



Unit 3, The Stables, Parrs Wood Thermal Comfort Assessment

For Europium World UK Ltd

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Issued by	Hydrock Consultants Limited Northern Assurance Buildings 9-21 Princess Street Albert Square Manchester M2 4DN United Kingdom T +44 (0)161 804 5550 E manchestercentral@hydrock.com hydrock.com	Client	Europium World UK Ltd
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Checked by	Andy Turl	
Approved by	Mark Walker	

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Executive Summary

Hydrock Consultants has been appointed by Europium World UK Ltd to provide a thermal comfort assessment for the existing office building, Unit 3, The Stables, located in Parrs Wood, Manchester.

This document gives an overview of current thermal comfort and overheating guidance, describes how to determine whether a building is at risk of overheating and also describes a number of solutions which can mitigate overheating.

The main purpose of the document, however, is to summarise the thermal comfort assessment which was undertaken for the existing office spaces. The assessment involved building a 3D computer model of the building and simulating a number of different scenarios to determine whether the building was at risk of overheating.

Following the simulations, it was determined that the building is at risk of overheating and that the most suitable solution to maintain occupant comfort and prevent overheating in the future is to provide a fixed, combined heating and cooling system.

This conclusion is also supported by evidence that the previous building occupiers attempted to utilise portable air conditioning units to maintain internal comfort conditions and prevent overheating with little practical success.

Thermal Comfort Assessment Outcomes

The offices were modelled following a site survey and investigation into the existing building services. Three different scenarios were simulated; the first simulation was as the building historically operates, with natural ventilation. The two other scenarios looked at mechanical ventilation as an alternative way to cool the offices without using a cooling system:

- 1. Historic Operation with Natural Ventilation:** This scenario modelled the office as it has historically operated, with natural ventilation using openable windows.
- 2. Standard Mechanical Ventilation:** The second scenario included mechanical ventilation with typical flow rates for an office. Mechanical ventilation can help cool spaces by extracting warm, stale air and supplying fresh, cooler air from outside.
- 3. Enhanced Mechanical Ventilation:** The final scenario is the same as the second, however this scenario used a higher flow rate, meaning more fresh air is supplied to the spaces.

All three scenarios were modelled using current weather data. The scenarios were also modelled using future weather data (year 2050) to predict what effect climate change would have on the thermal comfort of the offices.

The results from the modelling showed that all of the scenarios failed the thermal comfort / overheating assessments for both current and future weather data.

Following the failed assessments, the predicted temperatures were investigated to determine to what extent the building was predicted to overheat.

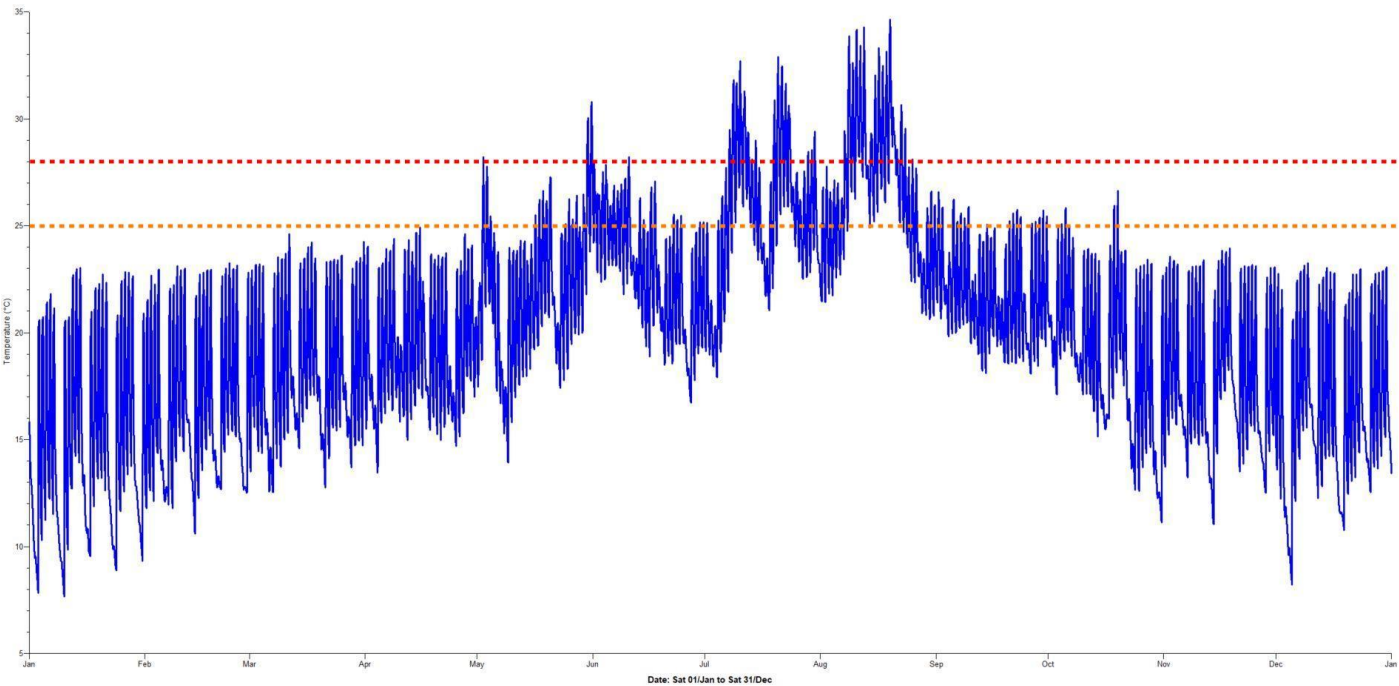
The Chartered Institution of Building Services Engineers (CIBSE) provides guidance which recommends a maximum summer temperature in offices of 22-25°C. Although there is no legal limit, CIBSE also provides guidance which states that indoor temperatures of over 28°C for long periods will result in increased dissatisfaction and reduced productivity. For many years the definition of "overheating" for office spaces was determined as more than 1% occupied hours exceeding 28°C.

Space	CIBSE Minimum Winter Temperature	CIBSE Maximum Summer Temperature	CIBSE Overheating Temperature
Office	20-23°C	22-25°C	28°C

Winter thermal comfort can be achieved by the provision of an appropriately sized heating system.

The following graph shows predicted temperatures from the thermal comfort assessment for Scenario 1 using current weather data without cooling (heating system included in model during occupied hours).

The graph highlights that during the summer months, there are many periods where internal temperatures are predicted to exceed the suggested maximum summer temperature of 25°C (orange dashed line) as well as 28°C (red dashed line) where increased dissatisfaction and reduced productivity are likely to occur.



The following table showed the same results in a table format.

Occupied hours are defined as Monday to Friday, 9am to 5pm.

Summer is defined as the start of May to the end of September.

	Total Occupied Hours	Hours Between 20°C - 25°C	Hours Between 25°C - 28°C	Hours Above 28°C
Annual Occupied Hours	2080	1508	399	173
Percentage of Annual Occupied Hours	100%	73%	19%	8%
Summer Occupied Hours	872	258	395	219
Percentage of Summer Occupied Hours	100%	30%	45%	25%

The results demonstrated that during the summer months (May to September), internal office temperatures were predicted to exceed the recommended maximum temperatures for 70% of the occupied hours.

Whilst including mechanical ventilation did improve the thermal comfort of the occupied spaces slightly, the spaces still exceeded the CIBSE recommended thermal comfort levels by some margin. It was therefore concluded that in order to achieve a comfortable and reasonable temperature within the spaces, additional intervention would be required in the form of comfort cooling.

Recommended Solution

In order to achieve a comfortable and reasonable temperature, during summer months, in line with legislation and industry guidance, the recommendation is to provide a fixed cooling system for all occupied spaces. If the system is also set up to provide heating during the winter, then the spaces can be adequately heated at an increased efficiency (compared to traditional boiler fed or electric radiator systems).

The recommended solution offers the greatest benefit in terms of both thermal comfort and carbon emissions.

Providing a fixed heating and cooling system would deliver the following benefits.

- » Thermal Comfort
- » Energy / Carbon Efficiency
- » Wider Public Benefits

Thermal Comfort

The modelling showed that the office spaces are predicted to overheat against the criteria set out in CIBSE TM59. Installing a combined heating and cooling system would ensure that all spaces could be maintained at a comfortable temperature throughout the year.

There are alternative solutions to minimise overheating, however only a fixed heating and cooling system fully addresses the overheating risk. A fixed heating and cooling system is also the only solution which will ensure that the building is future proofed against the increased future impacts of global warming and climate change.

The main alternative overheating prevention option to comfort cooling is increased mechanical ventilation. This was investigated in the thermal comfort model but the increased mechanical ventilation options were found to fail the thermal comfort assessment. This solution was also found to be more intrusive, requiring plant, louvres and penetrations through a building's façade or roof, as well as the ventilation units and ductwork to be coordinated with the existing building and services and structural beams.

Energy / Carbon Efficiency

A benefit of installing a fixed heating and cooling system, is that the systems offer improved heating efficiencies over traditional heating systems such as electric radiators or gas fired boilers. Installing the described system would mean the heating energy efficiency would be dramatically increased. Typical efficiencies are shown below:

- » Boilers approximately 90%
- » Electric radiators 100%
- » Heat Pumps (fixed heating and cooling system) approximately 350%

Installing a heating and cooling system would result in a reduction of the building's overall energy consumption and carbon emissions.

Benefits to the Public

Successfully implemented decarbonisation strategies will clearly deliver tangible environmental benefits that will inevitably include wider public benefits. The installation of an appropriately designed cooling system has improved the buildings demonstrably poor environmental performance, increasing its desirability as high-quality office accommodation and ensuring its longevity.

An ever increasing proportion of quality UK rental office space now includes comfort cooling as standard. As global warming impinges further on our society, office spaces without cooling may struggle to attract tenants and thereby increase the risk of buildings like this falling into disrepair through lack of continued use. This will particularly affect retrofit opportunities in older buildings with similar physical characteristics as the Stables. These buildings do not easily accommodate modern services without major interventions which can significantly damage appearance or fabric. This is not the case at the Stables as the physical configuration of the building allows the air handling plant to be located where it has no impact on the appearance of the historic building. Installing the cooling system in this case will enable the building to remain viable in spite of the forecast rising temperatures. This will be essential in ensuring the sensitive ongoing maintenance of the listed fabric, retaining positive use and thereby its contribution to the local community and economy for future generations.

Our understanding is that the previous occupier who owned the building for over 20 years may have previously attempted to address the needs of the current climate crisis, but had not taken steps to remedy the situation, as

their tenure was not critically affected by meeting the demands of the current climate crisis, or perhaps was unable to make the significant investment required in implementing a viable solution.

As well as this, the public will also gain from the environmental benefits delivered. The UK government has a stated commitment to achieve net zero by 2050. In aspiring to achieve this target, all building owners/stewards will need to look closely at ways to reduce their energy consumption and carbon emissions. An integral part of that strategy is to move away from the use of fossil fuels. Installing a cooling system which also provides heating during the winter months is in line with this plan and is substantially more efficient than using electric radiators.

All energy saving strategies implemented will have the result of benefitting the public in the long term.

