

What's included

This underfloor heating mat kit includes the following:

- High performance, self-adhesive Foil Mat 150 W/m²
- 1 x Thermostat (free Digital Touchpad thermostat, usual price £45)
- 1 x Commercial strength UFH tape
- 1 x Floor Probe Conduit
- 1 x Free next day delivery to mainland UK (Highland may take 3 days)

Kits covering more than 10m² comprise of 2 or more mats.

Each mat is approximately 0.5m wide.



Build Quality

Engineered to the highest European standards.

Low Cost

The heating mats are of the highest quality yet are provided to you at extremely competitive prices.

Minimal wiring

With mat sizes up to 10m² available, in most rooms there will be no more than one or two mats that will need to be wired into your home.

Fast response time

The mat has 100% heat diffusion coverage due to its foil layer which maximises the output of the system reducing response time.

Even heat distribution

The reinforced foil ensures even heat distribution.

Earthed

The system is earthed for added safety.

Warranty

The Rayoflex foil cable heating mat has a 30 year Manufacturers Warranty.

No self-levelling adhesive required

No expensive extra costs, mess or waiting time for adhesives to dry as the system is designed so that the final floor covering is laid directly on top!

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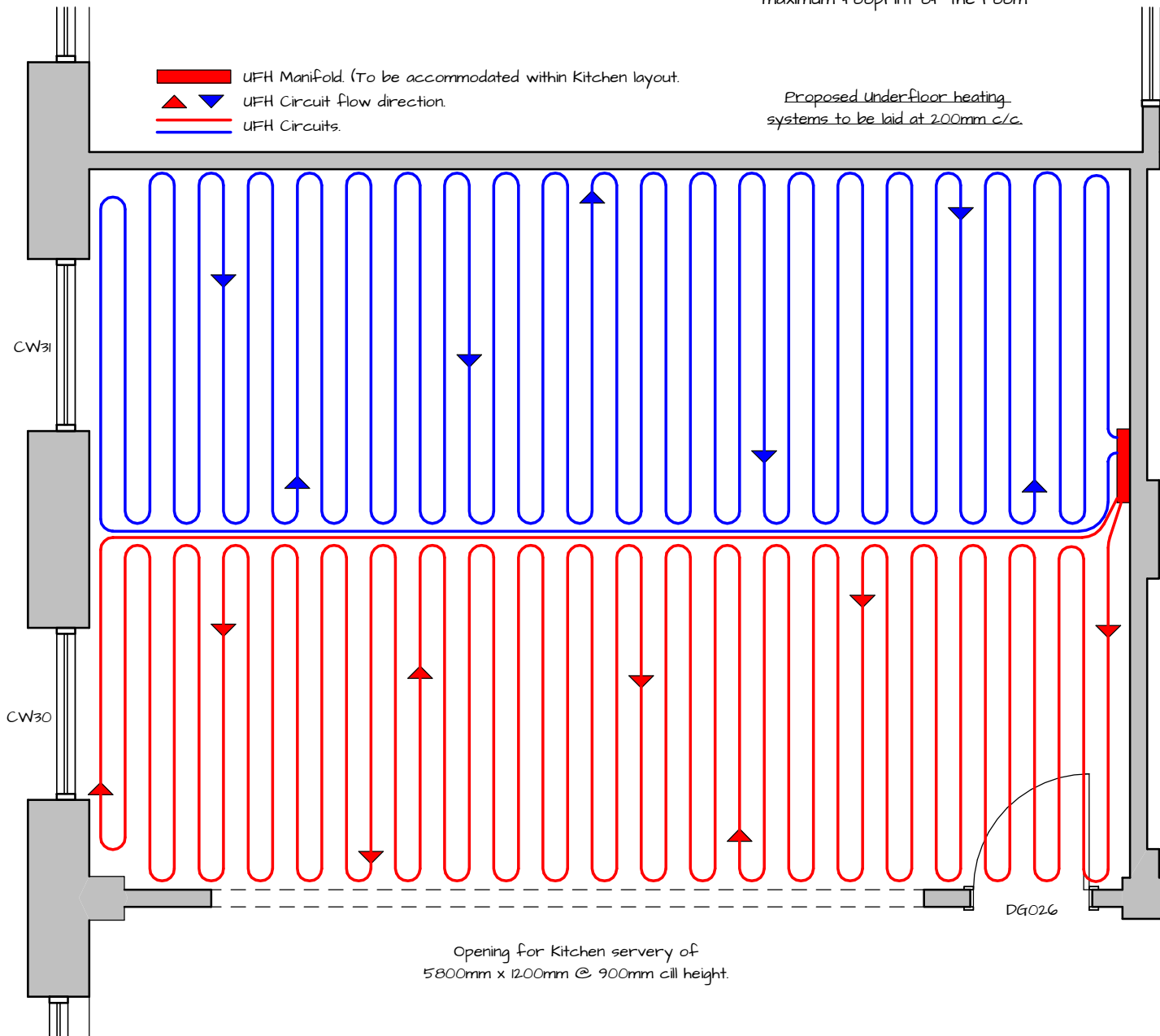
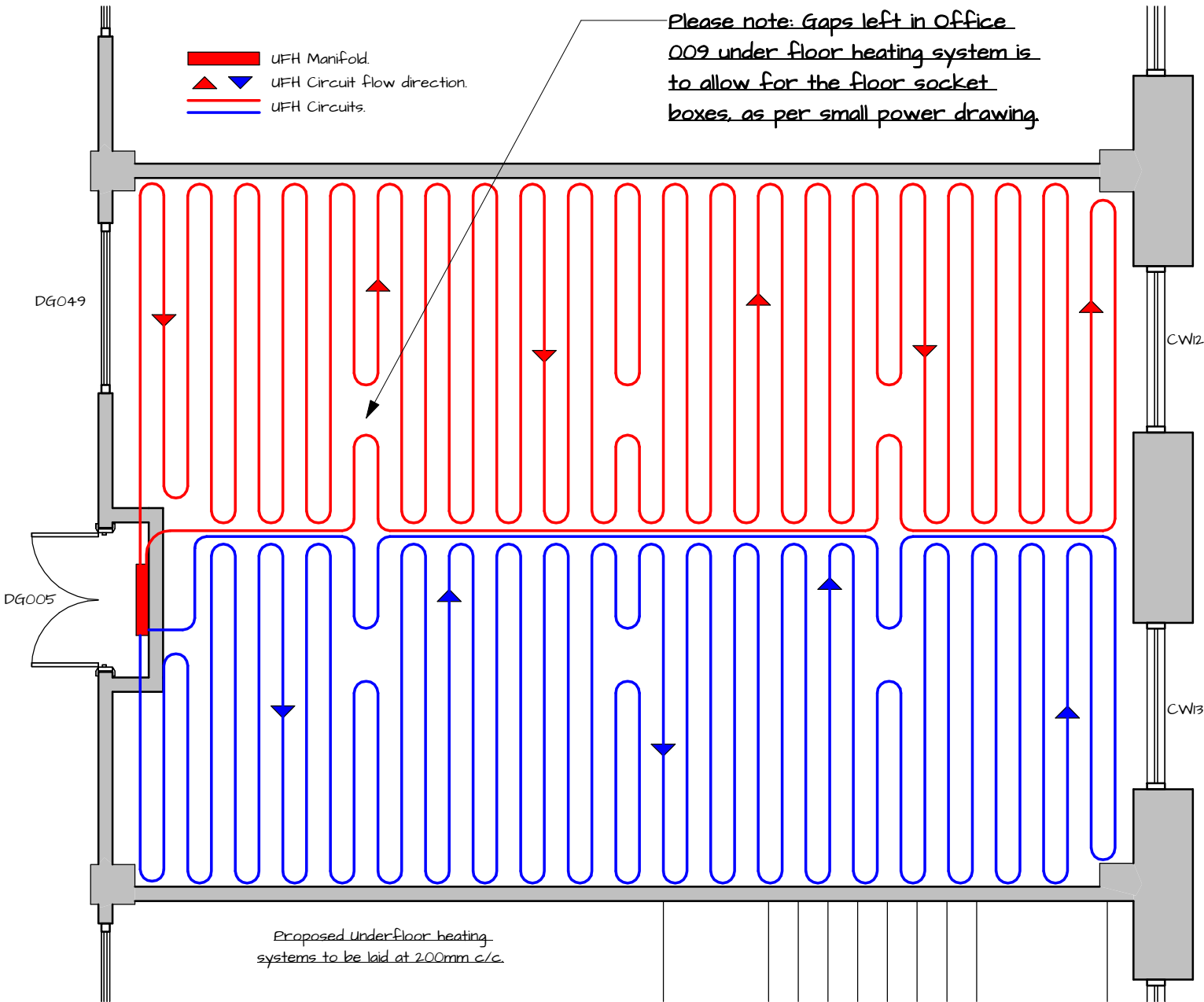


