

RIDGE

PROPERTY & CONSTRUCTION CONSULTANTS



**CAVERSHAM, ESFA SCHOOL
BUILDING SERVICES DESIGN REPORT**

EFA-RDG-Z03-XX-RE-9901 (C) Building Services Design Report

28th March 2018

**Prepared for
Ashley House**

Cressex Business Park
Cliveden Office Village
Lancaster Road
High Wycombe
HP12 3YZ

Tel: 01628 600 349
www.ashleyhouseplc.com

**Prepared by
Ridge and Partners LLP**

2 Cranbrook Way
Solihull Business Park
Solihull
B90 4GT

Tel: 0121 713 8000
www.ridge.co.uk

VERSION CONTROL

Project Name	Caversham, EFSA School Template
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Project No. 5004234

VERSION	DATE	DESCRIPTION	CREATED BY	REVIEWED BY
1.0	16/03/18	Draft issue	MM	AH
2.0	19/03/18	Planning Issue	MM	AH
3.0	23/03/18	Draft CP's	DS	AH
4.0	28/03/18	Sustainability Headlines Added	AH	IR

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EXECUTIVE SUMMARY

This document has been prepared to review thermal analysis outputs, compliance, daylight autonomy (DA) and useful daylight index (UDI) for the proposed modular school developed on behalf of Ashley House and compare findings against Education Skills and Funding Agency (ESFA) documentation and design guidance.

A design has been developed using passive design principles in conjunction with the architect Penoyre & Prasad. Through careful architectural design and analysis, optimum window apertures have been created to allow light to enter teaching spaces that is both useable and in line with ESFA requirements. The designed hall meets these daylight requirements.

The final daylight result showed the hall space achieved the minimum DA requirements. UDI was also met with UDI-E and UDI-S at a minimum. Windows reach as high as 2.6m to allow light to reach deep into the hall.

In achieving the maximum possible airflows, the tall windows accommodate a number of window openings via top hung sliding openings allow CO2 and temperature to remain to ESFA requirements. The hall shall benefit from windows to both sides of the building to promote cross ventilation and ensure ventilation and daylight is met in any arrangement.

To meet seasonal ESFA standards during winter months, a hybrid ventilation strategy is adopted through heat recovery units that can provide tempered fresh air efficiently throughout the year. CO2 levels do not exceed 1000ppm. The maximum occupancy has been confirmed at 100 people during assembly and dining hours. Therefore a single unit has been provided within the hall cupboard to achieve 800 l/s (8l/s/pp).

Summer time overheating temperatures are in accordance with ESFA guidance and comply with the Facilities Output Specification. This model is run for a full 12 month period.

Based on the thermal model the building complies with Building Regulations Part L 2013.

Summary of Derogations:

- Peak internal heat gains for the hall space accommodates a maximum of 100 occupants, 5 W/m2 lighting and 400 Watts of equipment (PC & projector).

This model was developed as per architectural drawing issue (12/03/18) of information based on elevation and plan drawings provided by Penoyre & Prasad Architects and Ashley House.

Constructional details have been provided by the design team above, of which this model has been developed.

Finally, the building was simulated to Building Regulations Part L 2013 and it was concluded that the current design passed the (TER) target emission rate. This was achieved with electric underfloor heating, low energy lighting, and a good thermal envelope. The EPC without renewables achieved a A (24) rating.

- Low power, LED lighting densities with daylight dimming has been used.
- Infiltration of 5 shall be targeted.
- It is assumed there is no domestic hot water requirement.

SUSTAINABLE DESIGN CHECKLIST

Health & Wellbeing

- The building incorporates good natural daylight with dimming LED lighting to reduce power consumption.
- A hybrid mechanical ventilation system has been adopted with CO2 sensors and heat recovery to reduce heat losses and maintain a healthy hall / dining environment. Large natural ventilation openings have been included also.
- A drinking point has been included for occupant use.

Energy

- The building has a passive first approach using good constructions, insulation and air tightness to reduce energy use.
- An efficient electric underfloor heating system has been adopted to reduce standing system energy losses.
- Local control allows heating to be provided where needed only.
- The building accommodates natural daylight.

Water

- Low water use, with water saving outlets.

1. INTRODUCTION

This document has been prepared to review thermal analysis outputs, compliance, daylight autonomy (DA) and useful daylight index (UDI) for the proposed ESFA modular school building and compare findings against design guidance.

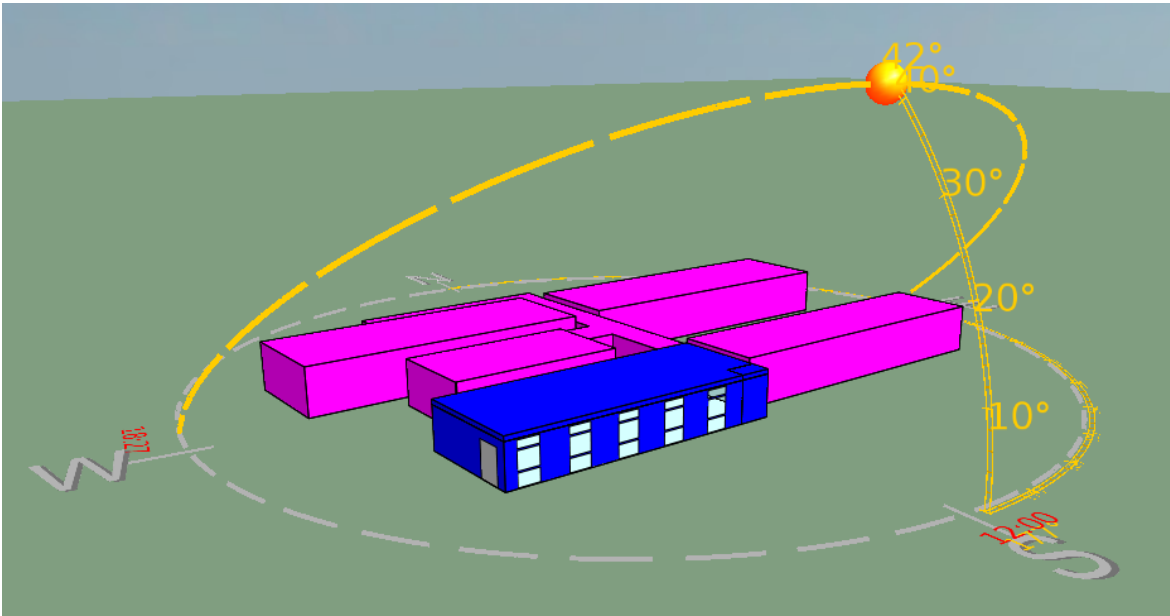
The thermal analysis element considers some fundamental design performances, and these include:

1. Overall performance of the thermal envelope
2. Size and orientation of window openings for daylight modelling
3. Assumptions of mechanical and electrical systems
4. Assumptions of thermal model inputs
5. Overheating assessment using CIBSE Design Summer Year (DSY) weather files and compared with TM52.
6. Check air quality to CIBSE AM10.
7. Compliance with Part L2A 2013 and TM54 energy predictions
8. Conclusion & Recommendations

1. OVERVIEW

Ridge has been requested to undertaken a review of the thermal performance, daylight autonomy and useful daylight index of the proposed ESFA modular school building. The software package used for this assessment is Integrated Environmental Solutions (IES) 2017.