1. Introduction

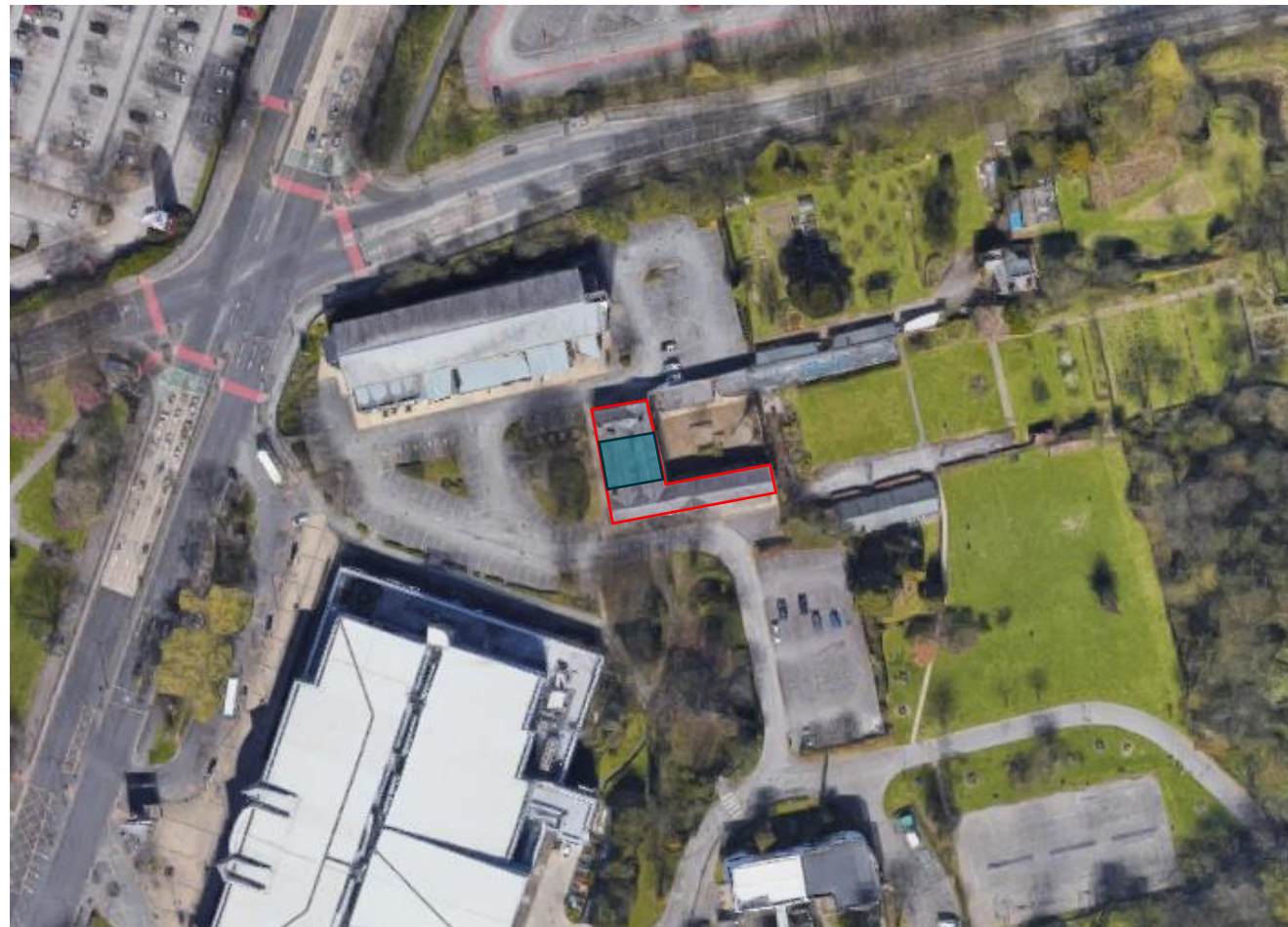
Hydrock Consultants has been appointed by Europium World UK Ltd to provide a thermal comfort assessment for the existing office building, Unit 3, The Stables, located in Parrs Wood, Manchester.

This document outlines the modelling process carried out to assess the building in terms of internal comfort temperatures. The aim of the modelling exercise is to understand whether the existing building is susceptible to excessive overheating. Overheating is defined by the industry guidance document, CIBSE TM52 The Limits of Thermal Comfort: Avoiding Overheating in European Buildings.

1.1 Site and Building Overview

The site is located in East Didsbury to the South of Manchester and is situated between the A34 (Kingsway), the A5145 (Parrs Wood Lane) and Manchester Road. The building is bordered by a Travelodge hotel to the North and the extensive Parrs Wood Entertainment Centre to the South.

The Stables Building is indicated on the plan below by the red outline. Unit 3 is indicated as a blue overlay.



Unit 3 is part of the wider Grade II listed Stables Building which overall forms an L shaped block with a walled courtyard.

A large portion of the stable block was damaged in a significant fire during the late 1990s and was restored and converted into office spaces in 2002.

The offices currently use openable windows for ventilation. The spaces historically used electric radiators to provide heating with no cooling provision.



The above image shows the building's previous occupants, it can be seen that the office had portable air conditioning units, which indicates that overheating has previously been an issue. The use of these portable air conditioners was reported by the previous occupier as impractical and ineffective due to localised cooling, noise and trailing hoses / cables.

1.2 Overheating in the Workplace

The following section outlines the current legislation and guidance around workplace thermal comfort.

1.2.1 Government advice

Government advice states that "During working hours the temperature in all indoor workplaces must be **reasonable**".

There's no law for minimum or maximum working temperatures, eg when it's too cold or too hot to work. However, guidance suggests a minimum of 16°C, or 13°C if employees are doing physical work.

There is currently no government guidance for a maximum temperature limit but employers are legally bound to comply with health and safety at work laws, including:

- » keeping the temperature at a **comfortable level**
- » providing clean and fresh air

1.2.2 The Workplace (Health, Safety and Welfare) Regulations

The Workplace (Health, Safety and Welfare) Regulations require employers to provide a **reasonable** indoor temperature in the workplace. This depends on the work activity and the environmental conditions.

Under the Management of Health and Safety at Work Regulations, employers must:

- » Assess the risks to workers
- » Put controls in place to protect them

1.2.3 The Health and Safety Executive

The Health and Safety Executive advises that there is no maximum temperature for workplaces. However, it states that all workers are **entitled to an environment where risks to their health and safety are properly controlled**.

Heat is classed as a hazard and comes with legal obligations like any other hazard.

1.2.4 The Chartered Institution of Building Services Engineers (CIBSE)

The Chartered Institution of Building Services Engineers is the main source of guidance on thermal comfort recommendations and modelling methodology.

Although there is no legal limit, CIBSE Top Tips document CTT8: Temperature in Indoor Workplaces (Thermal Comfort), states that indoor operative temperatures over 28°C for long periods will result in increased dissatisfaction and reduced productivity. For many years the definition of "overheating" for office spaces was determined as more than 1% occupied hours exceeding 28°C. CIBSE also provides guidance which recommends a summer temperature in offices of 22-25°C.

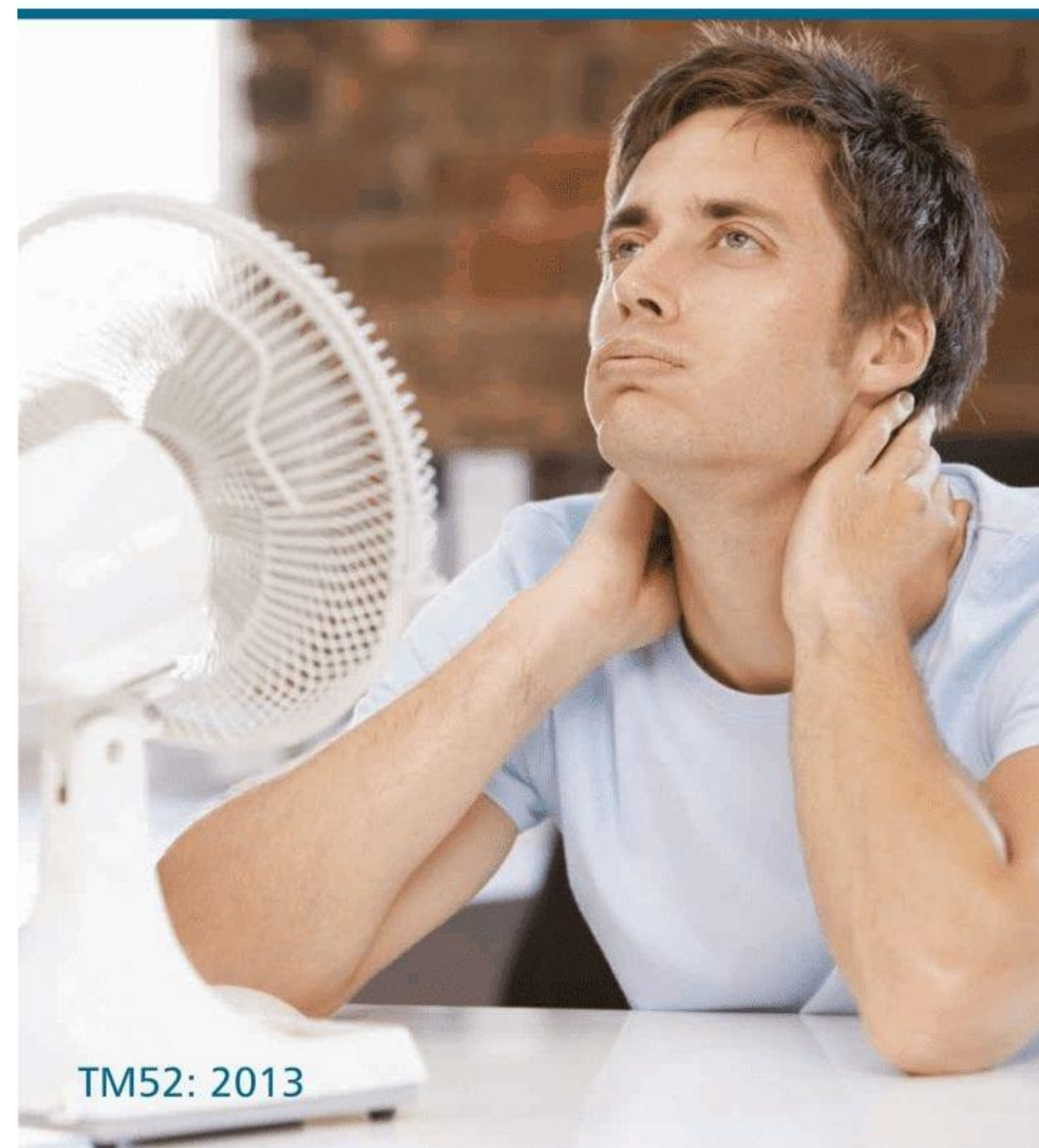
The following tables shows CIBSE's recommended temperatures.

Space	CIBSE Minimum Winter Temperature	CIBSE Maximum Summer Temperature	CIBSE Overheating Temperature
Office	20-23°C	22-25°C	28°C

The current standard method for assessing overheating in buildings is to undertake a modelling assessment in line with CIBSE TM52 The Limits of Thermal Comfort: Avoiding Overheating in European Buildings.

This methodology considers internal temperatures against the current and preceding external temperatures and assesses the overheating criteria against several metrics outlined later in the report.