A Services Drawings.

09/05/24

This system will bring lasting benefits to the Office's performance, with the heat distribution being consistent and evenly distributed throughout the space. The thermostatic controlled system allows the temprature of the room to vary depending on the occupants needs and comfort levels. An under floor heating system will give the room additional floor space and there will be no wall mounted fixtures, optimising the maximum footprint of the room

RAYOTEC UNDER FLOOR HEATING SYSTEM



1 Office 009 - UFH Circuits

2 Kitchen - UFH Circuits

LGH-RVXT-E
Commercial Series

The Commercial Lossnay (LGH) Mechanical Ventilation Heat Recovery (MVHR) systems are designed to supply clean, fresh air into commercial buildings, whilst simultaneously extracting stale air.

The **RVXT** units offer a significantly reduced height whilst maintaining a large airflow, allowing easy installation in ceiling voids.

Key Features & Benefits:

- Fresh air ventilation for improved air quality
- Mitsubishi Electric pioneered heat exchanger enables maximised latent heat exchange, resulting in cost and carbon savings
- Lightweight structure ideal for ceiling installation
- No condensate drain requirement
- Unit height of 500mm for ease of application
- Compatible with Mr Slim and City Multi air conditioning systems for a complete and highly effective system operation
- Optional high efficiency filters available

MVHR UNIT FEATURES



Plasma Quad Connect
Air Purifying Device

Mitsubishi Electric's powerful bolt-on air purifying device delivers Plasma Quad Technology to both new and existing installations of M-Series, Mr Slim and City Multi indoor units. Plasma Quad Technology significantly improves indoor air quality by neutralising 6 key indoor pollutants, as well as inhibits 99.8% of SARS-CoV-2*.

AC UNIT

- General**
- 6.1 This Approved Document sets out guidance for the following range of building types and uses:
- (a) offices – paragraphs 6.9 to 6.17;
(b) car parks – paragraphs 6.19 to 6.22;
(c) other building types – paragraph 6.18.
- 6.2 The **ventilation** provisions will not necessarily meet cooling needs. Guidance on limiting solar gains in summer to control overheating is considered in Approved Document L2A Conservation of fuel and power in new buildings other than dwellings.
- 6.3 Provision should be made to protect the fresh air supplies from contaminants injurious to health. Guidance on the siting of air inlets is provided in Appendix D.
- 6.4 Guidance on design measures to avoid legionella contamination, including design features not related to the **ventilation** of the building, is given in the HSE document Legionnaires' disease: the control of legionella bacteria in water systems (see paragraphs 79 to 144). Further guidance may be found in CIBSE TM13 Minimising the risk of Legionnaires' disease and in BSRIA Application Guides AG19/2000, AG20/2000 and AG21/2000.
- 6.5 Guidance on recirculated air in airconditioning and mechanical **ventilation** systems is given in HSE document L24 Workplace health, safety and welfare, Workplace (Health, Safety and Welfare) Regulations 1992, Approved Code of Practice and guidance (paragraph 32).
- Access for maintenance**
- 6.6 Reasonable provision would be to include:
- (a) access for the purpose of replacing filters, fans and coils; and
(b) provision of access points for cleaning duct work.

LUXAIR™
EXTRACTION WITH ATTRACTION

LA-NUVOLA-STRATOS

Charcoal Filters
Charcoal Filter Nuvola

Fuse Type
3 amp

Duct Size
N/A

Metal Grease Filters
LA-90-NUVOLA x2 350x200
LA-120-NUVOLA x3 350x200
You must measure your mesh grill size. Older models will have different sizes to current models.

Warranty
7 Years (Parts & Labour)

EEL Rating
A

Remote Control
Yes

Lighting
90cm 4x 1.2w LED Spots - 4000°Kelvin
120cm 5x 1.2w LED Spots - 4000°Kelvin

Motor
950m³/hr Recirculating Motor

Switch Type
N/A

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A Services Drawings.