Documentation provided by Penoyre & Prasad Architects and Ashley House has enabled Ridge to develop a thermal model of the school building based on information revised and current on the 12th March 2018.



2. CONSTRUCTIONS

Constructional details have been provided by Ashley House and the architect for the development. The current construction arrangements for the scheme are as given below.

TABLE 1 - MODULE WALL CONSTRUCTION

U-value	0.21		W/m ² K	
Material	Thickness (mm)	Thermal Conductivity (W/m K)	Density (kg/m ³)	Sp. Heat Capacity (kJ/kg K)
Render Panel/Wooden Clad	9 / 19	1.000	1300	1000
Insulation	25	0.045	12	840
SIPS OBS	11	0.130	300	1000
SIPS Insulation	101	0.022	12	840
SIPS OBS	11	0.130	300	1000
Plasterboard	12.5	0.210	801	837
Fermacell	12.5	0.210	801	837

TABLE 2 - MODULE ROOF CONSTRUCTION

U-value	0.18		W/m ² K	
Material	Thickness (mm)	Thermal Conductivity (W/m K)	Density (kg/m ³)	Sp. Heat Capacity (kJ/kg K)
Roof Finish (EPDM)	2	0.250	1700	1000
Plywood Deck	18	0.130	650	1600
Insulation	20	0.022	12	840
Insulation Steel Beams	200	0.032	1300	1000
Insulation	70	0.220	12	840
Fermacell Ceiling	12.5	0.210	801	837

TABLE 3 - MODULE FLOOR CONSTRUCTION

U-value	0.18		W/m ² K	
Material	Thickness (mm)	Thermal Conductivity (W/m K)	Density (kg/m ³)	Sp. Heat Capacity (kJ/kg K)
Recticel	70	0.032	12	840
Insulation/Joists	200 / 70	0.032	1300	1000
Recticel	50	0.022	12	840
Plywood Decking	25	0.130	650	1600
Insulation	9	0.032	12	840
Cellecta	18	0.040	12	840

TABLE 4 - MODULE PARTITION CONSTRUCTION

U-value	1.7667		W/m ² K	
Material	Thickness (mm)	Thermal Conductivity (W/m K)	Density (kg/m ³)	Sp. Heat Capacity (kJ/kg K)
Plasterboard + Fermacell	15	0.160	801	837
Metal Stud & Acoustic Insulation	50	0.032	12	840
Plasterboard + Fermacell	15	0.160	801	837

TABLE 5 – OTHER CONSTRUCTIONS

Construction	U-Value	Comments
Glazing and Curtain Walling	1.6 W/m ² /K	Inc. Frame (10% Area)
Insulated Panel	0.5 W/m ² /K	Ventilation Openings to Curtain Walling/Opaque Infill Panel
Glazed Personnel Access Doors	1.7 W/m ² /K	To Main Entrance/Classrooms
Standard Door	2.1 W/m ² /K	Solid Doors
Roof Lights	1.8 W/m ² /K	Circulation Corridors

All glazing systems have been based on a thermally broken double glazed system comprising of 6mm clear double glazed unit/film with 16mm cavity giving an overall u-value of 1.6 W/m²/K including the frame.

The constructions currently proposed are relatively lightweight. This may pose a threat to overheating which is later discussed within this report. Infiltration rates have been based off 5 m³/(h.m²) which can be easily achieved with good construction details and the use of tight seals between module sections as previously demonstrated on previous schemes constructed by F1 Modular (1.5 m³/(h.m²)).

For the purpose of the thermal analysis calculations the CIBSE London weather files have been used for summertime overheating assessments and annual energy assessments. These make use of both the Design Summer Year (DSY) and Test Reference Year – (TRY).

3. DAYLIGHT ASSESSMENT

Using a daylight analysis tool called RadianceIES analysis of a building’s natural daylight can be made. All aspects of the calculation are considered such as the buildings orientation, view out and views of the sky.

There is not a statutory requirement for daylight levels, but some good practice criteria are suggested by the ESFA (Education & Skills Funding Agency). There are three daylight criteria used to promote a good level of daylight which should be considered when designing window openings. The third criteria is required as a minimum, this is an average daylight factor of 2% in all occupied spaces.

The methodology used is Climate Based Daylight Modelling (CBDM) which takes into account the effects of direct and indirect sunlight and provide better modelling of daylight than daylight factor calculations. Two key measures are to be met in order to be compliant. Daylight Autonomy (DA) and Useful Daylight Index (UDI). This daylight methodology uses a far greater detail about light distribution and intensity which allows our architectural design to be adjusted to maximise the use of daylight.

The following key features have been included within the modular school building in order to meet guidance:

- Large tall glazed window openings to ensure that light travels deep into the hall space.
- Glazing has been provided to two sides where possible.
- Tall glazing for the Hall space.

3.1 Criterion 1 – Daylight Autonomy (DA)

‘DA in 80% of teaching and learning spaces: DA of more than 50% for more than 50% of the working plane for the target illumination (typically 300 Lux in teaching spaces), for the hours of operation 8.00am to 6.00pm. The working plane should be at desk height. 500mm around the wall perimeter is excluded from the calculation.’ - **ESFA**

3.2 Criterion 2 – Useful Daylight Index (UDI)

‘UDI is defined as the annual occurrence of luminance, for the hours of operation across the working plane that are within a range considered “useful” by occupants.

- UDI-s = UDI-supplementary light
- UDI-a = UDI-autonomous
- UDI-e = UDI-exceed

Therefore the UDI in 80% of teaching and learning spaces: UDI-a (100-3000lux) will be achieved for an average of 80% of the time over the working plane within a space. That is to say that the level of luminance provided below 100 lux (UDI-S) and above 3000 Lux (UDI-e) will occur no more than 20% of the time.’