The limits of thermal comfort: avoiding overheating in European buildings



1.3 Existing Site

The details of the existing site were gathered via survey and a review of record information.

1.3.1 Survey

Context External



Context External



Courtyard External (East Elevation)



Courtyard External (East Elevation)



Outside External (West Elevation)



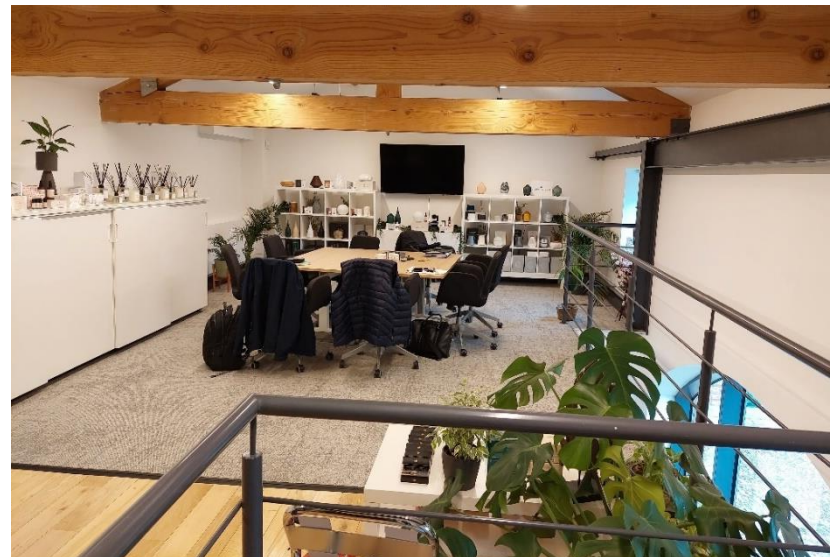
Outside External (West Elevation)



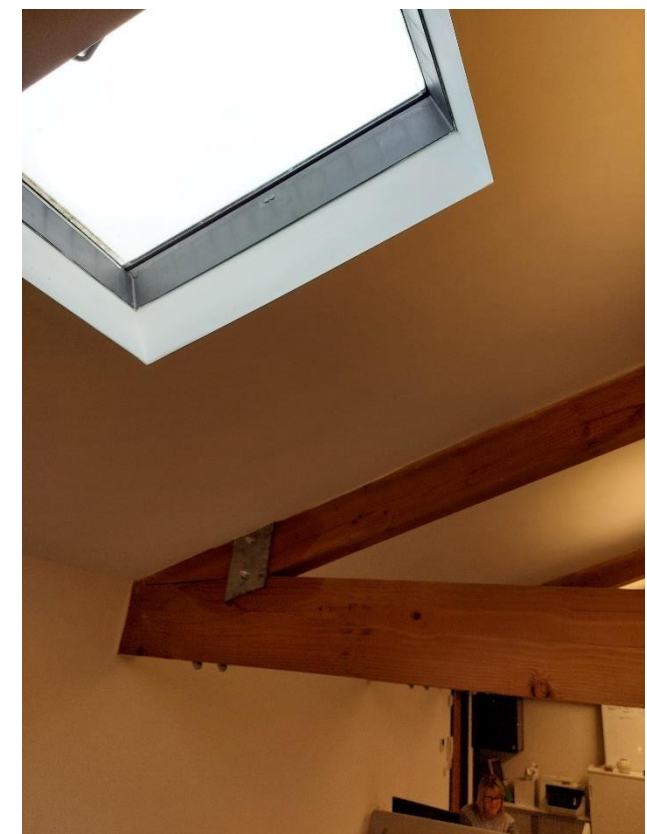
Ground Floor Internal



First Floor Internal (Open Plan Office 1)



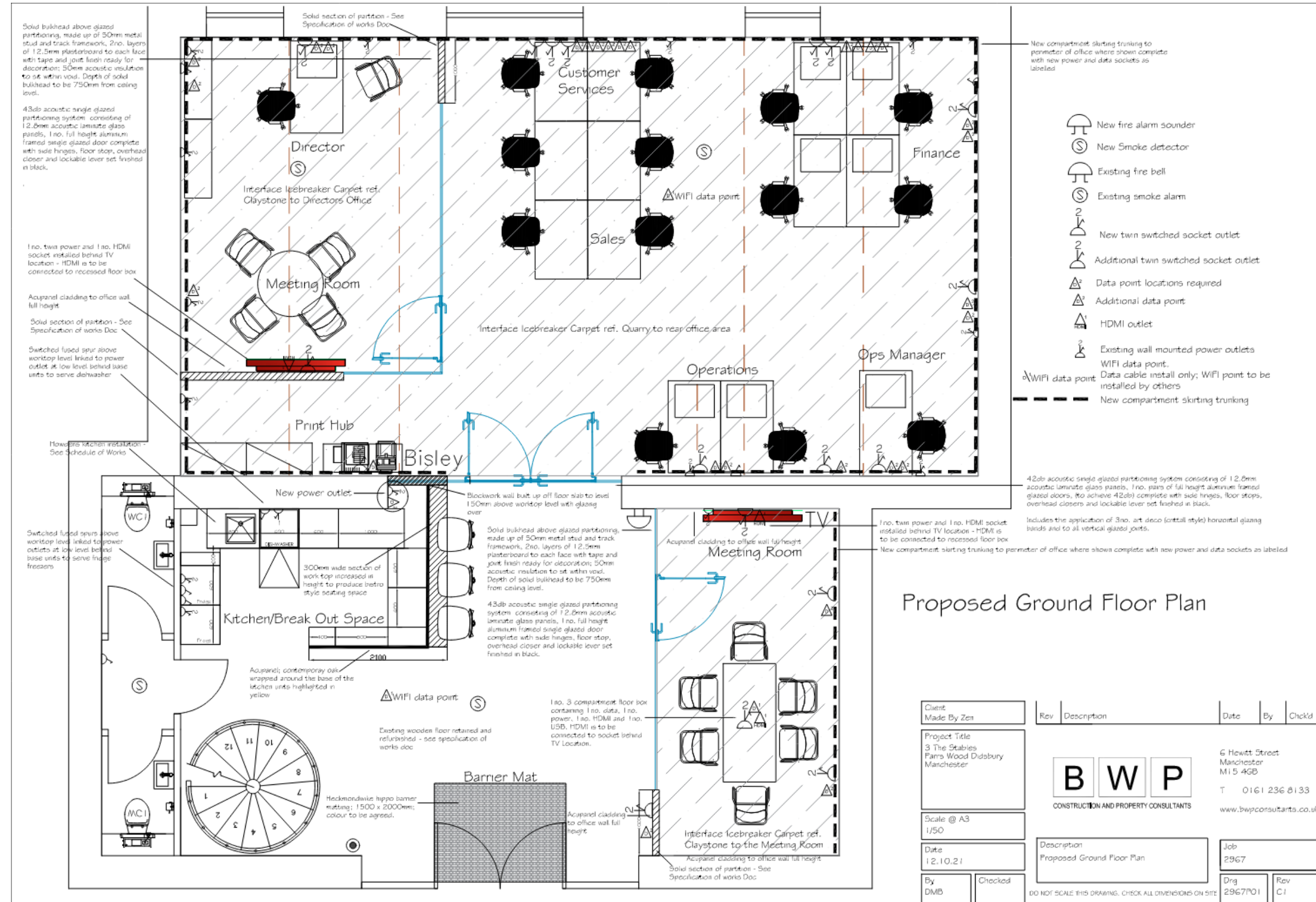
Internal (Open Plan Office 2)



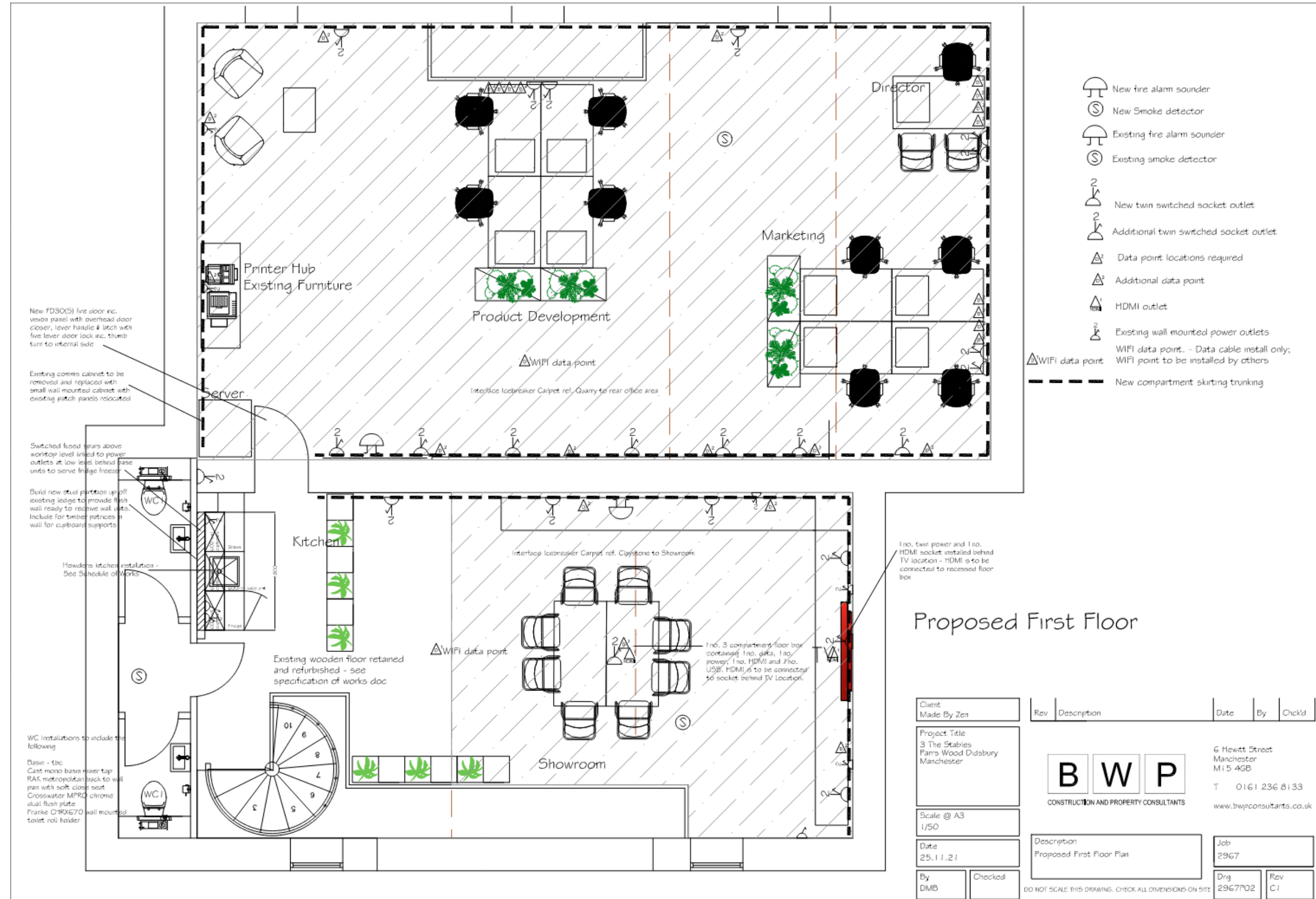
1.3.2 Record Information

The following Record Drawing information has been utilised in the production of the IES dynamic thermal model

Ground Floor Plan



First Floor Plan



2. Strategies to Mitigate Overheating

There are a number of strategies which can be used to mitigate overheating in buildings. The most energy efficient strategies are passive solutions. Passive solutions are strategies which use no energy. These include measures such as using building materials with a high thermal mass meaning they absorb more heat, or incorporating external shading to reduce solar gains from the sun.