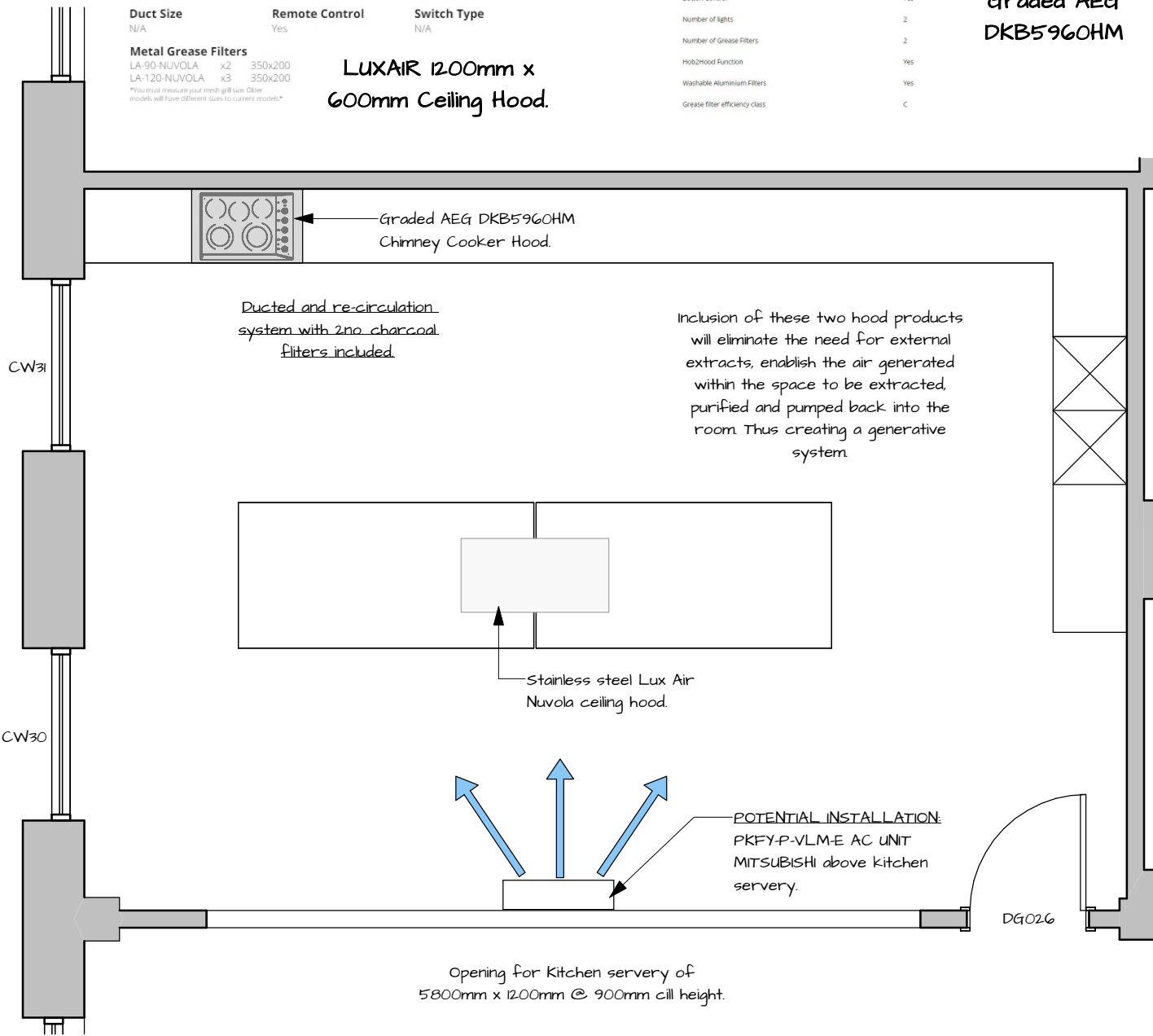
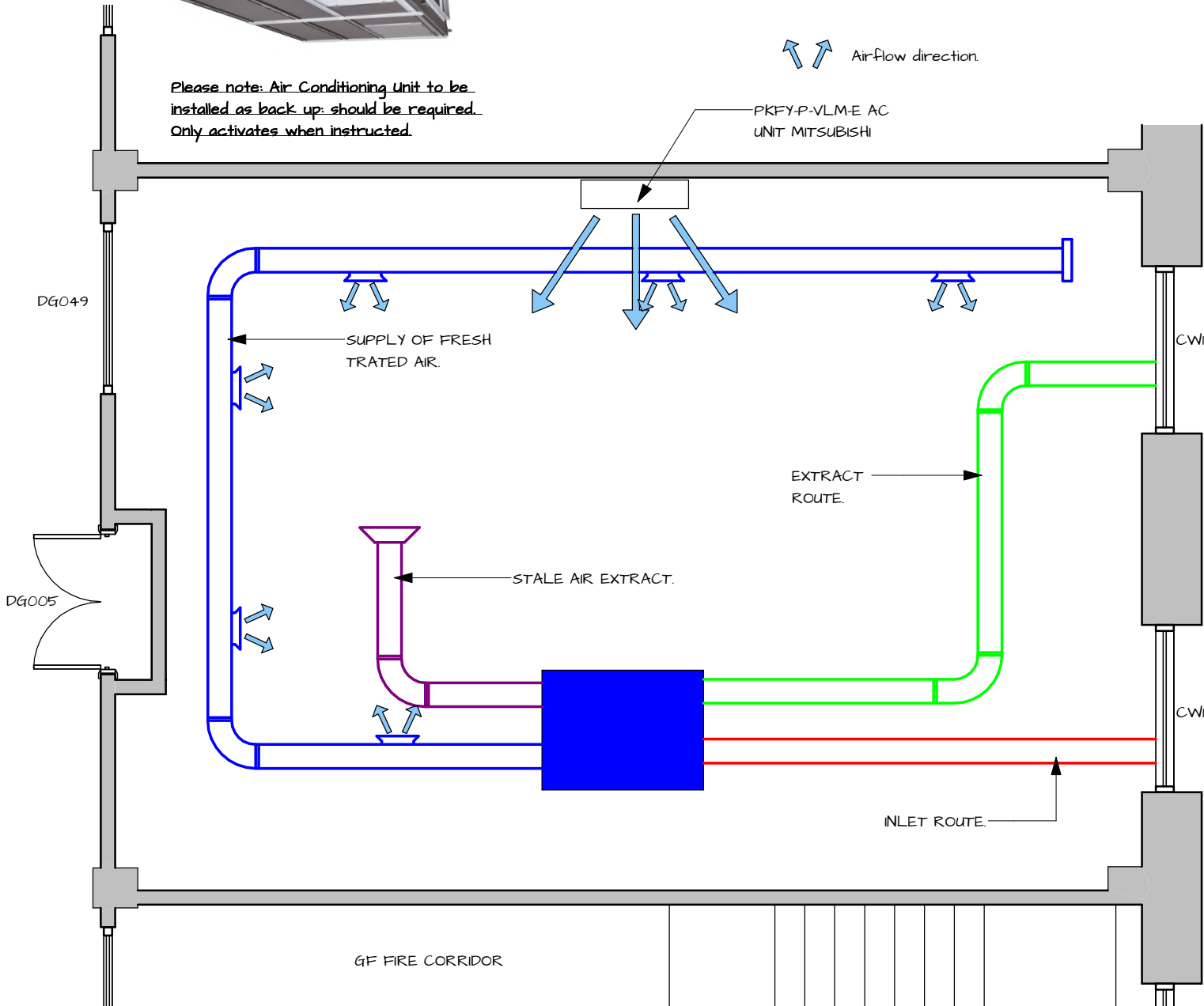
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Specifications

PRODUCT	
Type	90cm Chimney Cooker Hood
Brand	AEG
Model	DKB5960HM
GENERAL	
Colour	Stainless Steel
Installation Type	Ducted & Recirculation
Number of Speed Settings	3
Button Control	Yes
Number of Lights	2
Number of Grease Filters	2
Hob/Hood Function	Yes
Washable Aluminium Filters	Yes
Grease filter efficiency class	C



Graded AEG
DKB5960HM



1 Office 009 - Ventilation

2 Kitchen - Ventilation

Task 01 – Part B.

In conjunction with the attached drawings, the task was given to specify the following systems to the allocated spaces: Heating, Air Conditioning and Ventilation. The areas required to be specified were the Kitchen/Café area and an Office space, and with sustainability being the core of all decisions, careful consideration was required. In terms of a heating system, consideration was given to radiant panels and an underfloor heating system, which in turn gave lasting benefits as far as performance and sustainability were concerned. The sustainability attributes of both coincided, with both being valid options for these spaces, but upon analysis of their comfort levels, applying and envisaging these systems in real-life operation, the most adequate would be an underfloor heating system.

When selecting a heating system for spaces such as these, not only is it important to consider the sustainability aspects, but also the occupation and use of the spaces. The Kitchen area will remain a constant, but with intentions in place to possibly rent the Office spaces out independently, the services should be applied to cater for all eventualities. Therefore, the underfloor system should be zonal controlled, with each room controlled independently, this allows for rooms to only be heated when occupied or when necessary, which would reduce carbon emissions significantly. Each room will have its own thermostat and manifold built in, with an electronically openable valve fitted to the underside of the manifold. Should the thermostat detect the requirement for heat, it would open the aforementioned valve and this would then fire up the boiler.

In terms of heating, this played a vital role in determining the system, as an underfloor heating system is completely hidden, with no surface mounted appliances, optimising the entire footprint of the room, benefiting the occupants. Also, given the two spaces are contrasting in usage and occupancy, the floor finish will most definitely be different, which is not an issue as underfloor heating systems can be laid beneath any floor covering, giving it the flexibility to be used anywhere within the building. Generally, overheating is a hot topic with this building given the volume of south facing glazing and the choice of external cladding, but it should not be an issue in these spaces given the consistent and even heat distribution that an underfloor heating system offers. For example, should a radiator be placed on the external wall, it would release heat into the room, but would take a longer amount of time to distribute evenly, ultimately ending in temperature variations and cold spots. Whereas an underfloor heating system covers the entire footprint of the space, and given that heat rises, it would create a comfortable environment to be a part of. Lastly, it gives benefits to the occupants as the system operates silently, resulting in no excessive disruptive noises.