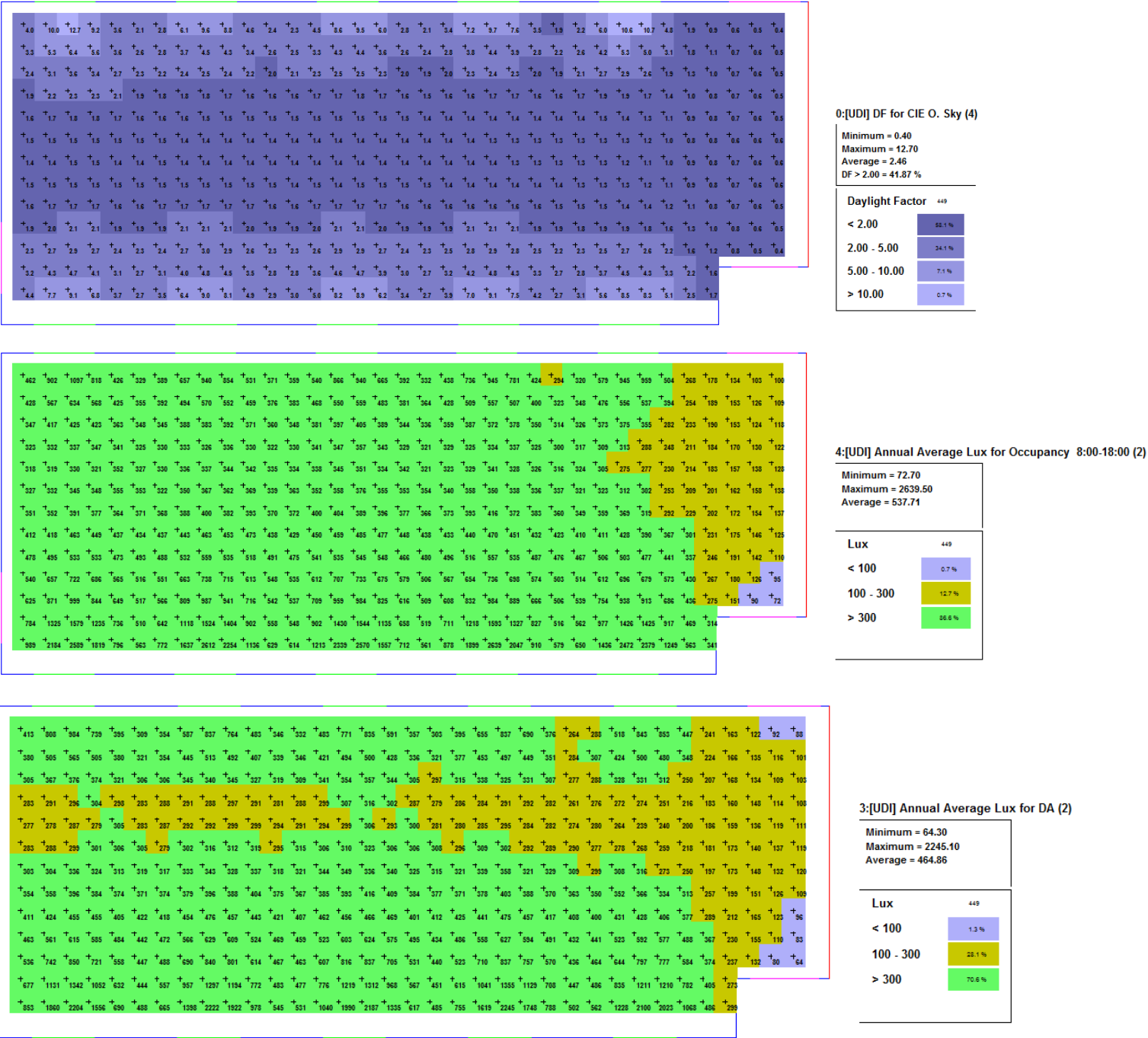
‘It should be noted that should blinds be installed, these should not obstruct the natural ventilation openings as this will compromise the overheating assessment of the module.’ - **ESFA**

3.3 Criterion 3 – Daylight Factor (DF)

Achieve a minimum average daylight factor of 2% within all occupied spaces.

3.4 Results

Dining Room – Daylight Factor Average **2.46 DF**, UDI Average 86.6%, DA 70.6%



3.5 Summary

The results indicate that a good level of daylight is achieved within the hall to give a light vibrant atmosphere. The daylight modelling is based off the architectural elevations with 2.6m tall windows by 1.5m wide. All spaces achieved 50%+ Daylight Autonomy and the UDI-a requirements without exceeding UDI-e and UDI-s where light was in exceedance or below usable standards.

Note – the adjacent school building was modelled to ensure the classrooms were not overshadowed by the existing school buildings within close proximity.

4. OVERHEATING ASSESSMENT

Thermal modelling module ApacheSim is a fully dynamic thermal modelling package which integrates with MacroFlo, an airflow analysis tool.

By studying the heat gains from internal and external influences we have been able to establish peak internal temperatures for each room. There are two sections each broken into three main criteria that are required to be met as recommended by CIBSE TM52.

Heat Gains have been assumed by Ridge these are generally as:

- Occupancy gains of 100 people.
- Lighting gains as per lighting power densities 5 W/m2.
- Solar gains as per the building’s geometry and openings, shading and the solar irradiance specified in the weather file for the given location.

Window openings have been assumed as the following based on the architectural design provided by Penoyre & Prasad Architects:

- Window operation times 0800-1800 for both lower and upper top hung sliding window opening.
- The upper top hung sliding window opening has assumed again to have a 35 degree opening.
- The lower top hung sliding window opening has assumed again to have a 10 degree opening.

All analysis was complete with CIBSE’s Weather Data for London.

4.1 Natural Ventilation

Criteria 1 – Free Openable Area

Fresh air free areas to be reviewed from the thermal model in due course.

Criteria 2 – CO2 Levels

CO2 levels to be extracted from the thermal model in due course.

4.2 Overheating Criteria (CIBSE TM52)

In order to show that the proposed school building will not suffer overheating two of these three below criteria must be met as per TM52 and ESFA requirements.

Criteria 1 – Hours of Exceedence (He)

‘An understanding of how often a building in any given location is likely to exceed its comfort range during the summer months (May-September) can provide useful information about the buildings thermal characteristics and potential risk of overheating over the range of weather conditions to which hit will be subjected. Simple hours of exceedence are something that designers are familiar with and provide a good first assessment of acceptability’.

Criteria 2 – Daily Weighted Exceedence (We)

‘This criterion sets an acceptable level for the severity of overheating, which so arguably more important than its frequency, and sets a daily limit of acceptability and is based on Method B – ‘Degree hours criteria’ in the BS EN15251: 2007. It is the time in hours during which the operative temperature exceeds the specified range during the occupied hours, weighed by a factor which is a function depending on by how many degrees the range has been exceeded. That value of the weighting factor is based on the observed increase in the percentage of occupants voting ‘warm’ or ‘hot’ on the ASHRAE scale (overheating risk) with each degree increase in the deltaT, the temperature above the comfort threshold temperature.’

