
	Single bedroom equipment	80		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.13
	Double bedroom equipment	80		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.13
	Studio equipment	450		0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	1	1	0.44	0.44	0.24	0.24
	Living/litchen equipment	450		0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	1	1	0.44	0.44	0.24	0.24
	Living equipment	150		0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1	1	1	1	0.4	0.4
	Kitchen equipment	300		0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	1	1	0.17	0.17	0.17	0.17
	Lighting profile	2 (W/m2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0

Appendix B – MRXBOX HYBRID COOLING SYSTEM

Appendix C – Purge Ventilation Unit

Purge Ventilation Unit

Easy to install ventilation solution

For use in residential dwellings

Titon's Purge ventilation unit has been designed to satisfy the Building Regulations Part F 2010 requirement for purging as set out in *Appendix B. It allows the rapid removal of stale, odorous and poor quality air from the dwelling allowing a healthier more comfortable environment to be reinstated.

Our Purge unit can be used in an independent purge system in its own right or integrated into our own HRV Q Plus MVHR system to provide additional dedicated purge ventilation.

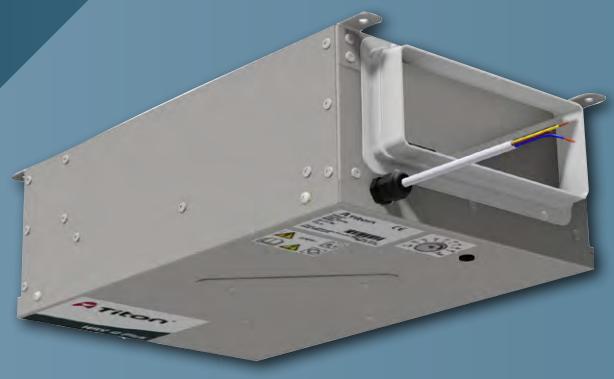
Purge ventilation can also be used to improve thermal comfort.

*Manually controlled intermittent ventilation of rooms or spaces at a relatively high rate to rapidly dilute high concentrations of pollutants and/or water vapour from occasional activities, equivalent to 4 air changes an hour.

Features & Benefits

- **Low Profile**
- **High efficiency EC fan**
- **100% variable speed control for commissioning set point**
- **90° configurable option**
- **Accepts configurations of 220x90mm rectangular ducting and Ø150mm or 220x90mm with adaptor for 90° option**
- **For use in rooms up to 45m²**
- **In line configurable option**
- **Simple 1 setting setup**
- **Light weight for easy handling**
- **Easy and quick to install**
- **Low sound levels**
- **IPX2 water resistant**

Purge



Ceiling cover kit available

Powered Damper Actuator

Product Codes

TP625 - Purge Unit
TP629 - Ø150 Back Draft Damper
TP630 - Powered Damper Actuator
TP631 - Ceiling Cover Kit (Ø150 only)

Standards

EU RoHS Directive Compliant.

Conforms to requirements of EC council Directives relating to electromagnetic Compatibility and Electrical Safety:
2006/95/EC (LVD), 2004/108/EC (EMC)
EN 60335-1:2002/A2:2006, EN 60335-2- 80:2003/ A1:2004.

CE Marked.