Mechanical strategies used to mitigate overheating are solutions which use energy. These include solutions such as mechanical ventilation which supply buildings with air from outside and air conditioning which cools the air inside a building.

A number of strategies are described in this section and their suitability for the Stables Building is discussed. Suitable strategies are investigated further as part of the thermal comfort assessment.

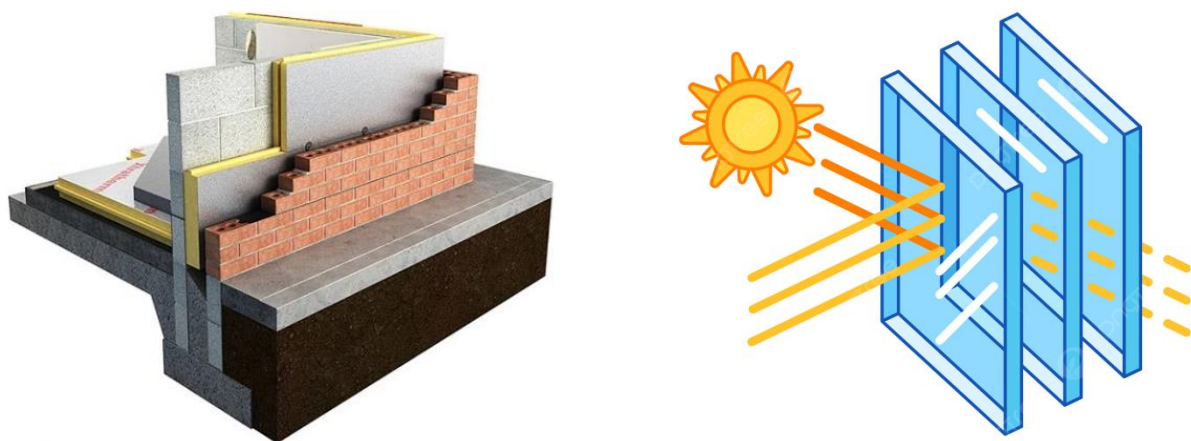
2.1 Passive Strategies

2.1.1 Building Fabric

A building's fabric has an impact on the internal environment. Walls and roofs with high levels of insulation will retain more heat, however, the thermal mass of a building material also has an effect. Materials with high thermal mass can absorb more heat from the surrounding environment, meaning a building or space with high thermal mass will be cooler than a building with lower thermal mass.

The glazing properties of windows also effects internal temperatures. Different windows have varying levels of insulation and some will retain heat better than others. However, glazing also allows solar energy to enter a building. Just as windows differ in their ability to retain heat, they also differ in their ability to prevent solar energy from entering a space. Windows which reduce the solar energy from entering a space will reduce the likelihood of overheating.

The Stables is an existing listed building, and because of this, it would be impractical to upgrade the existing building fabric and windows.

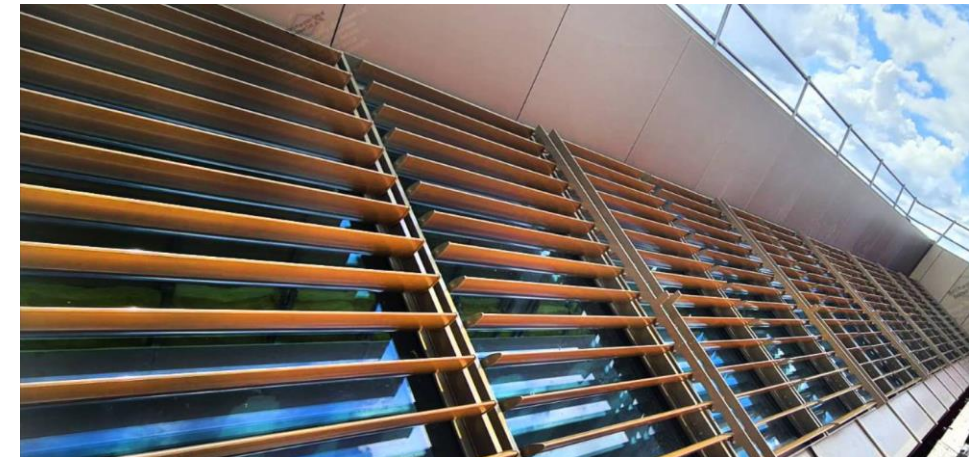


2.1.2 External Shading

External shading prevents solar energy from entering a building and is typically used to shade windows. During the summer this can help reduce overheating and shade occupants who otherwise would be sitting

in direct sunlight. However, incorporating shading can also increase the heating energy demand during the winter as it blocks out useful solar energy.

Because the Stables is a listed building, it is unlikely that installing external shading would be acceptable.



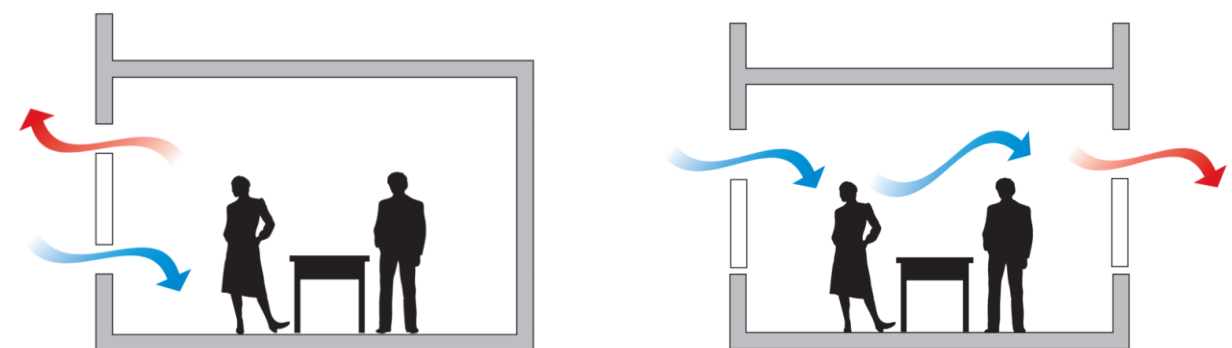
2.1.3 Natural Ventilation

Natural ventilation is any method of supplying fresh air to a space without the means of a mechanical fan. The most common form of natural ventilation is openable windows, however natural ventilation also includes systems such as louvres with mechanical dampers which open and close depending on internal temperatures.

Natural ventilation reduces overheating by allowing internal stale, warm air to escape and be replaced with fresh, cooler air from outside. The benefits of using openable windows are that it requires no energy, occupants are familiar with the system and they have control. The disadvantages of this strategy are that it is not possible to guarantee a fresh air flow rate and occupants can have issues with draughts.

The main issue however, is that if the external air temperature is above the desired internal temperature, then it is not possible to cool the space and opening the windows could in fact increase the internal temperature.

The Stables Building currently operates using natural ventilation with opening windows and this will therefore be investigated as part of the thermal comfort assessment.



2.2 Mechanical Strategies

2.2.1 Mechanical Ventilation

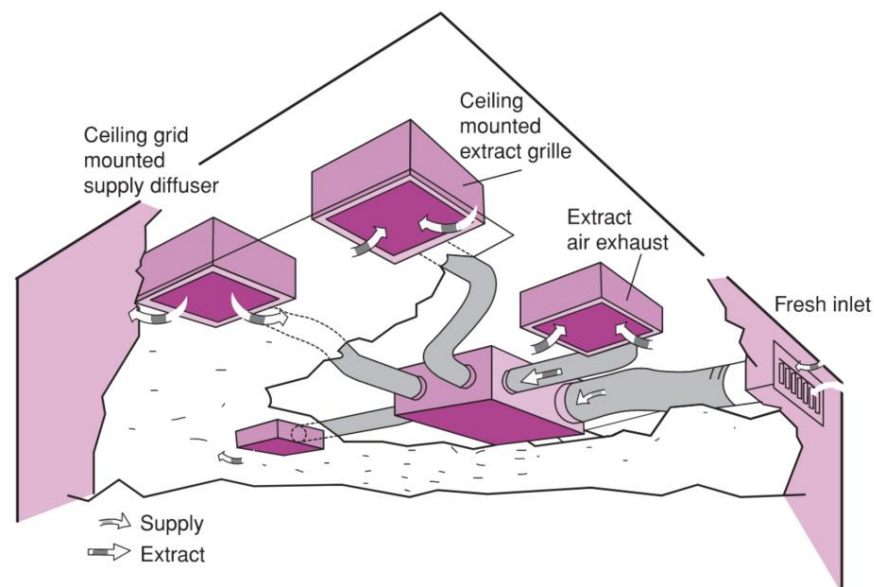
Mechanical ventilation uses fans to provide fresh air to spaces, as with natural ventilation, mechanical ventilation reduces overheating by extracting internal stale, warm air and replacing it with fresh, cooler air from outside.

The primary function of mechanical ventilation is to provide sufficient fresh air for occupants and one of the benefits is it guarantees a fresh air flow rate for the occupants all year round. It also means, if desired, you can provide a higher flow rate to spaces to try and reduce overheating during the summer.

One disadvantage however, is the same as with natural ventilation. If the external air temperature is above the desired internal temperature, then it is not possible to cool the space and supplying external air could in fact increase the internal temperature.

Mechanical ventilation also requires a location for the ventilation unit to be installed. This is typically either externally on the roof, or internally at high level. Penetrations are required for ductwork either in the external wall or roof in order to intake fresh air and exhaust stale air.

Mechanical ventilation could be installed in the Stables Building, provided issues with the unit location and ductwork penetrations could be resolved. Therefore, mechanical ventilation will be investigated as part of the overheating assessment.



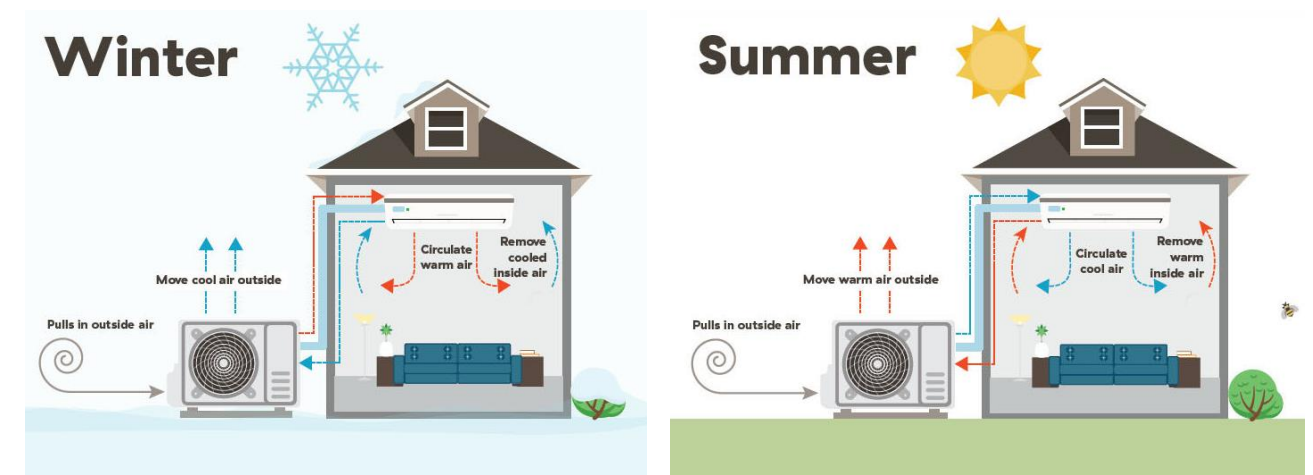
2.2.2 Mechanical Cooling

A mechanical cooling system is the only solution which will guarantee a desired internal temperature and prevent overheating. There are different types of cooling systems, however the most common systems comprise of external units and internal units linked by refrigerant pipework. The internal unit intakes warm air, cools it, and supplies it back to the room, the heat is then expelled by the external unit.