‘The Value of 6 is an initial assessment of what constitutes an acceptable limit of overheating on any single day.’

Criteria 3 – Upper Limit Temperature (Tupp)

‘The threshold or upper limit temperature is fairly self-explanatory and sets a limit beyond which normal adaptive actions will be insufficient to restore personal comfort and the vast majority of occupants will complaint of being ‘too hot’. This criterion covers the extremes of hot weather conditions and future climate scenarios.’

4.3 Overheating Results

ROOM REF	ROOM NAME	OCCUPIED (%)	CRITERIA 1	CRITERIA 2	CRITERIA 3	CRITERIA FAILING
	Main Hall	47.7	0.7	8	3	2

The overheating simulation passed on the assumption that the top hung windows are operated during the hours of 0800:18:00. It is assumed heating is OFF for the summer time overheating analysis. Heating has a set point of 21 degrees.

5. BUILDING SERVICES & LOAD ASSESSMENT

5.1 Existing Infrastructure

Please refer to the Ridge mechanical and electrical survey report of the school site for a full background of the existing incoming utility services and site infrastructure. Below is an executive summary of each service which has influenced the proposed building services strategy adopted.

Gas

The gas supply terminates into a gas meter in a store adjacent the D&T Block. This also feeds the kitchen on site.

Electric

There is currently a three phase electrical supply that enter the site. They supply terminates into the main reception office cupboard in the older section of the main school building.

Water

The water supply enters off Hemdean Road to supply the site. The water supply stopcock is located within the staff breakout room.

5.2 System Overview

5.2.1. Electric Underfloor Heating System

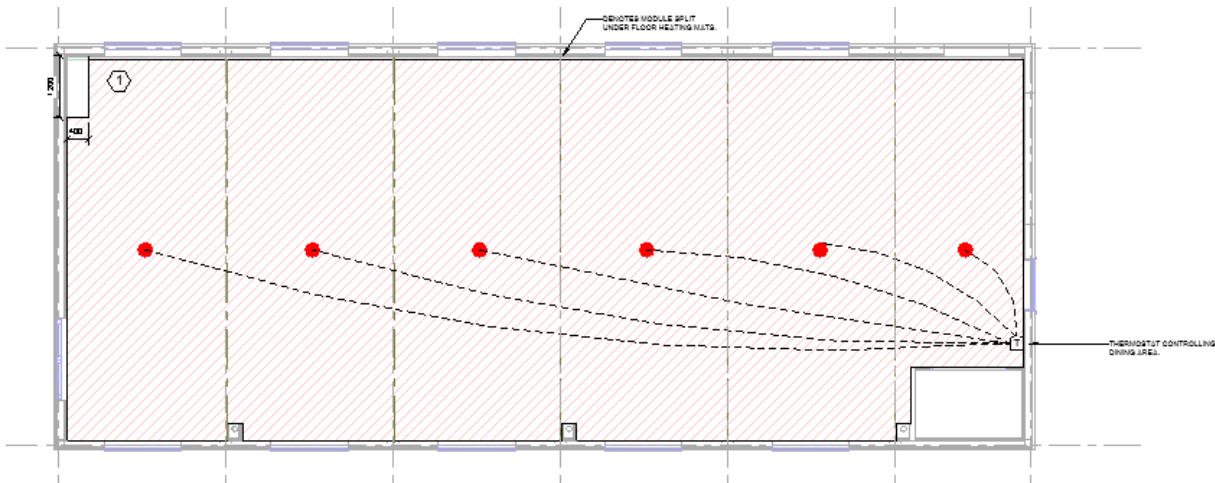
Heating is provided to offset heat losses within a space and achieve a comfortable environment. The hall space shall have its own control and adjust based on the internal heat gains and occupancy. Underfloor heating has been adopted to provide even distribution of heat over the space and prevent down draughts from windows.

To enable ease of off-site construction and simple connectivity and work with the existing available electrical infrastructure available to us, an Electric Underfloor heating has been adopted to plug and play all modules from factory to on site. This reduces the project programme on site and reduces the quantity of trades required on site when connecting the modules at each school. Each heating matt shall be linked back to the teaching wall room thermostat which allows some user adjustability and temperature monitoring.

To make the heating strategy affordable and sustainable, the heating load has been reduced significantly by adopting a passive first approach. Good constructions and air tightness has reduced the heating load of the modules down to 25-35W/m2 which means that only a small quantity of heating is required to temper the teaching spaces prior to occupation. Once occupied, the quantity of heating input is limited as there is sufficient heat gain within the teaching spaces to maintain the heating set point.

Overheating has been mitigated by designing the modules with good natural ventilation openings at occupant level and high level to give good air stratification. Seasonally hybrid ventilation has also been accommodated to maintain a good air quality and CO2 level. Again, heating is controlled room by room, and high efficiency heat recovery included within each ventilation unit.

All heating zones relay back to a common mechanical control panel within the plant room. Each classroom has a dedicated controller programmed on time, zone control and over-ridable +/- by the teaching staff on the end hall wall.



Alternative Heating Strategies

Other heating systems have been investigated, but all have an adverse effect on the collaborative design proposed. Wet heating systems have been designed out for the following reasons:

- Require on site plumbing and connectivity between modules increasing the project programme.
- Increased number of trades required on site to complete the on site connections needed between classroom modules.
- Increased size of plantroom to accommodate heating boilers, expansion vessels, circulation pumps.
- Increased risk of leaks and pipework failures with many connections within the system.
- Larger gas connection required to the building to provide heating to the system, subject to the existing infrastructure – this could have a significant upgrade cost.
- Increased circulation losses associated with heating being circulated and domestic water storage and circulation losses.
- Increased weight on modular system making transportation more difficult.
- Increased floor mass associated with screed floor should LPHW underfloor heating be adopted. Increased heating lag in a fairly lightweight building, could over compensate and cause overheating.
- Constant circulation and pumping of water throughout the building.

Advantages & Disadvantages

There are many added benefits of the system:

- The heating load for the building is low due to its passive design, the heating is used to pre-heat the building prior to occupation. Internal heat gains alone will maintain the internal temperature, with a hybrid ventilation system with 85% heat recovery, the ventilation losses are minimal.
- Individual room by room system – not reliant on central plant, improves resilience
- Individual room by room thermostat zone and time control and even distribution of heat over whole space
- Wet heating system would require continuous water pumping and circulation within the underfloor heating system and pipework. Increased chance of leaks between each module connection.
- Although gas is 1/3rd price of electric per kWh, with reduced losses, better control efficiency and lower maintenance costs – the ongoing lifecycle costs are matched between gas and electric heating as demonstrated within the following section.