Specification

Dimensions:
510mm long x 300mm Wide x 150mm Deep

Weight: 7.2Kg

Finish: Natural Zintec

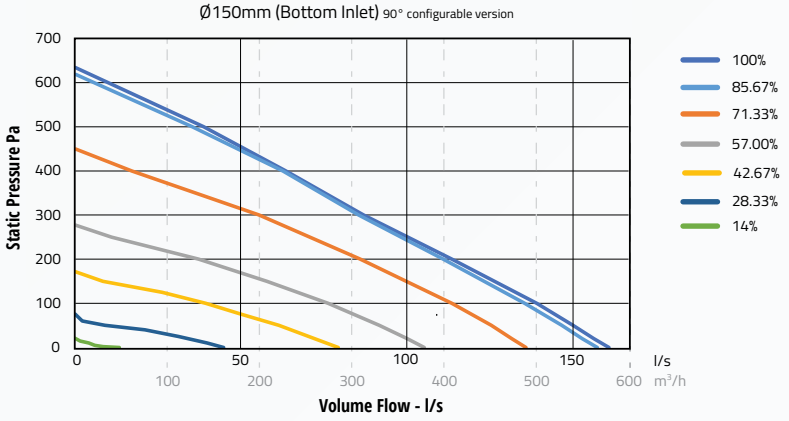
Materials: Zintec sheet steel casing

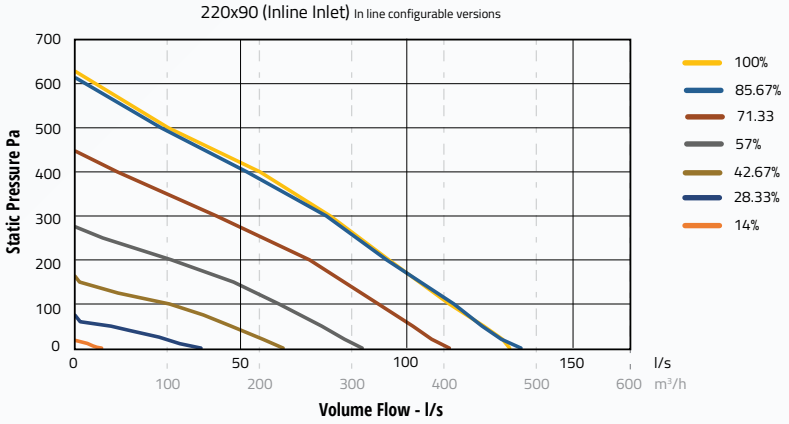
Guarantee Period: 2 Years

Electrical: 230V - 50/60Hz, 3A fuse

Maintenance: Service subject to local environment - see product manual.

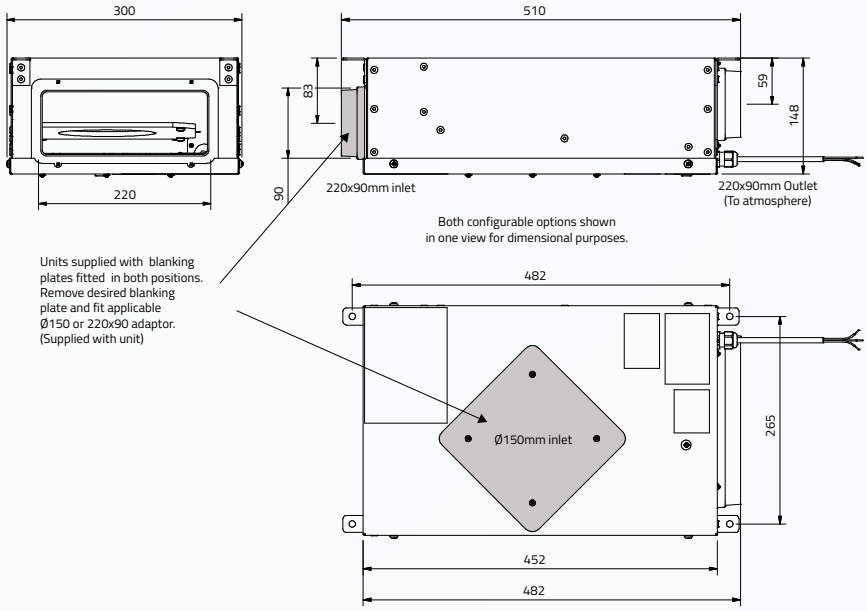
Performance



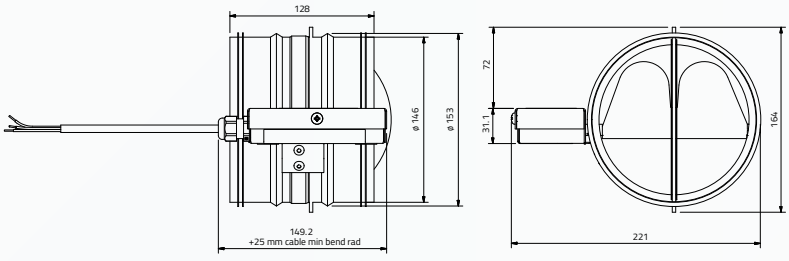


Drawing and Dimensions

Purge Ventilation Unit



Powered Damper Actuator



Dimensions in mm

nuaire

MRXBOX HYBRID COOLING SYSTEM

CONTENTS

PROUD TO BUILD BRITISH

We've been pioneers in new air technology since 1966. Our heritage is in the design and manufacture of fans and ventilation systems. We put our energy into efficient ventilation so you don't waste yours.