For the Office space, I have specified the *Rayotec Electric Underfloor Heating Mat Kit for Under Carpet*, which is renowned for its ease of installation and low costs. Its efficiency is unquestionable as the foil layer gives the mat a 100% heat diffusion coverage, which in turn maximises the output, minimising delays in the heat transfer. This specific system has a heat output of 150W/m², which Rayotec believe is more than adequate, as it provides the standards of current building regulations. To maximize the sustainability and efficiency of their systems, the thermostats are designed to automatically turn off heat supply when the room reaches a temperature of 27°, which can minimise overheating and running costs, making it far more efficient. The cost of this system starts at £127 which includes their own 'Coloursense WIFI Thermostat'.

The system chosen for the Kitchen/Café area is similar in functionality and heat output, but has a considerably less upfront cost, beginning at £90 including the thermostat. This system is referred to as *Electric Underfloor Heating Mat Kit for Under Tiles, Vinyl, Amtico & Karndean*, which is renowned for its' fully adhesive mats, giving the smoothest possible finish. <https://www.rayotec.com/electric-underfloor-heating>

To conclude, these specified underfloor heating systems should provide enough heat for these two spaces, as the occupancy of the Office room would generate additional heat, which in turn would minimise the need for the UFH system to operate. Whereas the Kitchen area will have enough generated heat from the appliances and activities to accommodate a comfortable environment, again, potentially minimising the need for the underfloor heating system to be operated.

In terms of Air conditioning and ventilating the spaces, I have chosen a Mechanical Ventilation Heat Recovery system for the Office space, which will be situated carefully alongside the structural elements of the building within the suspended raft ceilings. The main objective of this system is to regulate the temperature of the incoming air, and relying much less on the system generally, through utilizing air that would otherwise be lost from the building. The main advantage here is that the consumption of energy is much less, which in turn, lowers the carbon footprint. Despite their sustainability rewards, it does come at an extensive cost, but due to the high efficiency, it enables the system to work for shorter periods of time, resulting in financial saving. Like the underfloor heating systems, overheating can be managed successfully with the MVHR system having the ability to control humidity and comfort levels within a certain space, working harder to generate fresh clean air should the air quality weaken, and the humidity levels rise. Also, this humidity thermostat will be PIR controlled, enabling high-sensitivity and detection to any human movement. This will assist in activating the MVHR system as the sensor will be triggered immediately upon detection, giving the space the best chance of providing a comfortable indoor environment.

The clients' aspirations of potentially altering the use of the rooms and leasing out independently, again evokes the need for them to be individually controlled. These Mechanical Ventilation Heat recovery systems will be independent for each Office space within the building, ensuring that the temperature and humidity levels can be controlled solely based on the room requirements. Not only is this system a great solution for the Office spaces, but a great solution for the entire building. Should this system be implemented throughout the building, it would become fast-moving towards being a net-zero structure, with all ventilation being provided through natural air filtered in and out of the building.

In terms of sustainability, heating and cooling of a building now accounts for 40% of the energy usage consumption of a building, which is a significant figure. Due to this rise, there was an excellent demand for sustainable solutions and as a result, MVHR Units have fast become an innovative system which offers great energy efficiency benefits. According to an article published by the *Ventilation Megastore*, the energy consumption of a building can be reduced by a staggering 90% through using MVHR systems.

Specifically, to this scheme I have chosen to implement a Mitsubishi Electric product for the MVHR system, as it has several sustainable features which would assist in making the building as efficient as possible. The specific model is the *Lossnay LGH-150RVXT-E*, which

is a unique model, with great ability to recover valuable heat energy, maximising the efficiency. One of the main features of this model is its' slimline design, being a lightweight structure and having a unit height of 500mm, makes it an ideal solution for installation in confined spaces and within ceiling voids. Based on the Mitsubishi guidelines and specification, this model will require a 250mm x 750mm duct to accommodate the adequate airflow required. One of the main objectives behind this task was to specify a sustainable and efficient system to accommodate the requirements of the buildings' performance, and with the implementation of the Lossnay MVHR unit, its' pioneered heat exchanger allows for maximised heat exchange, evidently, resulting in carbon and cost savings. Occupancy and use of the space is crucial in determining the MVHR system, as the ability to install the system within the ceiling void or above the suspended elements, it can remain hidden and not impact the overall area of the room. *Mitsubishi Electric. Ventilation Units.* {Accessed 22nd April 2024}. Online. <https://es.mitsubishielectric.co.uk/products/ventilation>. Information regarding the running costs of this system is uncertain, but there is an initial upfront cost of £4,465.11 (Inc. VAT) for the purchase of the unit. GNP Air Conditioning. {Accessed 22nd April 2024}. <https://www.gnp-airconditioning.co.uk/product/lgh-rvxt-e/>

The Kitchen and Café area within the building will not be a fully functioning kitchen serving multiple hot meals regularly throughout the day, therefore, there is no need for a full commercial extract system. Due to the kitchen only preparing small hot meals such as paninis etc, the volume of moisture and steam circulating the air will be significantly lower, resulting in the possibility of including a much more feasible ventilation system. I have chosen to adopt a Rated A Efficiency re-circulating cooker hood system, which will eliminate the requirement for an external wall extraction.

The exact product is the *SAC (Staffs Appliance Centre) Graded AEG DKB5960HM 90cm Chimney Cooker Hood*. Independently controlled systems have been an important consideration throughout this project, with heating and cooling being specific to certain spaces. Supporting this consideration, the SAC product specified has three speed settings, enabling the extract to work at different speeds based on the demand. The embodied carbon of this product is low due to the Aluminium filters included being washable, and no need to replace after a period. Staff Appliance Centre. {Accessed 14th May 2024}. Online. https://www.staffsappliancecentre.co.uk/graded-aeg-dkb5960hm-90cm-chimney-cooker-hood.html?adGroupId=158906270792&device=c&gad_source=1&gclid=EAlaIqObChMIgph9scmMhgMVp5dQBh0grgrCEAQYAIBEGK0zfD_BwE

All odours and moisture present within the space will be sucked up by this system, purified and then pumped back into the room, creating a generative system. As part of the purifying process, there will be a carbon/charcoal filter located central of the hood. In terms of its' advantages, this system is a lot easier to install than most extraction/ventilation systems, and eliminates the requirement for ducting, which ultimately lowers the installation costs and maintenance costs. Despite all external ducts being insulated to minimize the heat loss from within the building, this system eliminates this completely, with the entire system being located within the space. On the other hand, an article focusing on the comparison of conventional extracts and re-circulating hoods, claim that due to the air being re-filtered and re-used, it may lead to the space becoming far more humid, which would typically result in an uncomfortable environment. Shipit Appliances. Cooker Hoods: Recirculation Hoods vs Extraction Hoods. {Accessed 14th May 2024}. Online.

<https://www.shipitappliances.com/cooker-hoods-recirculation-hoods-vs-extraction-hoods/#:~:text=If%20you%20do%20not%20have,it%20back%20into%20the%20room.>

In addition to this, there will also be a ceiling hood located above the food preparation area in the middle of the Kitchen, getting rid of any moisture and steam generated out of reach of the afore-mentioned cooker hood. I have chosen a '*LUX AIR*' product; LA-120-NUVOLA-STRATOS-SS, which is a 1200mm x 600mm stainless steel hood with 5no. 1.3W LED spotlights incorporated. In terms of the filtering process, I have decided that the long-life ceramic carbon filter is the most adequate for this use, as it's possible to extract the filter and clean it when required. It's stated that should the hood only be asked to function for around 2-3 hours a day, the system can last up to 2-3 years, whereas the standard carbon filter requires changing every 3-6 months. This lowers the maintenance significantly and lowers the embodied carbon associated with the product. Lastly, this product has great EEI (Energy Efficiency Index) rating of A, making it an incredibly sustainable product, which is at the forefront of this project. Lux Air Extraction with Attraction. {Accessed 14th May 2024}. Online. <https://luxairhoods.com/Recirculating-Ceiling-Cooker-Hood-120cm-stainless-steel>

FIXTURES AND SCHEDULE

Lighting Fixtures: **SERA** STLI49 Suspended LED Linear Lighting.
Adexa Rise & Fall Dome Heat Lamp Black | Adexa AG5121402.