Heating Loads

Heating loads for the building have been calculated using CIBSE Loads, also known as ApacheCalc or CIBSE Heat Loss and Heat Gain. The following loads have been calculated according to the procedures laid down in CIBSE Guide A (1995, 1999, 2001, 2006, 2015). A winter design temperature of -5°C has been used in the dynamic load calculation.

The following loads are based on steady state losses for the constructions currently listed under section 2 and thermal performances. Only fabric losses with intermittent heating has been assumed for the calculation.

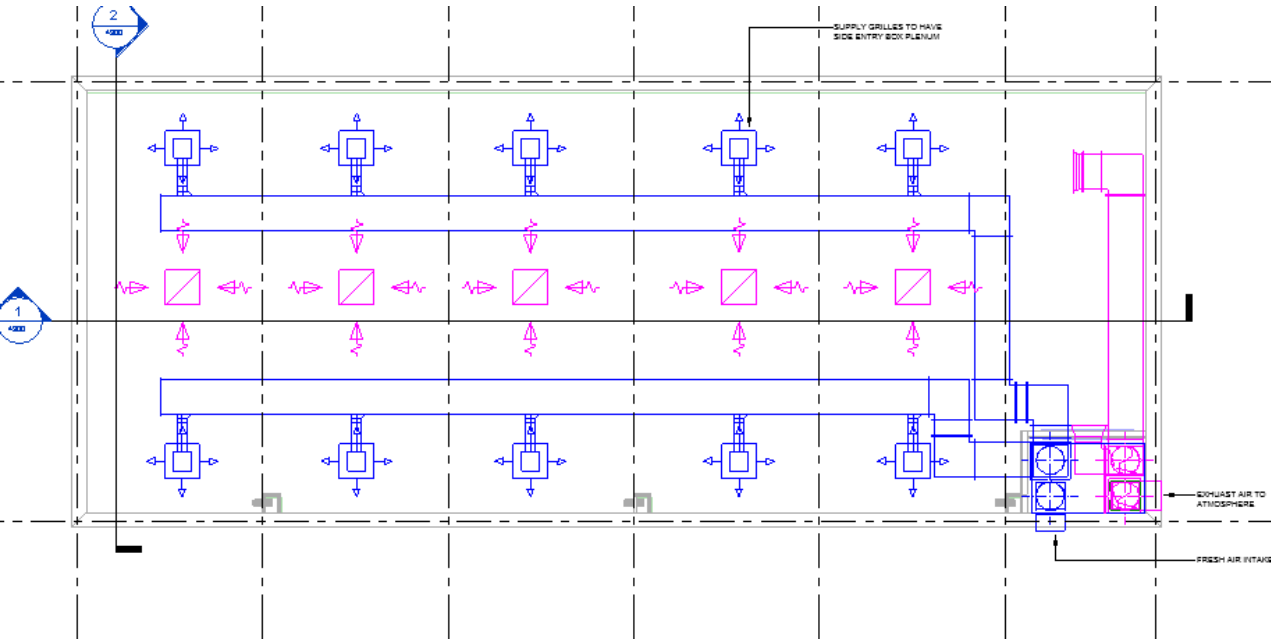
Room Name	Heating Load (Watts)	Area (m2)	Watts/m2	Comments
Main Hall	4224	130.8	32.3	

Hybrid Mechanical Ventilation System

MVHR (Mechanical Ventilation Heat Recovery) has been provided within the main circulation ceiling void. This heat recovery ventilation is required in order to maintain CO2 levels and comfort throughout the year and will operate in conjunction with window ventilation openings to form a hybrid system. Temperature analysis can be seen in the previous sections.

The benefit of the system is that it improves air quality, has a low specific fan power and running cost, fully variable with the CO2 levels within the space. The disadvantage is that it has an impact on the hall space as a service cupboard is required.

The MVHR design allows seasonal operation of ventilation as a hybrid system. Ventilation units shall provide both fresh air and extract into the hall at 8 l/s/p for up to 100 people.

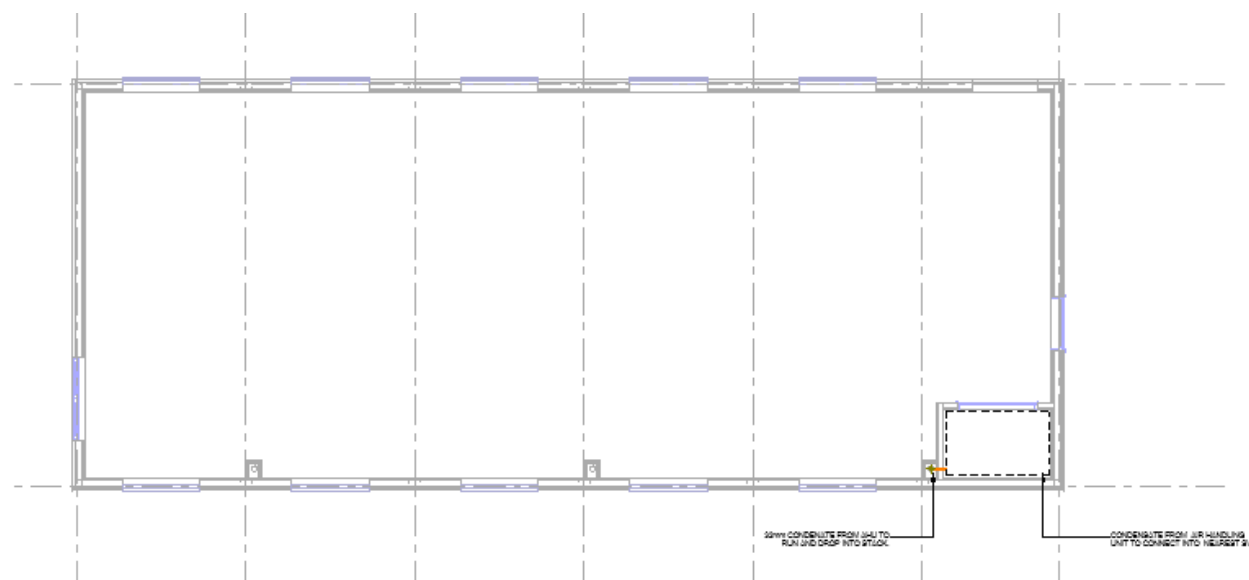


5.2.2. Domestic Hot Water

There is only a requirement for a water fountain within the hall space.

5.2.3. Above Ground Drainage

A drainage connection will be required within the plantroom for the heat recovery ventilation drainage point. Below ground drainage provided on site. This is detailed by Apply Structure.



5.2.4. General Lighting

The lighting design will complement the architectural vision, promote commitment to sustainable design, and provide technical compliance with all relevant good practice lighting design guidance documents and local statutory legislation.