Pioneering
We lead the way in product innovation with a stream of ground-breaking products over decades.

Trusted
We have a reputation for our build quality. We establish long term relationships and are always transparent with our test data.

Agile
We're one of the UK's leading manufacturers, covering both residential and commercial air quality. We offer innovative advice and provide flexible solutions.

Expert
Our team is made up of over 600 people, 50 of which have over 25 years' experience. We have the skills and knowledge to help find the best solution for our customers.

Attentive
We're expert listeners, rising to any challenge and going the extra mile for our customers. We add value by solving problems. We sell solutions, not fans.

Personal
We work closely with our customers and can provide bespoke solutions to meet their specific project needs. Many of our product ranges were developed this way.

"Our expertise, experience and innovation are what makes us stand out from the rest of the market."

Nuaire.

For help with selecting a unit, speak to us on 029 2085 8500 or email: residential.enquiries@nuaire.co.uk

UNDERSTANDING OVERHEATING

UK MADE

The tendency for new build dwellings, especially apartments, to reach uncomfortable internal temperatures during summer is an increasing problem in need of a solution.

Daytime internal heat build-up leads to night-time temperatures too high for comfortable sleep, adding to heat stress and increasing the risk to health. Single aspect dwellings with large glazing are particularly susceptible.

The move to ever higher levels of thermal insulation and airtightness, coupled with external factors such as environmental and noise pollution make it difficult to control internal temperatures by natural means.

Overheating in apartments presents a challenge to developers and causes misery for occupants. As global temperatures rise, the problem will only get worse.

WHAT IS THE SOLUTION?

Internal temperatures targeted year-round by conventional MVHR, even those with summer bypass, can contribute to internal heat build-up in summer.

Nuaire's MRXBOX Hybrid Cooling System combines year-round high levels of indoor air quality with the added benefit of summer cooling to mitigate overheating.

This added cooling significantly lowers the temperature of fresh air supplied into the dwelling, helping maintain comfortable internal temperature levels even in city centre apartments on the hottest days of summer.

THE CONTINUING PROBLEM OF OVERHEATING IS WELL KNOWN THROUGHOUT THE INDUSTRY.

MRXBOX HYBRID COOLING HELPS PROVIDE A SIMPLE SOLUTION.

> **This added cooling significantly lowers the temperature of fresh air supplied into the dwelling.**

THE CONTINUED DRIVE TOWARDS HIGHLY INSULATED AND BETTER SEALED HOMES WITH LARGE AREAS OF GLAZING HAS GIVEN RISE TO OVERHEATING IN HOMES.

HOW NUAIRE'S MRXBOX HYBRID COOLING SYSTEM CAN HELP

The below selection tables provide typical cooling data based on sample conditions. For project specific information, contact one of our Estimators on **029 2085 8500** or email **residential.enquiries@nuaire.co.uk.**

29°C EXTERNAL AIR TEMPERATURE

Conditions	Cooling (kW) / Airflow Rates (l/s)	50	60	70	80	90	100	110	120
23°C Internal	Combined kW	0.88	1.03	1.17	1.29	1.40	1.49	1.57	1.62
	Supply air °C	14.3	14.8	15.2	15.7	16.2	16.7	17.2	17.8
24°C Internal	Combined kW	0.82	0.98	1.12	1.24	1.34	1.43	1.49	1.53
	Supply air °C	15.0	15.4	15.9	16.3	16.8	17.3	17.8	18.4
25°C Internal	Combined kW	0.80	0.95	1.07	1.18	1.27	1.34	1.39	1.43
	Supply air °C	15.5	15.9	16.4	16.9	17.4	18.0	18.5	19.1
26°C Internal	Combined kW	0.78	0.91	1.02	1.11	1.19	1.25	1.30	1.33
	Supply air °C	15.9	16.4	17.0	17.5	18.1	18.6	19.2	19.8