The disadvantage of using cooling systems is they use energy to cool spaces rather than passive means. They also require an external location for the external unit. The units however are relatively small and require much less space than a ventilation unit would do.

Most cooling systems also have the capability to heat spaces as well as cool. This gives the added benefit of having one system which both heats and cools. These systems are also much more efficient than traditional means of heating such as electric radiators or gas fired boilers as they use energy in the air to help heat spaces. Using these systems, heating efficiencies are approximately 350%, electric heating is 100% efficient while gas boilers are approximately 90% efficient. Installing the described system would mean the heating energy demand would be dramatically reduced.

Whether mechanical cooling will be investigated will depend on the results of the thermal comfort assessment.



3. Thermal Comfort Assessment Methodology

The offices will be assessed against the overheating criteria set out in CIBSE TM52: The Limits of Thermal Comfort, Avoiding Overheating in European Buildings.

TM52 was generated in response to the absence of an adequate definition of overheating in naturally ventilated buildings. In the past, overheating has been defined as a number of hours over a particular temperature, irrespective of conditions outside the building.

Work embodied in European standards suggests that the temperature that occupants will find uncomfortable changes with the outdoor conditions in a predictable way. This can be referred to as adaptive thermal comfort and is used by TM52 to assess overheating.

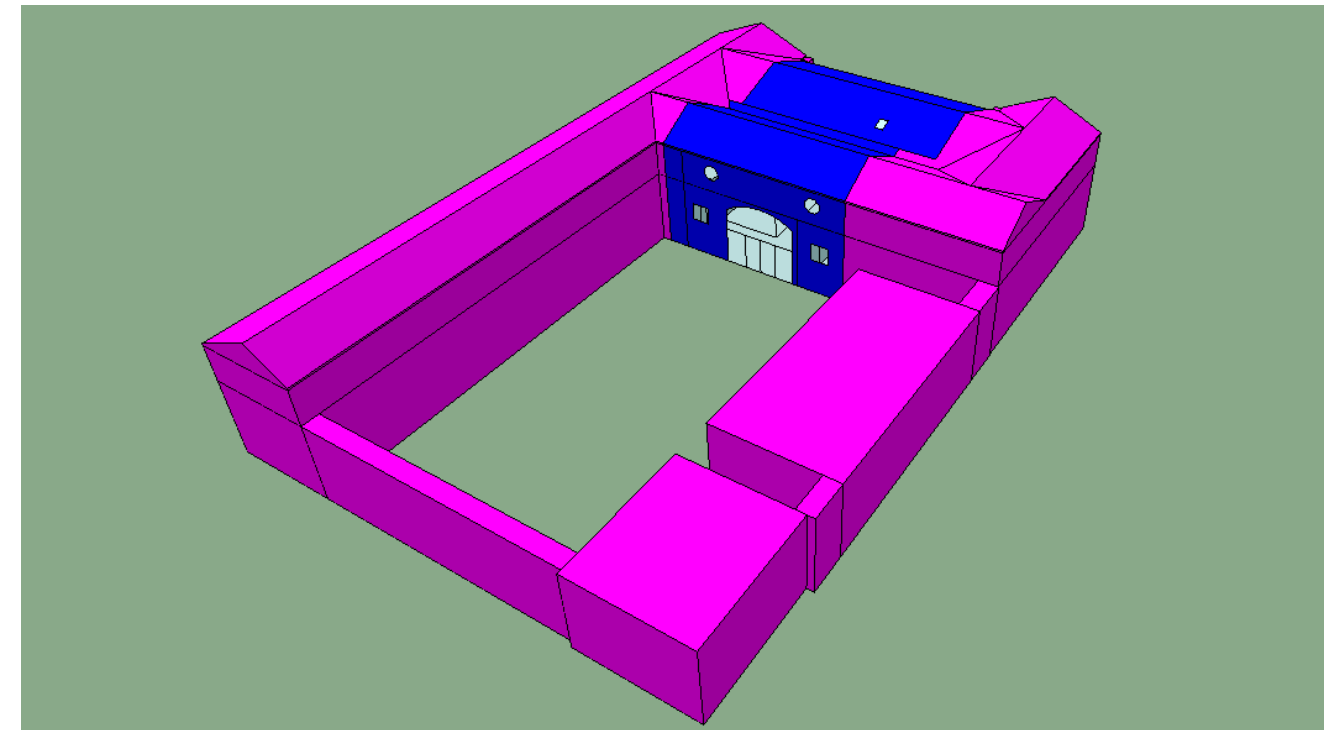
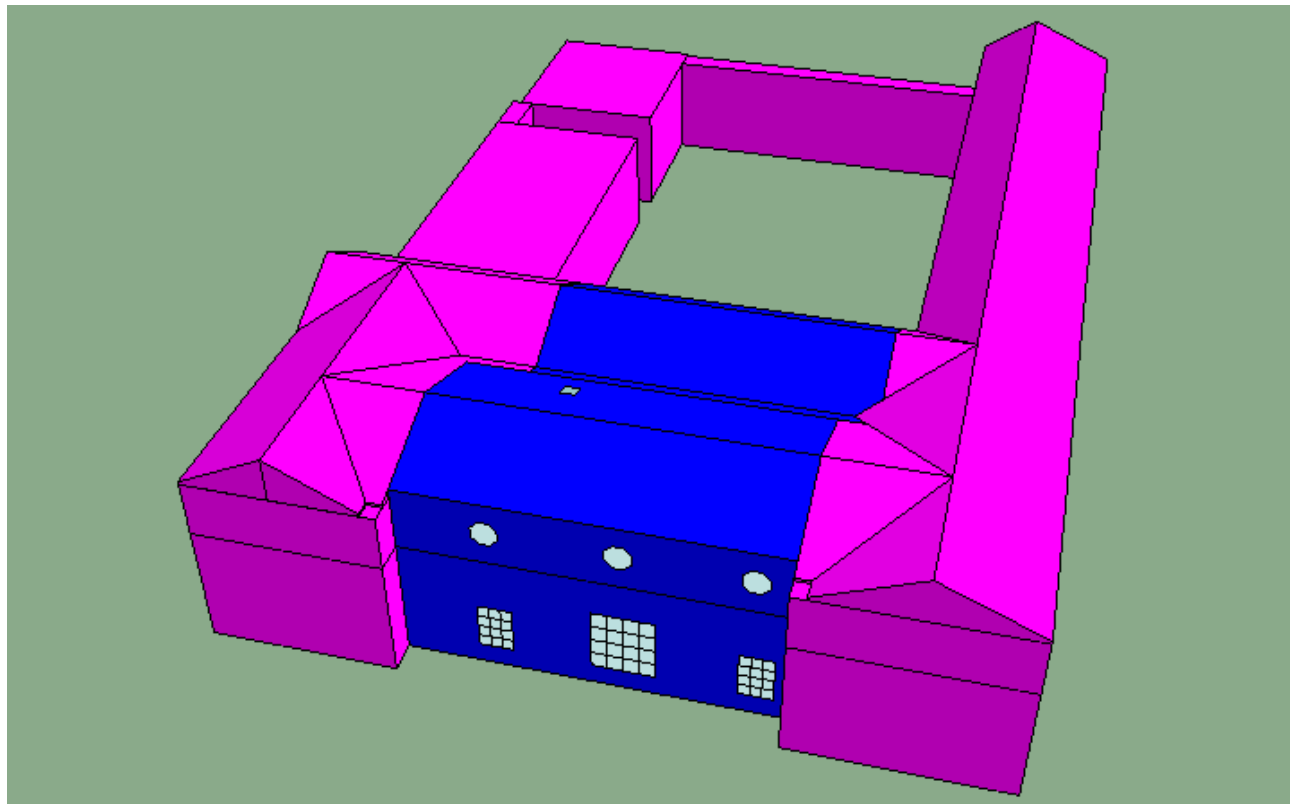
3.1 Model

In order to complete the thermal comfort assessment, a 3D computer model is required, this will be generated using IES Virtual Environment 2022 software; an advanced environmental modelling tool that is used for various building studies.

The model will be created using the following information:

- » Site survey and photos
- » CAD layouts from BTP Architects
- » Section and elevation views from BTP Architects

The 3D model which was created can be seen in the following images.



3.2 Model Inputs

Following the 3D geometry, inputs such as building fabric constructions, internal heat gains and window openings are input into the model. These are detailed in Section 4. Once all of the required inputs have been added into the model, the overheating assessment can be undertaken.

3.3 Assessment Scenarios

A number of scenarios will be modelled to investigate what effect they have on the building's thermal comfort. They will focus on the ventilation strategy. As discussed in the previous section, there are other strategies which could be investigated, such as external shading or changing the building fabric. However, due to the offices being an existing listed building, in reality, these options are not feasible.

The first scenario will be as the building has historically operated, with natural ventilation via openable windows "Historic Operation with Natural Ventilation". The second will be mechanical ventilation with typical flow rates for an office "Standard Mechanical Ventilation". The third scenario will be the same as the second, however this scenario will use higher flow rates "Enhanced Mechanical Ventilation". Both scenarios 2 and 3 will also include openable windows to aid ventilation.

- » Scenario 1 – Historic Operation with Natural Ventilation
- » Scenario 2 – Standard Mechanical Ventilation
- » Scenario 3 – Enhanced Mechanical Ventilation

3.4 Weather Files

The assessment uses weather files most appropriate to the site location. The initial runs will use weather files for the year 2020. However, to predict what effect climate change will have on the building regarding thermal comfort, the model will also be assessed using predicted future weather files for the year 2050.

4. Thermal Comfort Assessment Inputs

This section details the inputs used for the thermal comfort assessment model.

4.1 Weather Files

The TM52 assessment requires CIBSE Design Summer Year (DSY) weather files to be used for the analysis. The following weather files were used for the initial and future thermal comfort assessments:

- » Manchester DSY1 2020 High 50th percentile.
- » Manchester DSY1 2050 High 50th percentile.

4.2 Building Fabric Constructions

There are no records of the existing building's construction make-up, and therefore an assumption has been made based that the building was restored in line with the incumbent building regulations in 2002 following the fire.