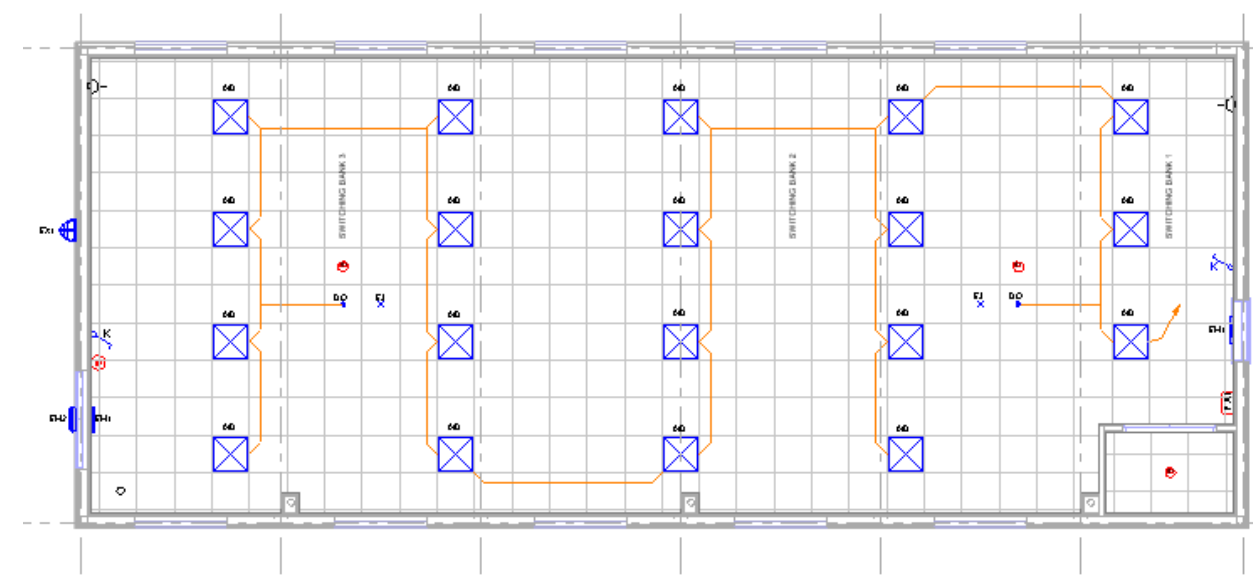
Strategies will address building occupant needs by:

- Promoting a safe and comfortable educational environment
- Achieve light levels which meet the needs of the space
- Be controlled in a user-friendly fashion to provide an optimum visual environment
- Promote flexible use

Design for internal lighting will follow requirements and recommendations provided in the following documents:

- BS EN 12464-1 (2011) - Lighting of Indoor Workplaces
- CIBSE Code for Lighting 2009 (superseded by the SLL Lighting Handbook, 2009 & 2012)
- Part L requirements

Lighting within the hall shall comprise of 600 x 600 recessed high output/efficiency LED luminaires. Luminaires to have dimmable functionality linked to daylight sensor. Luminaire control shall be via occupancy detectors. Upon entering the room, detection to operate luminaires and maintain illuminance of the given space during occupancy, luminaires shall switch off after a period of 10-20 minutes after the sensors fail to detect movement.



5.2.5. Emergency Lighting

An emergency lighting installation shall be provided to meet the requirements of;

- BS 5266: Part 1: 1999 Code of Practice for the Emergency Lighting of Premises.
- BS 7671: Requirements for Electrical Installations (17th Edition of IEE Regulations).
- Specific requirements of the local Building Control and Fire Officer.
- Proposed revised edition of BS 5266 to be issued 1994/95 to EC and HSE requirements.
- ICEL Guidelines

The installation shall be throughout the building to permit safe escape during times of power outage.

The emergency lighting system shall be provided to all areas. This shall include all designated escape routes and circulation areas providing a minimum of 1 lux throughout.

Emergency lighting luminaires shall also be provided on final exit doors to the building, external location to provide safe egress in the immediate vicinity of the exit door.

Emergency lighting to shall be self-contained emergency lighting luminaires to be used.

Dedicated individual self-contained three-hour emergency lighting luminaires complete with EC standard exit legend to be provided at all designated exit doors, along escape routes up to and including final exit locations.

All light fittings that require emergency battery packs shall meet with the relevant BS and manufacturers' recommendations.

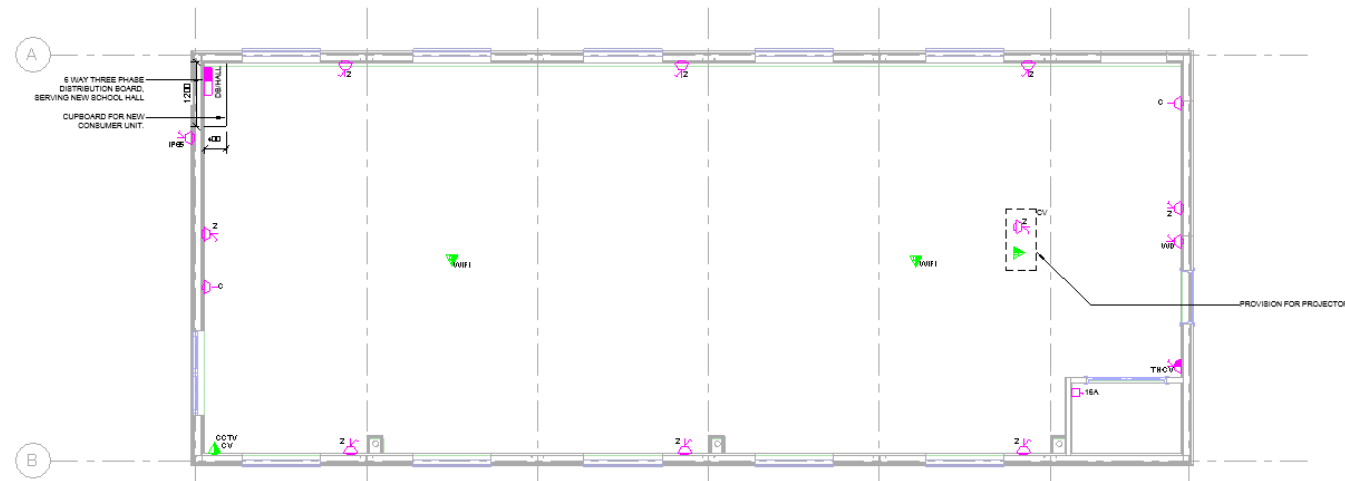
An emergency lighting self-testing facility, shall be provided as part of the designated control system.