32°C EXTERNAL AIR TEMPERATURE

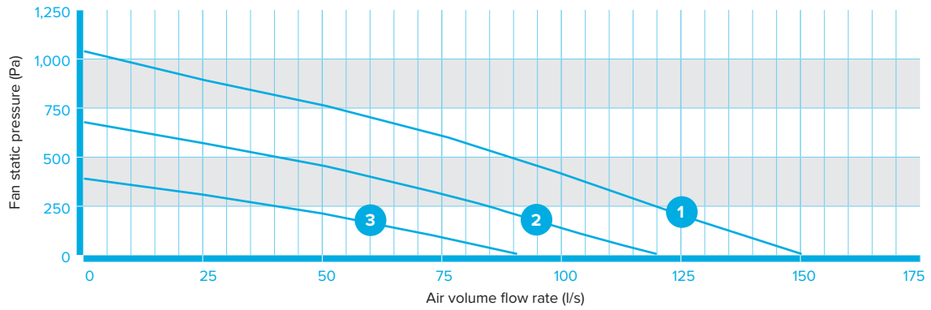
Conditions	Cooling (kW) / Airflow Rates (l/s)	50	60	70	80	90	100	110	120
23°C Internal	Combined kW	1.03	1.21	1.37	1.51	1.63	1.73	1.82	1.88
	Supply air °C	15.0	15.3	15.8	16.3	17.0	17.7	18.4	19.1
24°C Internal	Combined kW	0.98	1.14	1.29	1.42	1.54	1.65	1.74	1.82
	Supply air °C	16.0	16.4	16.8	17.2	17.8	18.3	18.9	19.6
25°C Internal	Combined kW	0.93	1.09	1.24	1.37	1.49	1.60	1.69	1.77
	Supply air °C	16.6	17.0	17.4	17.9	18.3	18.8	19.3	19.9
26°C Internal	Combined kW	0.88	1.04	1.19	1.32	1.44	1.55	1.64	1.72
	Supply air °C	17.3	17.7	18.1	18.5	18.9	19.3	19.7	20.2

34°C EXTERNAL AIR TEMPERATURE

Conditions	Cooling (kW) / Airflow Rates (l/s)	50	60	70	80	90	100	110	120
23°C Internal	Combined kW	1.13	1.31	1.49	1.65	1.80	1.94	2.08	2.20
	Supply air °C	15.4	15.9	16.4	16.9	17.4	17.9	18.4	18.9
24°C Internal	Combined kW	1.11	1.27	1.43	1.59	1.73	1.87	2.00	2.12
	Supply air °C	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5
25°C Internal	Combined kW	1.04	1.21	1.37	1.52	1.65	1.77	1.89	1.99
	Supply air °C	16.9	17.4	17.9	18.4	18.9	19.4	19.9	20.4
26°C Internal	Combined kW	0.97	1.15	1.31	1.45	1.57	1.68	1.77	1.85
	Supply air °C	17.8	18.3	18.8	19.3	19.7	20.2	20.7	21.2

Note: Typical External Ambient temperatures stated above are Dry Bulb. Combined kW = Combined Coolth recovery and sensible cooling. No allowance has been made for latent losses at supply air temperatures below the dew point. Consult Nuaire for cooling output data at your assumed external design conditions. A supply air temperature of 16°C or above is recommended for good air distribution.