Electrical Fixtures: **switch** LS 990 Matt Black Sockets.
THE SWITCH DEPOT Knightsbridge Screwless Matt Black 2G Light Switch SF3000MBB.
DATA COMMS DIRECT Floor Box 3 Comp - 4x UK Power & 6C Plate.

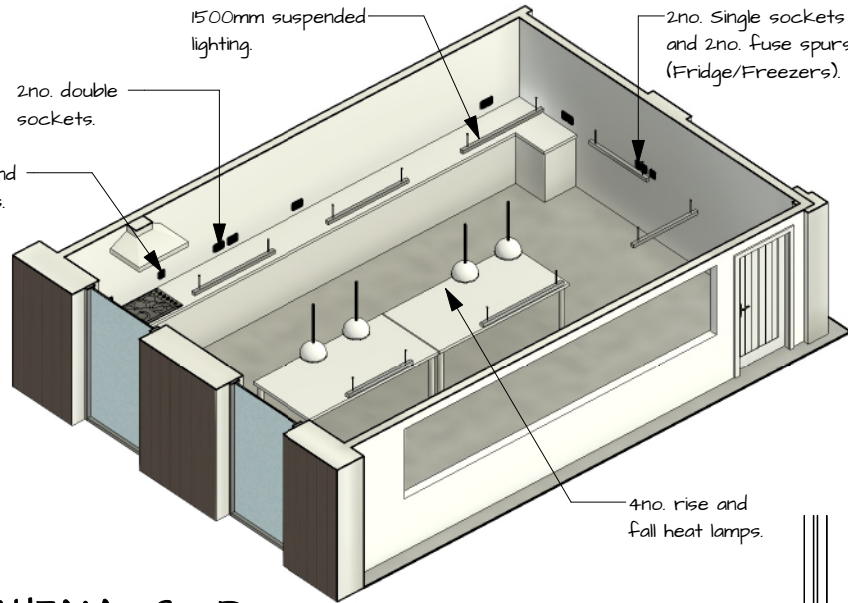
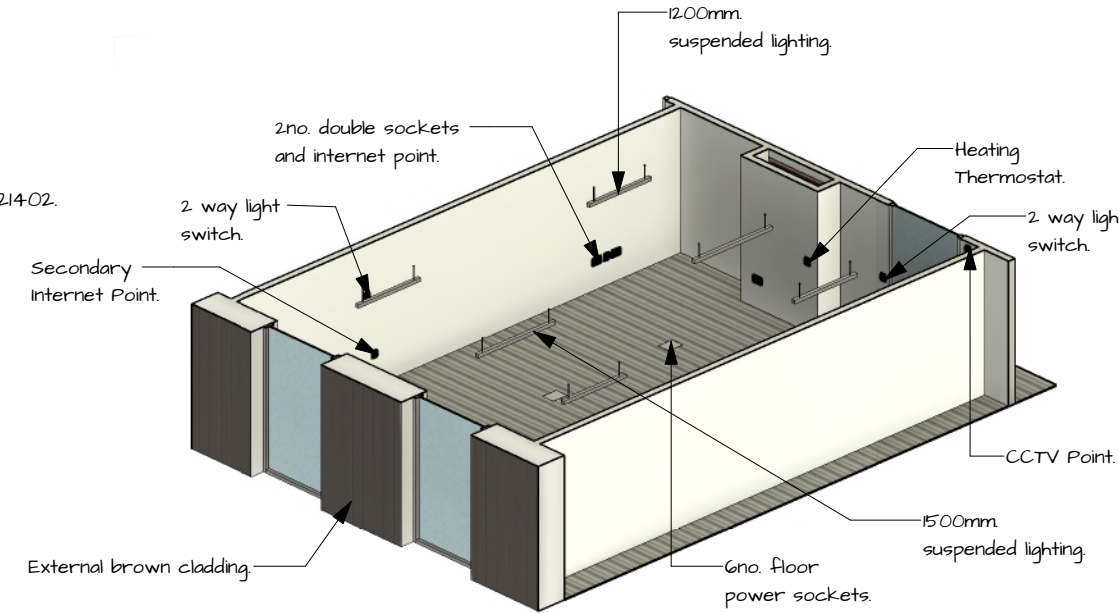
Fire Safety Fixtures: **LUMI-PLUGIN** Lumi-Smoke® World's smallest mains smoke alarm.