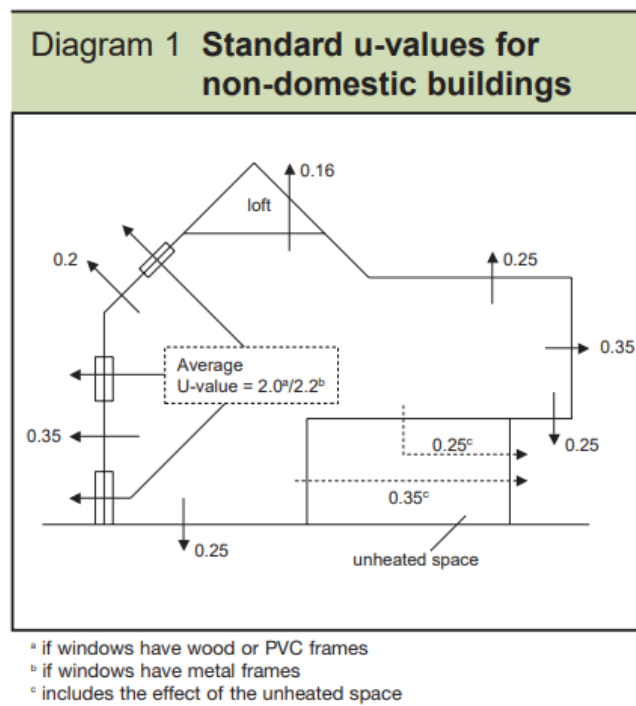
4.2.1 U-Values

U-value is a measurement of thermal performance, the lower the U-value, the better an element is at preventing heat from passing through it.

Thermal mass is the ability of a material to absorb, store and release heat. The higher the thermal mass, the more heat can be stored.

Below are excerpts from Building Regulations Part L2 2002.

Table 1 Standard U-values of construction elements	
Exposed Element	U-value (W/m ² K)
Pitched roof ^{1,2} with insulation between rafters	0.20
Pitched roof ¹ with insulation between joists	0.16
Flat roof ³ or roof with integral insulation	0.25
Walls, including basement walls	0.35
Floors, including ground floors and basement floors	0.25
Windows, roof windows and personnel doors (area weighted average for the whole building), glazing in metal frames ⁴	2.2
Windows, roof windows and personnel doors (area weighted average for the whole building), glazing in wood or PVC frames ⁴	2.0
Rooflights ^{5,6}	2.2
Vehicle access and similar large doors	0.7



The following table shows the fabric constructions used in the model.

Element	U-Value (W/m ² K)	Thermal Mass (kJ/ m ² K)
Roof	0.20	9
External Wall	0.35	9
Ground Floor	0.25	35
Windows	2.0	N/A
Rooflights	2.2	N/A

4.2.2 Glazing G-Value

Glazing G-value is a measure of how much solar energy passes through a glazing element, 1 being 100% and 0 being 0% of solar energy.

- » Glazing G-value input – 0.70

4.2.3 Air permeability

Air permeability is a measurement of a building's air tightness and is measured as the air leakage rate per hour per square meter of building envelope area at a pressure of 50 pascals.

- » Air Permeability – 10 m³/h/m² @ 50Pa

4.3 Internal Heat Gains

The internal heat gains have been based on existing furniture plans and CIBSE Guide A Environmental design information. These are included in Appendix A.

The following table shows the internal gain inputs for each type of space.

Room Type	Equipment (W/m ²)	Occupancy Density (m ² /person)	Occupancy Sensible Gain (W)	Occupancy Latent Gain (W)	Lighting (W/m ²)
Circulation	-	-	-	-	6
Kitchen / Breakout	15	12	74	56	6
Meeting Room	15	12	74	56	6
Office	15	12	74	56	6
WC	-	-	-	-	6

It should be noted that the British Council for Offices (BCO) Guide to Specification describes a typical office workplace density as 10m²/person and a high density workplace density as 8 m²/person.

4.4 Window Openings

The following window openings were applied to the model.

Window Type	Opening Type	Openable Area	Max Angle Opening	Opening Profile
1	Fixed	-	-	-
2	Centre Hung	90%	90°	Begins to open when internal temp is 23°C, fully open when internal temp is 27°C.
3	Sash	30%	-	
4	Side Hung – Wall	90%	30°	
5	Side Hung – Roof	90%	20°	



4.5 Ventilation

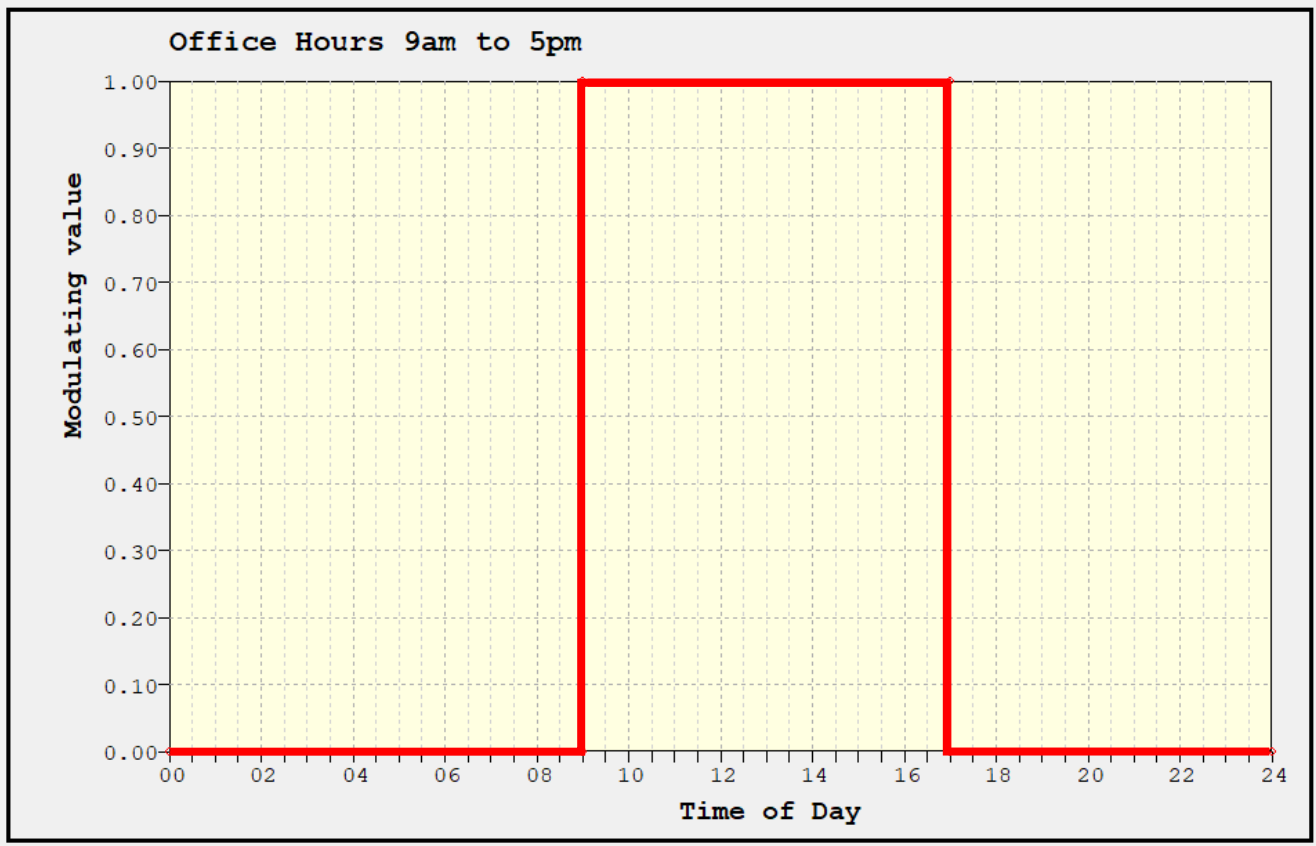
The following ventilation was applied to the model.

Room Type	Scenario 1 - Historic Natural Ventilation		Scenario 2 – Standard Mechanical Ventilation		Scenario 3 – Enhanced Mechanical Ventilation	
	Infiltration	Mech Vent	Infiltration	Mech Vent	Infiltration	Mech Vent
Circulation	0.35 ACH	-	0.35 ACH	-	0.35 ACH	4 ACH
Kitchen / Breakout	0.35 ACH	-	0.35 ACH	10L/s/person	0.35 ACH	4 ACH
Meeting Room	0.35 ACH	-	0.35 ACH	10L/s/person	0.35 ACH	4 ACH
Office	0.35 ACH	-	0.35 ACH	10L/s/person	0.35 ACH	4 ACH
WC	0.35 ACH	6 ACH	0.35 ACH	6 ACH	0.35 ACH	6 ACH

4.6 Profiles

Operating profiles are used to tell the model when the inputs should operate. All inputs including heat gains, window openings and ventilation had the below profile applied to them, meaning they were only “on” between 9am and 5pm and “off” outside of these hours.

The only input which operated constantly is air infiltration rate.



5. Thermal Comfort Assessment Results

In total 6 scenarios were modelled for the assessment. The model was run for the 3 scenarios described previously and each of these scenarios was run with 2020 weather files and also future predicted 2050 weather files.

CIBSE TM52 uses 3 criteria to determine whether a space is predicted to overheat. To comply, a space must pass 2 out of the 3 criteria. Below are the criteria descriptions taken from CIBSE TM52:

1. The first criterion sets a limit of 3 per cent of occupied hours, for the number of hours that the operative temperature can exceed the threshold comfort temperature (upper limit of the range of comfort temperature) by 1 K or more during the occupied hours of a typical non-heating season (1 May to 30 September).
2. The second criterion deals with the severity of overheating within any one day, which can be as important as its frequency, the level of which is a function of both temperature rise and its duration. This criterion sets a daily limit for acceptability. To allow for the severity of overheating the weighted exceedance should be less than or equal to 6 in any one day.
3. The third criterion sets an absolute maximum daily temperature for a room, beyond which the level of overheating is unacceptable. The internal operative temperature must not exceed the external temperature by more than 4 K.

It is worth noting that only occupied spaces are considered under TM52 analysis.

5.1 CIBSE TM52 Overheating Compliance - 2020 Weather

The following tables show whether the spaces within the modelled building comply with TM52 assessment, when modelled using 2020 weather files. If a space fails the assessment it is classed as overheating.

The results of the modelling show that each scenario fails the TM52 assessment.