PERFORMANCE



ELECTRICAL AND SOUND DATA

COOLING ON
MRXBOXAB-ECO5-AECV WITH MR-ECO-COOL-V

Curve	MVHR Power Consumption (Watts)		Sound Power Levels dB re 1pW (Frequency Hz) 63	125	250	500	1k	2k	4k	8k	Hemispherical dBA@3m
1	319	Breakout	66	65	56	52	39	35	29	21	36
		Open Inlet	58	58	58	53	49	38	30	24	
		Open Outlet	58	61	61	71	60	52	49	44	
2	167	Breakout	66	65	54	49	37	34	26	18	34
		Open Inlet	56	58	58	53	47	37	26	19	
		Open Outlet	58	61	61	71	59	52	48	43	
3	77	Breakout	65	65	54	45	34	30	22	<16	33
		Open Inlet	56	56	55	49	45	32	21	<16	
		Open Outlet	56	59	62	66	54	50	41	41	

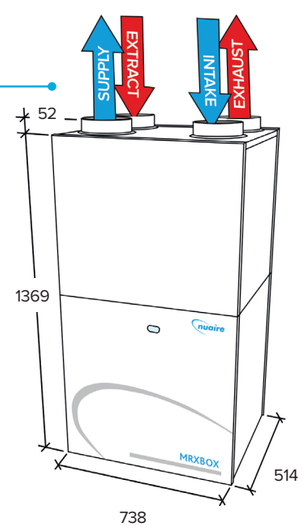
Cooling module motor input power 650W. Above data refers to vertical units. Please contact Nuaire for performance data on the in-line version.

The breakout case-radiated dBA values are given for Hemispherical free field radiation at 3m - to obtain the Spherical radiated data, subtract 3 dBA.

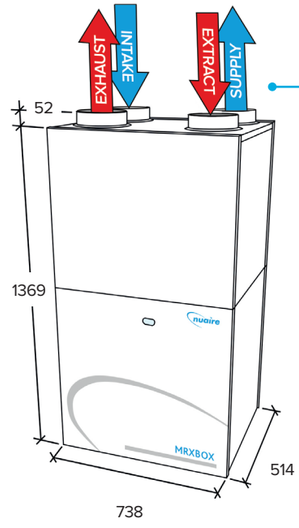
Please note: Sound data is provided at a particular duty point, with the cooling module running, approximately 60%, 80% and 100%. For accurate sound data at a specific duty, please use Nuaire's fan selector or call the office on 029 2085 8500.

DIMENSIONS (mm)

SPIGOT CONFIGURATION SHOWN IS VALID FOR THE *OPPOSITE HANDED UNIT*



VERTICAL MRXBOX HYBRID COOLING SYSTEM



SPIGOT CONFIGURATION SHOWN IS VALID FOR THE *STANDARD HANDED UNIT*

Combined MRXBOXAB-ECO5-AECV and MR-ECO-COOL-V weight 121Kg.

MRXBOX HYBRID COOLING SYSTEM CONSULTANT SPECIFICATION

OPERATION

The MVHR unit shall be fully insulated providing excellent thermal and acoustic characteristics and shall be complete with a multi plate counter flow high efficiency heat exchanger block, with a thermal efficiency of up to 95%. The heat exchanger shall be protected by filters on fresh air inlet and system extract. The heat exchanger and filters shall be accessible via the front access panel, enabling quick and easy maintenance.

The unit shall have low energy, high efficiency EC fan/motor assemblies with sealed for life bearings, the impellers shall be backward curved centrifugal type. The motors shall be suitable for an ambient temperature of 40°C.

The unit shall be supplied complete with a condensate drip tray and 21.5mm drain connection.

The unit shall be suitable for 150mm circular ducting. The breakout noise level and power requirements shall be as detailed by the unit manufacturer and in accordance with the ventilation equipment schedule.

The unit shall be provided within a white pre-painted or coated steel acoustic enclosure lined with a minimum of 20mm class ‘0’ acoustic foam insulation to reduce breakout noise.

Flexible duct connections shall be within the enclosure, pre-fitted between the MVHR unit and the connection spigots on the top face of the enclosure.

(Removing the need for flexible duct connectors outside of the unit which may cause breakout).

The MVHR unit shall be retained within the enclosure on a metal tray supported on turret type anti-vibration mounts of suitable deflection to ensure that vibration is not transmitted to the supporting structure.

All operational components of the MVHR unit shall be accessible via the front panel of the enclosure.