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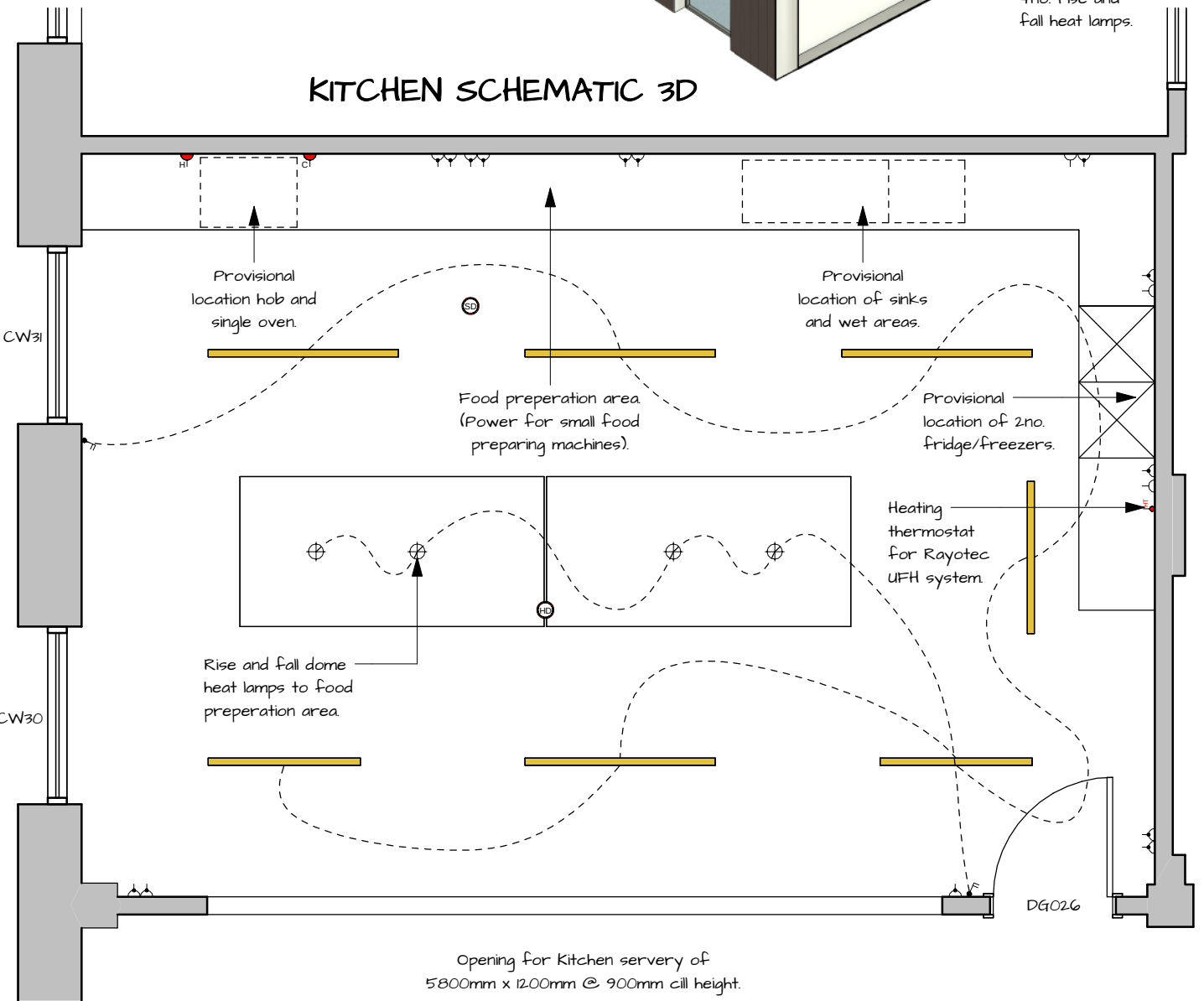
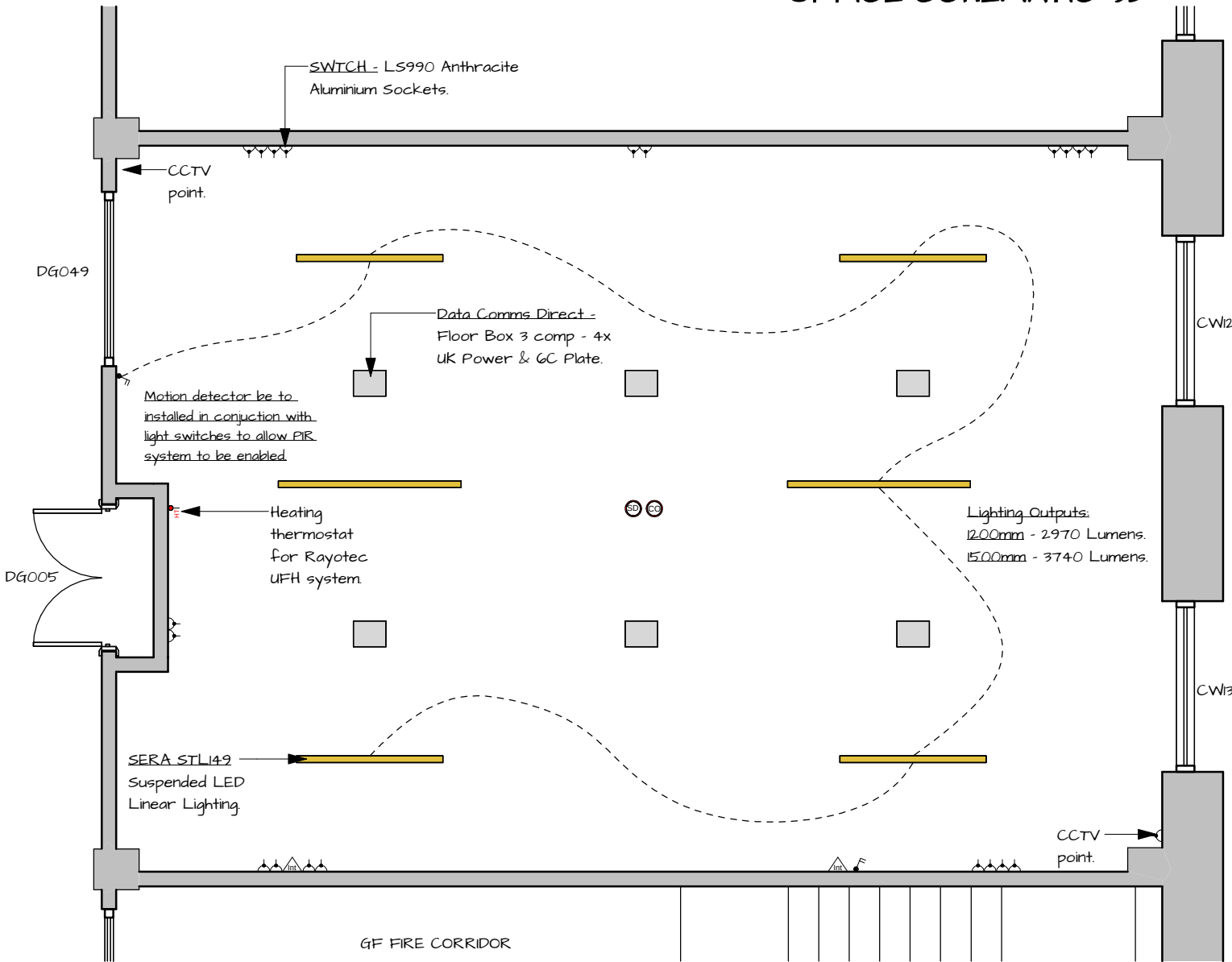
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A Services Drawings.



OFFICE SCHEMATIC 3D

KITCHEN SCHEMATIC 3D



1 Office 009 - Small Power & Lighting

2 Kitchen - Small Power & Lighting

Task 02 – Part B.

It's vitally important to appreciate that a good lighting design is a crucial asset for a certain space to establish productivity, and there are several factors that should be considered. The two types of lighting provisions are natural and artificial and are both applicable to these designated spaces. An article published by 'hbreavis' claims that to achieve productivity and a comfortable working environment, work should be carried out within 7.5m from an external window which supplies natural lighting. Despite the importance of natural lighting, it can also create discomfort should it become overwhelming, therefore, adequate shading provisions should be available, the most obvious being a blind system. Another option to consider in terms of shading, is variable transmission glass, this changes its' transparency levels depending on heat gain and glare. Lastly, the time of year can play a role in the natural lighting levels, as typically, in the winter months, it's relatively darker which means there'll be more dependence on artificial lighting within the building. Un-known. 2022. *10 Principles of Lighting Design*. {Online}. Hbreavis. [10 principles of lighting design - HB Reavis](#) {Accessed 4th May 2024}.

In terms of the Office space, a specific type of artificial lighting will have to be used to achieve the required LUX levels. According to the standard EN 12464 Light and Lighting, between 500 and 1000 LUX is the recommended level for any associated office work. This varies depending on the activity carried out within the space, therefore, due to the possibility of renting out the spaces independently, the maximum LUX level should be achieved to ensure that all possible uses are accounted for. A supportive statement made by RICOMAN outlined that low LUX levels and poor lighting provision can lead to excessive muscle strain and fatigue, which in turn, harms the productivity of the users. For this reason, all lights within the Office space should be installed with a dimmable feature, which allows the intensity to be dependent on the rooms' use. Un-known. 2023. *Office Lighting LUX Levels*. {Online}. [Office Lighting Lux levels | RICOMAN Lighting](#) Accessed 4th May 2024.

One of the main principles of light design is the Colour of the light, and it's believed that a medium to dark shade of blue is the most adequate for spaces such as meeting and conference rooms, whereas a redder/darker shade is designed for relaxation spaces. The main reason behind this is that these colours are deemed welcoming and can improve alertness, which in turn enhances the productivity. One of the main factors related to lighting is glare, which can be created by both natural and artificial lighting. The way of minimising glare is down to how the space is occupied, such as the orientation of workstations for example. Un-known. 2022. *10 Principles of Lighting Design*. {Online}. Hbreavis. [10 principles of lighting design - HB Reavis](#) {Accessed 4th May 2024}.

Office space lighting – Specification.