5.1.1 Scenario 1 – Historic Operation with Natural Ventilation

Room Name	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing	Pass / Fail
00 - Kitchen/Break Out	71.2	21.1	45	6	1 & 2 & 3	Fail
00 - Meeting Room 01	71.2	16.9	36	5	1 & 2 & 3	Fail
00 - Office 01	71.2	16.7	30	7	1 & 2 & 3	Fail
00 - Office 02	71.2	22.7	45	6	1 & 2 & 3	Fail
01 - Kitchenette	71.2	25	43	7	1 & 2 & 3	Fail
01 - Office 01	71.2	12.7	27	6	1 & 2 & 3	Fail
01 - Office 02	71.2	27.2	47	7	1 & 2 & 3	Fail

5.1.2 Scenario 2 – Standard Mechanical Ventilation

Room Name	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing	Pass / Fail
00 - Kitchen/Break Out	71.2	16.9	40	6	1 & 2 & 3	Fail
00 - Meeting Room 01	71.2	13.1	30	5	1 & 2 & 3	Fail
00 - Office 01	71.2	10.8	24	6	1 & 2 & 3	Fail
00 - Office 02	71.2	18	43	6	1 & 2 & 3	Fail
01 - Kitchenette	71.2	16.6	36	5	1 & 2 & 3	Fail
01 - Office 01	71.2	9.8	22	5	1 & 2 & 3	Fail
01 - Office 02	71.2	17	38	6	1 & 2 & 3	Fail

5.1.3 Scenario 3 – Enhanced Mechanical Ventilation

Room Name	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing	Pass / Fail
00 - Kitchen/Break Out	71.2	8.1	23	4	1 & 2	Fail
00 - Meeting Room 01	71.2	3.4	12	3	1 & 2	Fail
00 - Office 01	71.2	3.9	11	4	1 & 2	Fail
00 - Office 02	71.2	8.6	26	4	1 & 2	Fail
01 - Kitchenette	71.2	6.6	18	4	1 & 2	Fail
01 - Office 01	71.2	4.9	13	4	1 & 2	Fail
01 - Office 02	71.2	7.6	20	4	1 & 2	Fail

5.2 CIBSE TM52 Overheating Compliance - 2050 Weather

The following tables show whether the spaces within the modelled building comply with TM52 assessment, when modelled using 2050 weather files. If a space fails the assessment it is classed as overheating.

The results of the modelling show that each scenario fails the TM52 assessment.

5.2.1 Scenario 1 – Historic Operation with Natural Ventilation

Room Name	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing	Pass / Fail
00 - Kitchen/Break Out	71.2	29.4	53	7	1 & 2 & 3	Fail
00 - Meeting Room 01	71.2	23.5	44	6	1 & 2 & 3	Fail
00 - Office 01	71.2	22.9	38	8	1 & 2 & 3	Fail
00 - Office 02	71.2	29.7	53	7	1 & 2 & 3	Fail
01 - Kitchenette	71.2	33.3	51	8	1 & 2 & 3	Fail
01 - Office 01	71.2	17	34	7	1 & 2 & 3	Fail
01 - Office 02	71.2	36	55	8	1 & 2 & 3	Fail

5.2.2 Scenario 2 – Standard Mechanical Ventilation

Room Name	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing	Pass / Fail
00 - Kitchen/Break Out	71.2	22.4	47	6	1 & 2 & 3	Fail
00 - Meeting Room 01	71.2	17.2	37	6	1 & 2 & 3	Fail
00 - Office 01	71.2	15.9	32	7	1 & 2 & 3	Fail
00 - Office 02	71.2	23.6	49	7	1 & 2 & 3	Fail
01 - Kitchenette	71.2	21.4	41	6	1 & 2 & 3	Fail
01 - Office 01	71.2	12.4	28	6	1 & 2 & 3	Fail
01 - Office 02	71.2	23.1	46	7	1 & 2 & 3	Fail

5.2.3 Scenario 3 – Enhanced Mechanical Ventilation

Room Name	Occupied days (%)	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing	Pass / Fail
00 - Kitchen/Break Out	71.2	10.8	31	5	1 & 2 & 3	Fail
00 - Meeting Room 01	71.2	5.6	19	4	1 & 2	Fail
00 - Office 01	71.2	5.2	17	5	1 & 2 & 3	Fail
00 - Office 02	71.2	11.6	33	5	1 & 2 & 3	Fail
01 - Kitchenette	71.2	9.9	26	5	1 & 2 & 3	Fail
01 - Office 01	71.2	6.3	19	5	1 & 2 & 3	Fail
01 - Office 02	71.2	10.6	27	5	1 & 2 & 3	Fail

6. Predicted Temperatures

As each scenario failed the thermal comfort / overheating assessment, the predicted temperatures were investigated to determine the severity of the overheating.

6.1 Summer Temperatures

The below tables show the predicted summer temperatures for the following scenarios:

- » 2020 Weather File - Scenario 1 Existing
- » 2050 Weather File – Scenario 1 Existing
- » 2020 Weather File - Scenario 3 Enhanced Mechanical Ventilation

Summer is defined as the start of May to the end of September.

6.1.1 2020 Weather File - Scenario 1: Historic Operation with Natural Ventilation

Room Name	Min Temp (°C)	Max Temp (°C)	Average Temp (°C)
00 - Kitchen/Break Out	20.8	34.8	26.2
00 - Meeting Room 01	20.7	34.0	25.8
00 - Office 01	20.7	35.6	25.9
00 - Office 02	20.8	35.3	26.3
01 - Kitchenette	20.7	34.9	26.4
01 - Office 01	20.6	34.4	25.7
01 - Office 02	20.8	35.3	26.7

The above table shows the predicted temperatures for the building as it currently operates, with no mechanical ventilation. It shows that the maximum temperatures during the summer are predicted to reach over 35°C and the average temperature throughout the summer above 26°C.

6.1.2 2050 Weather File - Scenario 1: Historic Operation with Natural Ventilation

Room Name	Min Temp (°C)	Max Temp (°C)	Average Temp (°C)
00 - Kitchen/Break Out	21.3	36.2	27.1
00 - Meeting Room 01	20.9	35.5	26.8
00 - Office 01	21.0	37.1	26.8
00 - Office 02	21.3	36.7	27.2
01 - Kitchenette	21.1	36.3	27.4
01 - Office 01	20.8	35.8	26.5
01 - Office 02	21.2	36.8	27.6

The above table shows the future predicted temperatures for the building if no interventions are undertaken. This is the worst-case scenario and it shows that maximum temperatures during summers are predicted to reach over 37°C and the average temperatures during summer months will be above 27°C.

6.1.3 2020 Weather File - Scenario 3: Enhanced Mechanical Ventilation

Room Name	Min Temp (°C)	Max Temp (°C)	Average Temp (°C)
00 - Kitchen/Break Out	20.5	32.6	23.8
00 - Meeting Room 01	20.6	31.6	23.1
00 - Office 01	20.6	33.2	23.1
00 - Office 02	20.4	32.7	24.0
01 - Kitchenette	20.3	32.3	23.5
01 - Office 01	20.5	32.4	23.4
01 - Office 02	20.6	32.6	23.7

The above table shows the predicted temperatures for the building if mechanical ventilation with enhanced flow rates is installed in the building now. This scenario results in the lowest temperatures of the 6 scenarios which were modelled, however the maximum temperatures still reach over 33°C.

6.2 Number of Hours Overheating

The below table shows the number of hours annually that the office spaces are predicted to spend in the following temperature ranges:

- » 20°C to 25°C – CIBSE recommended temperatures for offices
- » 25°C to 28°C – Above CIBSE recommended temperatures but below excessive temperatures
- » Above 28°C – Above temperature where increased dissatisfaction and reduced productivity is likely to occur (overheating)

	Total Occupied Hours	Hours Between 20°C - 25°C	Hours Between 25°C - 28°C	Hours Above 28°C
Annual Occupied Hours	2080	1508	399	173
Percentage of Annual Occupied Hours	100%	73%	19%	8%
Summer Occupied Hours	872	258	395	219
Percentage of Summer Occupied Hours	100%	30%	45%	25%

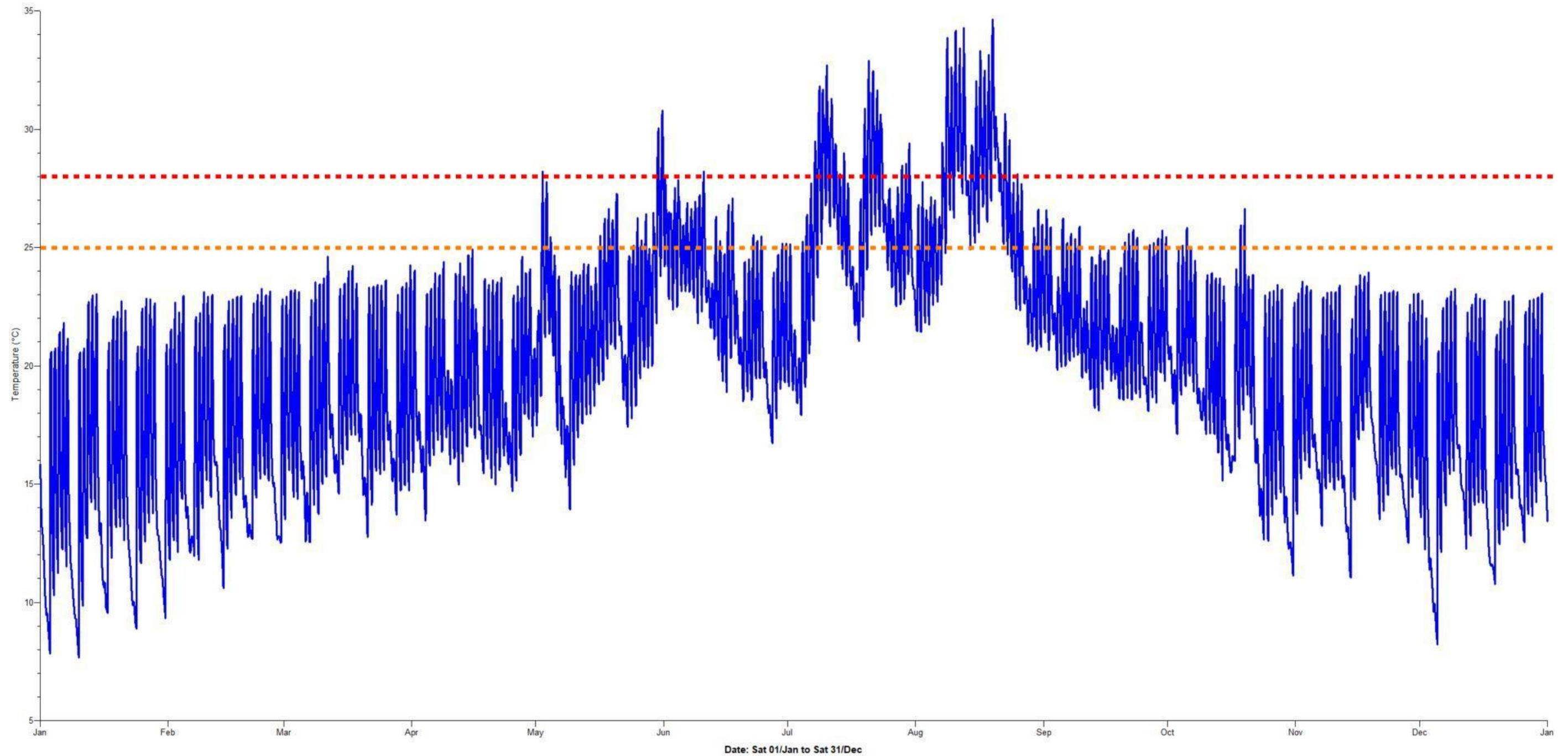
Occupied hours are defined as Monday to Friday, 9am to 5pm.

The results demonstrated that during the summer months (May to September), internal office temperatures are predicted to exceed the recommended maximum temperatures for 70% of the occupied hours.

6.3 Predicted Temperature Graph

The following graph shows predicted temperatures from the thermal comfort assessment for Scenario 1 using 2020 weather files without cooling (heating system included in model during occupied hours).