Bypass operation can be manually overridden via an external switch in colder months so the unit continually recovers heat.

The MVHR unit shall be offered with a five year warranty. The product warranty applies to the UK mainland and in accordance with Clause 14 of our Conditions of Sale. Customers purchasing from outside of the UK should contact Nuaire International Sales office for further details.

The Cooling module shall mount directly on-top-of, and operate in conjunction with, the MVHR unit. On/Off control of cooling and room temperature set-point shall be by adjustable wall mounted cooling-stat. Control links between MVHR and cooling module shall activate a higher airflow when cooling is enabled and inhibit operation of the cooling module in the event of fan failure.

The maximum coolth-recovery and sensible cooling of the MVHR and cooling module, combined, shall be in excess of 2 kW.

The Cooling module shall incorporate a sealed-for-life R134a cooling circuit and a double-skinned casing with class ‘O’ fire-rated acoustic foam lining to minimize noise breakout.

Inner panels shall be thermally insulated to prevent condensation. The module shall have 150mm diameter circular duct connections.

The cooling module shall include an integral condensate tray and drain with a 15mm connection pipe. Condenser and evaporator coils shall be accessible for cleaning from the front of the unit irrespective of orientation.

All maintainable components shall be accessible in situ. It shall not be necessary to remove or withdraw cooling components from the casing for cleaning.

The cooling module shall include a factory fitted foam base-gasket to effect an airtight seal between module and matching MVHR. The module shall be supplied with mounting brackets, to ensure that it is mechanically fixed to the MVHR and an upper restraining bracket to be fitted between the module and the wall.

The MVHR and Cooling module assembly shall be supported on unit-specific floor-mounting stand, unit-specific prefabricated steel cantilever brackets or other suitable fabricated steel supporting frame.

The cooling module shall be supplied with a two year (parts only) warranty.

The product warranty applies to the UK mainland and in accordance with Clause 14 of our Conditions of Sale. Customers purchasing from outside of the UK should contact Nuaire International Sales office for further details.

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01634 727255

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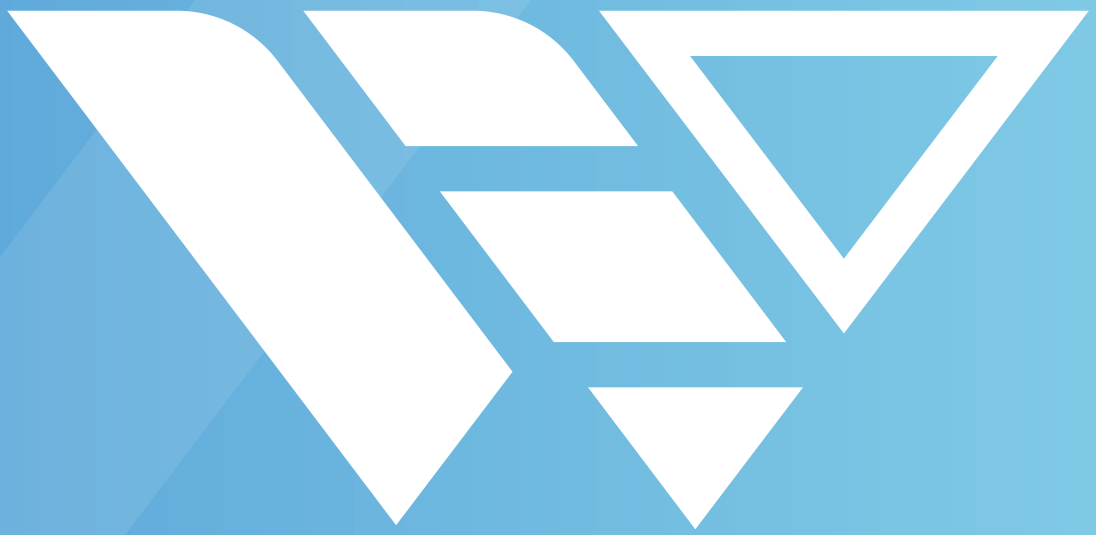

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