The chosen lighting system for the Office space is a SERA Lighting product, which is a *STL149 Suspended LED Linear* light. According to an article published by *Story Box by Karman*, current regulations state that around 300-400 lumens per square meter would be required to illuminate Office spaces and create a comfortable environment. (Un-known). 2021. How to calculate how many lumens and watts are needed to illuminate a room. {Online}. Story Box by Karman. [How to calculate how many lumens and watts are needed to illuminate a room \(karmanitalia.it\)](#) {Accessed 4th May 2024}.

See below:

Office 009 – 52m²

Square meterage x Lumens = Required Lumens.

$$52 \times 400 = 20,800.$$

This product is available in a variety of different lengths, ranging from 600mm up to 1500mm, all of which having different lumen output. To achieve the desired amount of lumen output, I have chosen to include the following:

$$1 \times 600\text{mm} (@ 1650 \text{ lumens}) = 1,650\text{lumens}$$

$$4 \times 1200\text{mm} (@ 2970 \text{ lumens}) = 11,880\text{lumens}$$

$$2 \times 1500\text{mm} (@ 3740 \text{ lumens}) = 7,480\text{lumens}$$

$$\text{Total} = 21,010\text{lumens}.$$

The combination of luminaire design and the high efficiency LED's used in this product gives it an impressive light output to power input ratio of 110lumens/watt. As standard, this product comes as a non-dimmable feature, but at an additional cost, it's possible to have a dimmable feature included, which based on the points made previously regarding the rooms' use and occupation, this will be a necessity. [Linear Suspended Lighting STL149 | Linear LED Lighting \(seratechnologies.com\)](#)

On the other hand, there are several important factors which require consideration for the Kitchen lighting layout. In this instance, a lighting output of 50lumens/sq.ft is required, which equates to around 540 LUX. Despite the lighting output being the same as the minimum requirement of the Office space, the type of lighting fixtures etc will need to be significantly different, due to the conditions in which they are operating. Despite the Kitchen/Café space not being a fully functioning commercial Kitchen, there will still be condensation caused by steam and hot water vapour, which will evidently impact the performance of the lighting fixtures, therefore, these fixtures should be vapor tight and be compliant with food rating safety standards. The main source of lighting for the Kitchen area will be overhead and recessed in the ceiling providing a flush and smooth finish. These lights will be in the main operating area within the space, but accompanied by further smaller sources, such as suspended LED lighting. These will be in zoned specific areas where greater lighting levels are required. Within the Kitchen space, a figure of 300lumens is required for areas where food is prepared, with greater requirements for areas where inspections are taken place. These can amount to a 1000lumens.

Kitchen lighting – Specification.

In terms of the lighting selection for the Kitchen area, I have chosen to implement the Kenall product, which is a *EnviroSeal FES12* ceiling mounted light and the Adexa A65121402. rise and fall dome heat lamps for above the food preparation area.

The Kenall EnviroSeal lights will be located throughout the kitchen, with 4no.150mm lengths and 3no. 120mm lengths. The provision of these lights will provide adequate lighting for the circulation spaces within the kitchen and provide light to the work surfaces. The main reason

<https://kenall.com/FES12.htm>

<https://adexa.co.uk/Rise-Fall-Dome-Heat-Lamp-Black-Adexa->

As per the drawing which should be read in conjunction with this document, the lighting sources are controlled via a switch located to the right of the access door to the room, acting as a secondary control. Ultimately, energy efficiency and cost savings are an extremely important factor in this task, therefore, there will be a PIR sensor built into the system, eliminating any risks of energy being used up when not required. This sensor will detect any movement within the room, ensuring that the lighting remains on whilst the room is occupied, but as soon as no movement is detected after a period, the lighting will be de-activated, eliminating wastage and lowering running costs.

In terms of small power provision, there will be an adequate number of power points located throughout both spaces. Within the Office space, there will be 10no. wall mounted double sockets provided, with two internet points. With flexibility being at the forefront of this scheme, to accommodate modern-working desks, there will be 6no. power floor boxes included, evenly spaced within the footprint of the room. The Data Comms Direct product has a toughened galvanised lid with a 6mm recess for carpet tiles, which is an ideal solution for this project, as it's compatible with the finishing specification. To conclude, this small

power plan accommodates a range of layouts and room configuration, with power points located throughout the room, offering great flexibility. As shown on the drawing, which should be read in conjunction with this document, there will also be a heating thermostat located to the rear of the Manifold C/BD which is recessed into the Office, this will provide control for heating and cooling the space, ensuring the space is comfortable for its' occupants.

Small power provision for the Kitchen area is slightly different, with a series of 6no. double sockets, 4no. single sockets, heating thermostat, fuse spurs and a cooker/hob point.

Building Regulations compliance – 1100mm high for all sockets above Kitchen surfaces.

450mm high for other sockets.

For clarity on the positioning and locations of power/lighting points, manufacturer details and product images, please refer to 3D drawings shown on attached drawing, no. 03.

NOTE: Difference in referencing format due to combination of both informative data and specific product data sheets.

Task 03.

The IM Building is a standalone structure located on the UWTSD SA1 campus in Swansea. The design of the building is straightforward, a rectangular shape stretching approximately 50m in length and spanning a width of approximately 18m. The central spine of the ground floor layout is left open plan and vaulted to the exposed steel structure of the pitched roof above. This creates a gallery-like feel to the first-floor access routes allowing for a dense flood of light throughout the entire building. At ground floor level, the open-plan environment is accompanied by two straight-flight staircases, one at each end of the building. Central to the ground floor layout are two curved walls, stepping out beyond the afore-mentioned gallery/walkways at first floor, thus creating an enclosed lobby to the secondary staircases, located on both east and west facades. Like the Library Building on campus, all ground floor rooms have direct access to the open plan communal space, creating an easily navigable layout. Lastly, the south-westerly corner of the ground floor will house the Café and Bar area, which will be left open into the open plan central spine. This layout could bring a negative perspective to the buildings' performance, with the heat being lost from this space and flooding into what will more than likely be an incredibly warm space; given the extensive volume of gable glazing.

It's understandable that the designers' objective when designing the innovation matrix was to provide the University with a statement making structure that would draw attention yet deliver a successful building sustainably. The decision to incorporate two completely glazed walls to the northern and southern elevations of the vaulted open-plan central spine is aesthetically pleasing but is economically unviable. Once the building is completed and fully occupied, the chances of it experiencing overheating is extremely high, floor to roof glazing on a southern elevation with no measures in place to control the amount of natural light that floods into the building is a poor approach. This will undoubtedly cause discomfort and distress for the buildings' users/occupants and may result in creating health risks. The temperature won't be the only reason for the space becoming uncomfortable, the glaring issues will also be a problem, especially for those who chose to carry out their studies in this space.

The entire external envelope of the building will be wrapped in aluminium box-profiled cladding, creating a simple yet effective façade. One of the biggest downfalls to this decision-making is that the cladding will be a dark brown colour, which will undoubtedly absorb all the heat and restrict its' entry to the building. This will affect the buildings' performance dramatically as there was an opportunity to create an external envelope that would allow as much heat as possible into the building, thus relying less on the buildings' services. This decision now means that the heating services within the building will have to work harder to keep the building at a comfortable temperature, resulting in higher financial expenditure. An article published in July of 2023, focusing on the psychology of metal colours, stated that having a light-colour aesthetic, it would reflect sunlight better, assisting in keeping the building cooler. Again, resulting in financial saving in the summer months. It also states that if the building is in a cooler climate, then a darker-coloured envelope would be advisable, due to its' heat absorbing qualities, but, in this case, there is a danger of the absorption becoming too much, resulting in an uncomfortable environment for the users. Allen. L. 2023. *The Psychology of Metal roof colors: How they affect your home's energy efficiency.* {Online}. LinkedIn. <https://www.linkedin.com/pulse/psychology-metal-roof-colors-how-affect-your-homes-energy-allen-liu>. To conclude, opportunities were missed in this phase of the scheme, especially given the extensive amount of glazing located in the southern elevation. It would have been a great opportunity to implement a lighter-coloured cladding to this section, allowing for the heat absorption and reflection to even out, creating sustainable benefits all round.