The graph highlights that during the summer months, there are many periods where internal temperatures are predicted to exceed the suggested maximum summer temperature of 25°C (orange dashed line) as well as 28°C (red dashed line) where increased dissatisfaction and reduced productivity are likely to occur.



7. Conclusion

7.1 Thermal Comfort Assessment Outcome

The offices known as The Stables, located in Parrs Wood, Manchester, were modelled following a site survey and investigation into the existing building services. Three different scenarios were simulated; the first simulation was as the building historically operated, with natural ventilation. The two other scenarios looked at mechanical ventilation as an alternative way to cool the offices without using a cooling system:

1. **Historic Operation with Natural Ventilation:** This scenario modelled the office as it has historically operated, with natural ventilation using openable windows.
2. **Standard Mechanical Ventilation:** The second scenario included mechanical ventilation with typical flow rates for an office. Mechanical ventilation can help cool spaces by extracting warm stale air and supplying fresh cooler air from outside.
3. **Enhanced Mechanical Ventilation:** The final scenario is the same as the second; however this scenario used a higher flow rate, meaning more fresh air is supplied to the spaces.

All three scenarios were modelled using current weather data. The scenarios were also modelled using future weather data (year 2050) to predict what effect climate change would have on the thermal comfort of the offices.

The results from the modelling showed that all of the scenarios failed the thermal comfort / overheating assessments for both current and future weather data.

Following the failed thermal comfort assessment, the predicted temperatures were investigated to determine to what extent the building was predicted to overheat.

The results demonstrated that during the summer months (May to September), internal office temperatures were predicted to exceed the recommended maximum temperatures for 70% of the occupied hours.

Results showed that if no intervention is undertaken, temperatures are predicted to reach above 35°C. This is markedly higher than any office temperatures which people would typically be expected to work in.

Whilst including mechanical ventilation did improve the thermal comfort of the occupied spaces slightly, the spaces still exceeded the CIBSE recommended thermal comfort levels by a significant margin.

It is concluded that in order to achieve a comfortable and reasonable temperature within the spaces during the summer months, additional intervention is required.

7.2 Recommended Solution

In order to achieve a comfortable and reasonable temperature, during summer months, in line with legislation and industry guidance, the recommendation is to provide a fixed cooling system for all occupied spaces. If the system is also set up to provide heating during the winter, then the spaces can be adequately heated at an increased efficiency (compared to traditional boiler fed or electric radiator systems).

The recommended solution offers the greatest benefit in terms of both thermal comfort and carbon emissions.

Providing a fixed heating and cooling system would deliver the following benefits.

- » Thermal Comfort
- » Energy / Carbon Efficiency
- » Wider Public Benefits

7.2.1 Thermal Comfort

The modelling showed that the office spaces are predicted to overheat against the criteria set out in CIBSE TM59. Installing a combined heating and cooling system would ensure that all spaces could be maintained at a comfortable temperature throughout the year.

There are alternative solutions to minimise overheating, however only a fixed heating and cooling system fully addresses the overheating risk. A fixed heating and cooling system is also the only solution which will ensure that the building is future proofed against the increased future impacts of global warming and climate change.

The main alternative overheating prevention option to comfort cooling is increased mechanical ventilation. This was investigated in the thermal comfort model but the increased mechanical ventilation options were found to fail the thermal comfort assessment. This solution was also found to be more intrusive, requiring plant, louvres and penetrations through a building's façade or roof, as well as the ventilation units and ductwork to be coordinated with the existing building and services and structural beams.

7.2.2 Energy / Carbon Efficiency

A benefit of installing a fixed heating and cooling system, is that the systems offer improved heating efficiencies over traditional heating systems such as electric radiators or gas fired boilers. Installing the described system would mean the heating energy efficiency would be dramatically increased. Typical efficiencies are shown below:

- » Boilers approximately 90%
- » Electric radiators 100%
- » Heat Pumps (fixed heating and cooling system) approximately 350%

Installing a fixed heating and cooling system would result in a reduction of the building's overall heating energy consumption and carbon emissions.

7.2.3 Wider Public Benefits

Successfully implemented decarbonisation strategies will clearly deliver tangible environmental benefits that will inevitably include wider public benefits. The installation of an appropriately designed cooling system has improved the buildings demonstrably poor environmental performance, increasing its desirability as high-quality office accommodation and ensuring its longevity.

An ever increasing proportion of quality UK rental office space now includes comfort cooling as standard. As global warming impinges further on our society, office spaces without cooling may struggle to attract tenants and thereby increase the risk of buildings like this falling into disrepair through lack of continued use. This will particularly affect retrofit opportunities in older buildings with similar physical characteristics as the Stables. These buildings do not easily accommodate modern services without major interventions which can significantly damage appearance or fabric. This is not the case at the Stables as the physical configuration of the building allows the air handling plant to be located where it has no impact on the appearance of the historic building. Installing the cooling system in this case will enable the building to remain viable in spite of the forecast rising temperatures. This will be essential in ensuring the sensitive ongoing maintenance of the listed fabric, retaining positive use and thereby its contribution to the local community and economy for future generations.

Our understanding is that the previous occupier who owned the building for over 20 years may have previously attempted to address the needs of the current climate crisis, but had not taken steps to remedy the situation, as

their tenure was not critically affected by meeting the demands of the current climate crisis, or perhaps was unable to make the significant investment required in implementing a viable solution.

As well as this, the public will also gain from the environmental benefits delivered. The UK government has a stated commitment to achieve net zero by 2050. In aspiring to achieve this target, all building owners/stewards will need to look closely at ways to reduce their energy consumption and carbon emissions. An integral part of that strategy is to move away from the use of fossil fuels. Installing a cooling system which also provides heating during the winter months is in line with this plan and is substantially more efficient than using electric radiators.

All energy saving strategies implemented will have the result of benefitting the public in the long term.

Appendix A CIBSE Guide A Environmental Design Information

Table 6.3 Heat emission (W) from an adult male body (of surface area 2 m²) and average heat emission per person for a mixture of men, women and children typical of the stated application

Activity	Typical application	Occupancy density (m ² /person)	Total, sensible and latent heat emission (W) for stated application and dry bulb temperature (C) for adult male and (average for mixture of men, women and children)										
			Total	15		20		22		24		26	
				Sensible	Latent	Sensible	Latent	Sensible	Latent	Sensible	Latent	Sensible	Latent
Seated, inactive	Theatre, cinema (matinee)	0.75–1.0 ^(2,3)	115 (100)	100 (87)	15 (13)	90 (78)	25 (22)	80 (70)	35 (30)	75 (65)	40 (35)	65 (57)	50 (43)
Seated, inactive	Theatre, cinema (evening)	0.75–1.0 ^(2,3)	115 (105)	100 (91)	15 (14)	90 (82)	25 (23)	80 (73)	35 (32)	75 (68)	40 (37)	65 (59)	50 (46)
Seated, light work	Restaurant	1.0–2.0 ^(2,3)	140 (126)	110 (99)	30 (27)	100 (90)	40 (36)	90 (81)	50 (45)	80 (72)	60 (54)	70 (63)	70 (63)
Seated, moderate work	Office	8–39 ⁽⁴⁻⁶⁾ , 14 ^{(4,7)*}	140 (130)	110 (102)	30 (28)	100 (93)	40 (37)	90 (84)	50 (46)	80 (74)	60 (56)	70 (65)	70 (65)
Standing, light work, walking	Department store	1.7–4.3 ^(2,3)	160 (141)	120 (106)	40 (35)	110 (97)	50 (44)	100 (88)	60 (53)	85 (75)	75 (66)	75 (66)	85 (75)
Standing, light work, walking	Bank	—	160 (142)	120 (107)	40 (35)	110 (98)	50 (44)	100 (89)	60 (53)	85 (76)	75 (66)	75 (66)	85 (76)
Light bench work	Factory	—	235 (209)	150 (133)	85 (76)	130 (116)	105 (93)	115 (102)	120 (107)	100 (89)	135 (121)	80 (71)	155 (138)
Medium bench work	Factory	—	265 (249)	160 (150)	105 (99)	140 (132)	125 (117)	125 (117)	140 (132)	105 (99)	160 (150)	90 (85)	175 (164)
Heavy work	Factory	—	440 (440)	220 (220)	220 (220)	190 (190)	250 (250)	165 (165)	275 (275)	135 (135)	305 (305)	105 (105)	335 (335)
Moderate dancing	Dance hall	0.5–1.0	265 (249)	160 (150)	105 (99)	140 (132)	125 (117)	125 (117)	140 (132)	105 (99)	160 (150)	90 (85)	175 (164)

* Recommended

Notes:

(1) Figures in parenthesis are adjusted heat gains based on normal percentage of men, women and children for the applications listed. This is based on the heat gain for women and children of 85% and 75% respectively of that of an adult male.

(2) For restaurant serving hot meals add 10 W sensible and 10 W latent for food per individual.

Table 4.16 Empirical values for air infiltration rate due to air infiltration for rooms in buildings on normally exposed sites in winter: office type 1 (naturally ventilated up to 6 storeys (100–3000 m²)); partial exposure

Air permeability / (m ³ /m ² ·h at 50 Pa)	Infiltration rate (ACH) for given building size / h ⁻¹							
	1 storey; 250 m ² (20 m × 12.5 m × 3 m)*		2 storeys; 500 m ² (20 m × 12.5 m × 3 m)*		4 storeys; 2000 m ² (25 m × 20 m × 3 m)*		6 storeys; 3000 m ² (25 m × 20 m × 3 m)*	
	Peak	Average	Peak	Average	Peak	Average	Peak	Average
20.0 (leaky)	1.20	0.90	0.95	0.70	0.75	0.55	0.75	0.55
10.0 (Part L (2002))	0.60	0.45	0.50	0.35	0.40	0.30	0.40	0.30
7.0 (Part L (2005))	0.45	0.30	0.35	0.25	0.25	0.20	0.30	0.20
5.0	0.30	0.25	0.25	0.20	0.20	0.15	0.20	0.15
3.0	0.20	0.15	0.15	0.10	0.15	0.10	0.15	0.10
Air change rate at 50 Pa (/ h ⁻¹)	9.30		5.95		3.50		2.95	
ACR ₅₀ divisor	22.0		16.9		13.5		11.5	

* (length × width × height) for each storey

Table 6.1 Benchmark values for internal heat gains for offices (at 24 °C, 50% RH)

Building type	Use	Density of occupation / m ² per person	Sensible heat gain / W·m ⁻²			Latent heat gain / W·m ⁻²	
			People	Lighting	Equipment	People	Other
Office	General	4	20	12	25	15	—
		8	10	12	20	7.5	—
		12	6.7	12	15	5	—
		16	5	12	12	4	—
		20	4	12	10	3	—

range of values of 8–12 W·m⁻² for the lighting heat gain allowance is based on fluorescent lamps with high frequency ballasts. The upper value is appropriate to older installations and the lower to current guidance in the *The SLL Code for Lighting* (SLL, 2012). LED lamps are becoming more common and these values can be reduced by up to 50% if these lamps are used.

but a method for estimating the heat gains from laboratory animals is given in section 6.9.

The emission of heat from a human body in relation to the surrounding indoor climate is discussed in section 1.3.1.5 of this Guide. Table 6.3 provides representative heat emissions (sensible and latent) from an average adult male in different states of activity. The source for a mixture of