Each emergency lighting luminaire where designed and installed as an integral units to the normal lighting luminaires shall be provided with a LED indicator lamp to identify mains healthy condition.

5.2.6. Small Power & Data

The new modular hall is to be supplied from the local distribution board within the Kiln room. The maximum demand calculated for the hall is 16kVA. The new three phase supply shall terminate into a new TPN MCB Distribution board to serve small power circuits.

Load monitoring of the existing school supplies has been undertaken to determine if load balancing to the existing school arrangement is required.



LV distribution systems shall be designed, installed, tested and commissioned in accordance with:

- BS.7671 - Requirements for Electrical Installations (IEE Wiring Regulations 17th Edition).
- National Inspection Council for the Electrical Contracting Association.
- Electrical Contractors Association (ECA) guidelines.

Circuits shall comprise of a combination of radial and ring-main systems suitably designed to minimise disruption on failure of a circuit or operation of a protective device.

General small power RCD protected 13A/switched/socket outlets for cleaning and maintenance to all areas shall be provided based on a wall mounted single outlet.

All items of fixed equipment i.e. fridge freezer, ovens / cookers, etc. shall be wired and connected to a permanent supply not plugged into the general service socket outlets.

Final connection shall be by 230V/13A switched/fused final connection units, suitably located in respect to the particular item of equipment.

Small Power & lighting circuits shall be distributed from a 6 Way 125A Type B TPN MCB Distribution Board.

Distribution board shall be provided with 25% spare capacity (as a % of used circuits) for future circuits.

Supplies shall be provided in the dining hall, as necessary to serve cleaner's equipment, fire alarm services, access control, etc.

Electrical supplies to all equipment and plant should include: -

- Lighting system, including controls.
- Small power outlets. This includes cleaners, plant areas etc. Use double 13A switched socket outlets unless single outlets are specifically required.
- Fixed items of equipment. This includes, underfloor heating, water dispensers, Heat Recovery Units etc. Supply radially using switched fused spur points.
- Mechanical plant and equipment. Include all independent supplies and control panels. Items requiring power supplies include main items of plant, heat recovery units, underfloor heating, etc.
- General Service socket outlets in plant areas for maintenance purposes.
- Fire alarm system. Ensure that the fire alarm system has a dedicated power supply labelled accordingly. Include all ancillary supplies, contactors and relays to mechanical plant etc.
- CCTV
- IT Systems
- Intruder alarm system

All wiring shall be installed concealed within the ceiling voids with flush conduit drops.

All armoured cables fixed to galvanised steel cable tray/basket.

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5.2.7. Fire Detection and Alarm

The hall shall be provided with a fully addressable monitored type; mains powered with battery back-up fire alarm and detection system extended from the schools existing fire alarm system.

The system shall be designed in accordance with BS 5839 part 1.

The system shall be configured to meet building control approval and the fire strategy of the building and existing school.

The fire alarm shall interface with mechanical plant, access control etc to operate under a fire condition.

The systems will conform to BS 5839 and meet with the requirements of the appropriate authorities.

Audible alarm shall be in the form of sounder to match existing schools fire alarm system.

The new fire alarm system shall link to the existing.

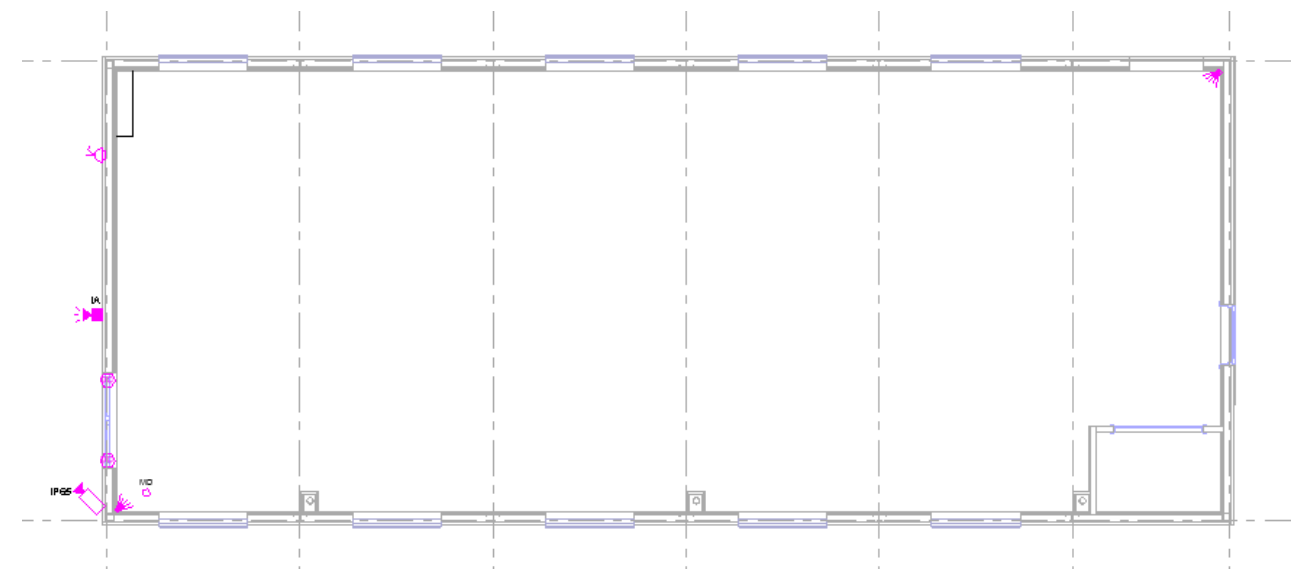
5.2.8. Security Design

The coverage areas for CCTV devices are based on best practice to enable effective visual verification; the following are examples of areas which must be covered:

- All entry and exit points (includes emergency exits).

The recording of images from the CCTV cameras to provide evidence which can be used to identify people and to prove what has occurred at what time requires suitable image quality.

CCTV is to be recorded in local server room and have the ability to be accessed off-site.



5.2.9. External Lighting

Install external lighting to the perimeter of the building.

Lighting scheme shall be designed in accordance with CIBSE Guide LG 6 & BS12464:2.

Lighting to consist of surface mounted LED luminaires mounted to façade of the building.

The scheme shall utilise timeclock and photocell.

Luminaires shall be positioned where practical to suit future maintenance.

6. REGULATIONS COMPLIANCE

To achieve Building Regulations Compliance you must meet three main criteria:

- Criterion 1 – Achieving the TER (Target Emission Rate)
- Criterion 2 – Limits on Design Flexibility
- Criterion 3 – Limiting Effects of Solar Gains in Summer

6.1 Criterion 1 & 2 – Building Emission Rate & Target Emission Rate

To achieve this a Building Regulations “Pass” is required as a minimum requirement. By using National Calculation Methodology (NCM) templates on the building, assessment of internal gains, occupancy and hot water demand against a “similar target building” also known as a Notional Building to determine energy improvement against government targets in kgCO2/m2/annum can be made.