The entire buildings' heating system will be zoned independently, with distribution boards located in each room. One of the biggest benefits of this zoned system is that the cost of running the building will be significantly lower than if it was ran on one big system, keeping energy usage to a minimum. The reason for this is because certain areas of the building will have exposure to southerly natural lighting, enabling the rooms to be heated naturally. Therefore, the lesser exposed rooms such as north-facing, can increase the energy usage, ensuring thermal comfort, but at the same time, not dramatically increasing running costs. The ultimate outcome of the zoned heating is that energy usage is kept to a minimum therefore creating financial saving for the University.

The central spine of the ground floor is split into four zones in terms of under floor heating, each individually controlled, based on the demand, and need for additional heating. Differently, each individual office room at ground level is heated through ceiling recessed radiant panels, keeping the aesthetic look of the rooms minimal and clean. Other benefits include its' heat distribution qualities when compared to conventional radiators, it can emit heat directly to objects and surfaces rather than heating the air, resulting in less energy being wasted. Lastly, in terms of maintenance, the central spine of the building will prove a difficult challenge when maintenance is required, due to the system being covered up. Whereas the rented office spaces will have a much further straightforward approach, as the panels can be removed with ease.

Another feature of this Innovation Matrix building that draws attention is the decision not to include a fire sprinkler system. The obvious reason behind this decision is the cost implications that come with the system, and therefore, they have incorporated an alternative within the building design. The afore-mentioned vaulted central spine of the building is left exposed to the steel structure beneath the roof makeup, with a series of high-level windows located along the entire perimeter.



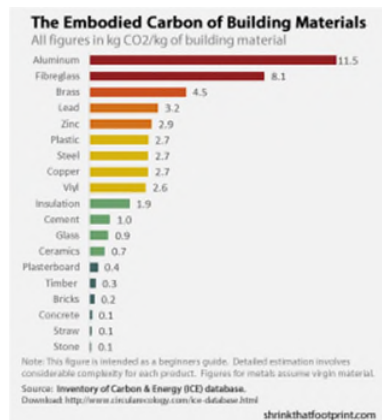
The pictures above show views of the exposed steel structure with the windows located in the easterly and westerly walls. These are designed with the intention of automatically opening in the event of a fire, allowing the smoke to rise and exit the building, giving all occupants enough time to exit the building via the fire exits provided. This is an interesting strategy as they have comprised at the expense of aesthetic values. Despite the cost saving utilized by not including a fire sprinkler system, additional costs have been added by increasing the height of the building to incorporate these automatically openable windows,

therefore, the cost implications aside, an improvement would be to have included the sprinkler system and improved the aesthetic appeal of the building, lessening the height of the vaulted space in the centre of the building. Lastly, to critique the use of the space, there is a great amount of waste included in this central space, additional rooms or more usable spaces could have been included.

Based on the analysis and critique of the existing design, fabric, and services, it's safe to say that several opportunities were missed in the design phase that could have assisted in bettering the buildings' sustainability standards. Had more careful consideration been given to the buildings' overall envelope and choice of services, standards such as BREEAM and Passivehaus may have been achieved, which would be a great asset for the University and the local economy. There are different levels to BREEAM (Building Research Establishment Environmental Assessment Method), with the best being outstanding. To reach the 'outstanding' threshold, the building will be required to achieve a score of at least 85%. When assessing the buildings' score, attention is given to its' energy efficiency, how sustainable it was built, and how it responds to the occupants' needs. For the building to achieve the outstanding rating, it's required to meet several guidelines within different aspects of the scheme; these include energy, waste, pollution, materials, transport, and Health/Wellbeing.

To achieve BREEAM outstanding requirements, careful consideration should be given from the outset, with these standards kept high on the agenda throughout the entire design process. It's important to remember that BREEAM can be incorporated into the project at an early stage, with design considerations holding great value. Careful detail given early in the design process could bring great performance and cost saving benefits in the long run, as the need for compensating features post completion is eliminated.

Given that this building is a steel framed structure, the embodied energy is significantly higher than other conventional structural methods of brick, timber, and concrete. According to the Inventory of Carbon & Energy (ICE) database, the embodied carbon of steel amounts to 2.7kg Co2/KG of building material, which is significantly higher than Concrete; at 0.1kg Co2/KG.



Un-Known. 2024. Embodied Energy of Materials – 76. {Online}. Paul Mcalister architects and energy consultants. <https://www.pmcarchitects.com/sustainability-information-blog-content/embodied-energy-of-materials>

After taking into consideration the above graph and values it represents, both high and low embodied carbon values have their advantages and disadvantages. Making use of materials with low embodied carbon will result in the requirement for far greater operational energy usage, which will affect the sustainability rating and performance of the building. What this means is that there would be more demand on lighting, heating/cooling, and ventilation

methods within the building. In effect, it has the opposite effect when opting for materials with higher embodied carbon, as the building then requires less operational energy usage, which evidently results in financial saving for the operatives. Therefore, this is the optimum where designers and consultants should aim for, the balance between the carbon emitted into the atmosphere and extracted from it. Should this balance be achieved and mastered, the structure would then be classed as Net Zero, which assists in reducing costs through wastage and relying less on fossil fuelled energy sources. Crawford, R., Hall, M. 2020. *Embodied Energy*. {Online}. Yourhome. <https://www.yourhome.gov.au/materials/embodied-energy>

The overall efficiency performance of the building has several opportunities for improvement, with a much better option for heating the building being a ground source heat pump system with PV panels, reducing the need for non-renewable power, utilizing natural air and daylight. These systems would hold great value to the scheme as not only do they meet the users' needs, but also maximizes efficiency, giving the building a sustainable reflection.

As noted above, the buildings' ability to meet occupants' needs is a critical aspect in its' bid to achieve BREEAM outstanding. The building will need the flexibility to adapt to any required use and offer a successful space for those who use it. Previously discussed, the users' comfort levels may become uncomfortable given the existing design, therefore, an improvement would be to re-assess the central south-facing glazed elevation and incorporate some wall place, carefully detailed externally to control the rate that heat is transferred through the buildings' envelope. Alternatively, adequate measures should be put in place to compensate for the overheating, which is unavoidable with this design. The UK have recently launched its' Net Zero strategy to reduce emissions from destroying today's climate, with the long-term aim of achieving net-zero by 2050. Based on *JAGA Climate Designers article focusing on tackling overheating in buildings*, they state that 17% of UK greenhouse gas emissions come from buildings, and this figure is used as an example for urgent change in how the industry delivers their buildings. Charles, S. 2020. *Tackling Overheating in Buildings*. {Online}. Jaga Climate Designs. <https://jaga.co.uk/blog/tackling-overheating-in-modern-buildings#:~:text=Overheating%20is%20only%20going%20to,that%20best%20suits%20your%20space.>

The first improvement for overcoming the overheating issues, would be to mitigate the solar gains the building possesses, such as incorporating fixed shading devices or include aesthetic features to somewhat shade the glazing, still allowing light into the building, but control its' severity. Ultimately, it comes back to the design of the building, and its' orientation, potentially, a lesser amount of glazing may have resulted in better result in terms of the buildings' performance, having less surface area for the heat to enter the building. In conjunction with mitigating solar gains, removing excess heat is a great solution to overcome overheating. An improvement would be vents within the building allowing for cross ventilation when windows are opened, this will allow the air to flow through the building, and not trap it within confined spaces.



Picture above of the south-facing glazed elevation.