The building has **passed** Building Regulations using the information provided, in achieving this value the following has been completed:

- Electric Underfloor Heating with Zone / Time Control.
- Low SFP for heat recovery ventilation to the building.
- Low lighting power densities with daylight lighting control.
- Metering and Monitoring Controls, Weather Comp. Zone Controls, Time/Temp.

U-values have been based on the previous issue of information and as reported within section 2.

The building has passed building regulations Part L, and achieved the required EPC rating of a A (24). Results overleaf.

6.2 Criterion 3 – Limiting Effects of Solar Gain in Summer

The IES software has a solar analysis package called Suncast embedded within its calculations. The module calculates the effects of the sun on the building by simulating the altitude and azimuth of the sun throughout the year. This produces a breakdown of the solar heat gains on the building and the results can be seen in the overheating results previously discussed and the Criterion 3 solar gain check.

All rooms have passed criterion 3 and do not exceed the allowable limit on solar gain.

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Plant Room	N/A	N/A
Dining Hall	NO (-10.3%)	NO

7. USER CONTROLABILITY

The hall space shall be installed with the following user controls to allow each teaching environment to be adjusted:



Heating Control

Each space shall be temperature controllable. Each sensor shall control each rooms heating, this generally shall be automated on a weekly schedule. To only heat when required and not cause overheating or energy wastage.



Lighting Control

Allow control of lighting operation, dimming capability and adjustment of the end wall light outputs. Shall be interfaced with a PIR occupancy detector.



Ventilation Control

Hybrid ventilation system controller, generally shall be fully automatic to maintain low CO2, but can be manually overridden. Contains a temperature stat for night purge ventilation during summer.

8. CONCLUSIONS & RECOMMENDATIONS

8.1 Daylight & Ventilation

The final daylight result showed the hall space achieved the minimum DA requirements. UDI was also met with UDI-E and UDI-S at a minimum. Windows reach as high as 2.6m to allow light to reach deep into the hall.

In achieving the maximum possible airflows, the tall windows accommodate a number of window openings via top hung sliding openings allow CO2 and temperature to remain to ESFA requirements. The hall shall benefit from windows to both sides of the building to promote cross ventilation and ensure ventilation and daylight is met in any arrangement.

To meet seasonal ESFA standards during winter months, a hybrid ventilation strategy is adopted through heat recovery units that can provide tempered fresh air efficiently throughout the year. CO2 levels do not exceed 1000ppm. The maximum occupancy has been confirmed at 100 people during assembly and dining hours. Therefore a single unit has been provided within the hall cupboard to achieve 800 l/s (8l/s/pp).

Summer time overheating temperatures are in accordance with ESFA guidance and comply with the Facilities Output Specification. This model is run for a full 12 month period.

No further changes are required to the architectural design at this stage to achieve the thermal comfort and internal environment set out within ESFA guidance. Please note, the model will require re-simulation on receipt of the final construction U-Value.

8.2 Building Regulations Part L 2013

Based on the thermal model, the building complies with Building Regulations Part L 2013 without any renewable technology. It has been confirmed by local planning that on site renewables are not required as part of the planning requirements. This was achieved with the following servicing strategy with a EPC without renewables achieved a A (24) rating.:

- Electric underfloor heating
- Point of use electric hot water heaters to mitigate pipework and storage losses.
- Low energy LED lighting with daylight dimming and manual override.
- A good thermal envelope and air tightness (1.5 Tested).

Summary of Derogations:

- Peak internal heat gains for the hall space accommodates a maximum of 100 occupants, 5 W/m2 lighting and 400 Watts of equipment (PC & projector).

No further changes are required to the building services design. Energy calculations demonstrates that electric heating when controlled efficiently is as cost effective to run as a wet gas system. Electric underfloor heating better suits the site limited infrastructure, the modular build process and ongoing maintenance and running costs.

9. APPENDIX 1

BRUKL Output Document

Compliance with England Building Regulations Part L 2013



HM Government

Project name

Caversham

As designed

Date: Tue Mar 13 12:37:15 2018

Administrative information

Building Details

Address: Address 1, City, Postcode

Owner Details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.7

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.7

BRUKL compliance check version: v5.3.a.0

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Criterion 1: The calculated CO₂ emission rate for the building must not exceed the target

CO ₂ emission rate from the notional building, kgCO ₂ /m ² .annum	22.2
Target CO ₂ emission rate (TER), kgCO ₂ /m ² .annum	22.2
Building CO ₂ emission rate (BER), kgCO ₂ /m ² .annum	16.6
Are emissions from the building less than or equal to the target?	BER ≤ TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	U _g -Limit	U _g -Calc	U _g -Calc	Surface where the maximum value occurs*
Wall**	0.35	0.21	0.21	ZN000000:Surf[1]
Floor	0.25	0.18	0.18	ZN000000:Surf[0]
Roof	0.25	0.18	0.18	PL000000:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.6	1.6	DN000001:Surf[4]
Personnel doors	2.2	2.2	2.2	DN000001:Surf[1]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

U_g-Limit = Limiting area-weighted average U-values [W/(m²K)]
U_g-Calc = Calculated area-weighted average U-values [W/(m²K)]
U_g-Calc = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
m ³ /(h.m ²) at 50 Pa	10	5

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Energy Performance Certificate

Non-Domestic Building



HM Government

Address 1

Address 2

Address 3

Address 4

City

Postcode

Certificate Reference Number:

0000-0040-0030-9000-0803

This certificate shows the energy rating of this building. It indicates the energy efficiency of the building fabric and the heating, ventilation, cooling and lighting systems. The rating is compared to two benchmarks for this type of building: one appropriate for new buildings and one appropriate for existing buildings. There is more advice on how to interpret this information in the guidance document *Energy Performance Certificates for the construction, sale and let of non-dwellings* available on the Government's website at www.gov.uk/government/collections/energy-performance-certificates.

Energy Performance Asset Rating

More energy efficient



A 0-25

B 26-50

C 51-75

D 76-100

E 101-125

F 126-150

G over 150

Less energy efficient

Net zero CO₂ emissions

24

This is how energy efficient the building is.

Technical information

Main heating fuel: Grid Supplied Electricity
Building environment: Heating and Mechanical Ventilation
Total useful floor area (m²): 130.925
Building complexity (NOS level): 5
Building emission rate (kgCO₂/m² per year): 14.71
Primary energy use (kWh/m² per year): 87.02

Benchmarks

Buildings similar to this one could have ratings as follows:

31 If newly built

84 If typical of the existing stock

