DSTL BM21

Building Services Engineering Design Description

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1.0 INTRODUCTION

2.0 PROJECT DESCRIPTION

3.0 DESIGN STANDARDS

4.0 ENERGY AND ENVIRONMENTAL ISSUES

5.0 INCOMING SERVICES

6.0 MECHANICAL SERVICES

7.0 ELECTRICAL SERVICES

1.0 INTRODUCTION

The purpose of this document is to provide the client with a brief description of the mechanical and electrical systems proposed for the new teaching facility at BM21 as part of RIBA stage 2.

Our proposals are based on preliminary discussions with the client team. Options will be considered further and developed at RIBA 4.

The current proposal is to provide a fitted out modular building to serve as the BM21 facility. This report has been updated to incorporate the VVRM and Wernick modular building supplier requirements and to elevate the report to assist at RIBA stage 3 level.

2.0 PROJECT DESCRIPTION

The BM21 development is located on the range at DSTL Porton Down. The range area of the Porton Down facility lies within an SSSI area.

The works comprise the construction of a new a new range teaching facility with associated welfare facilities. It is the intention to provide the facility as a modular building with the building services completely fitted out.

The project shall meet the requirements of DREAM excellent.

3.0 DESIGN STANDARDS

The following list provides the general basis for design development, it should not be regarded as exhaustive;

i) BRE and BSRIA Technical Publications.
ii) Building Regulations
iii) Local Authority's Bylaws and Regulations
iv) Local Authority's Sustainable Design and Construction Guidance SPG
v) Water Authority's Bylaws
vi) Electrical Supply Authority's requirements
vii) The Gas Safety Regulations
viii) The requirements of the Environmental Protection Act and the local Environmental Health Officer
ix) Appropriate British Standard Specification and Codes of Practice and the Standards of the International Electrotechnical Commission (IEC)
x) Regulations for Electrical Installations (IEE Wiring Regulations) Current Edition including all current amendments
xi) Health and Safety at Work Act, Shops and Offices Act and Electricity at Work Regulations
xii) CIBSE Guides, Codes and Technical Memoranda.
xiii) CDM Regulations
xiv) Manufacturer's stipulations & recommendations for installing & testing
xv) The COSHH Regulations
xvi) The Employer's Insurer's
xvii) HVCA standards publications
xviii) The Employers Insurers requirements
xix) Employers Requirement Documents

4.0 ENERGY AND ENVIRONMENTAL ISSUES

4.1 INTRODUCTION

This section considers the energy efficiency and renewable energy options available and reviews each systems suitability against capital cost, carbon emissions, life cycle costs and energy costs.

Various energy-saving measures have been considered both in terms of technical and economic feasibility and their effect on any carbon dioxide emissions. A broad package of energy-saving measures is proposed and is described in more detail in the following sections.

4.2 BASELINE EMISSIONS

The proposed newbuild development will fall under the new building regulations requirements 2021 and must comply with building regulations approved document L2A 'Conservation of fuel and power in new buildings other than dwellings'.

The methodology for computing CO_2 emissions is via the Governments iSBEM assessment calculation procedures using accredited software. Calculations have been undertaken to inform decision making in respect of the engineering solutions and to ensure compliance with the governments Target CO_2 emissions Rating (TER).

As an approved low carbon assessor HWM shall undertake an L2A (SBEM) calculation to help inform decisions on building fabric and building services systems to ensure compliance is achieved.

4.3 ENERGY DEMAND

Good low carbon design starts with good building design, low carbon and renewable technologies should only be considered once the development has maximised its energy saving potential.

Proposed developments should consider the following energy saving measures to limit energy demand prior to incorporating renewable technologies;

- Excellent thermal performance of the building envelope
- Efficient 'air tight' structure
- Efficient hot water and heat generation plant
- Natural ventilation where applicable
- Energy efficient lighting and controls
- User friendly energy efficient controls
- Consider the thermal mass of the building
- Building orientation to minimise adverse impact of environmental noise, excess heat gain and to maximise advantageous impact daylighting, fortuitous energy gains and visual comfort to users
- Low embodied energy materials

These energy efficiency measures have been considered and will be incorporated into our design proposals wherever possible and where technically and economically feasible.

4.4 RENEWABLE ENERGY SOLUTIONS

What constitutes renewable energy is defined by the Government through the Department for Communities and Local Government and is as follows:

- Wind Power
- Solar
- Hydro
- Biomass
- Combined Heat and Power (CHP)
- Ground source Heat Pumps
- Air source Heat Pump

Wind Power





Harnessing wind energy is possible with roof mounted turbines or ground mounted units.

A wind turbine converts the energy of wind into kinetic energy to drive a generator which in turn creates electricity, electricity can then be used at source or exported back to the grid thus taking advantage of the Governments feed in tariff scheme.

Wind turbines in locations with constantly high wind speeds bring the best return on investment.

Wind speed investigations can be undertaken and it is likely that the sites rural location would provide sufficient wind speeds for wind turbines to be a viable option. The erection and use of a wind turbine would require planning permission and significant civil engineering.

Given the activities on the range where the BM21 facility is to be located a wind turbine would not be suitable.

Solar





Solar energy can be harnessed in a number of ways.

The orientation of the building can be optimised to;

- Harness fortuitous heat gains in winter to reduce heating energy
- Maximise the use of daylight and reduce energy consumed by artificial lighting
- Minimise solar overheating in summer to reduce cooling energy

The building can also be provided with solar collectors, in the form of photovoltaic panels and solar thermal panels for generating electricity and hot water for heating and hot water generation respectively.

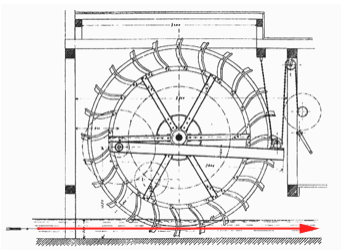
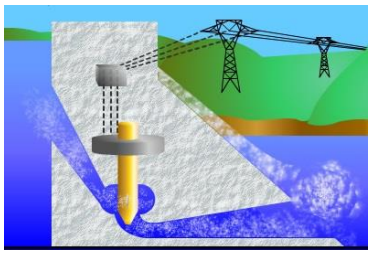
Solar electricity systems capture the sun's energy using photovoltaic (PV) cells. The cells convert the sunlight into electricity, which can be used to power appliances and lighting. It would also be possible to provide power to a ground or air source heat pump.

Solar thermal panels are effective and could be proposed to assist in the production of domestic hot water. The use of a solar panel array depends on the roofscape of the building sufficiently sized to accommodate the panels together with other plant and equipment. Solar panels could be utilised located on the South facing roofs.

A photovoltaic array located on the roof is a viable option for the development. Battery storage is a further consideration which will be reviewed further at detailed design stage.

Traditional solar thermal for the use of hot water generation is also a viable option however will not be used as the proposal is for hot water to be generated by a thermodynamic system which utilises solar power and is more efficient and reliable.

Hydro

Should the site be adjacent to a water course that has a drop in excess of 2-3m then a hydro scheme could be investigated. It is not an option for this project.

Biomass





The use of a biomass source burned to produce thermal energy is seen to be carbon neutral.

Biomass can be consumed from several sources, waste, wood chip and wood pellet.
Of these wood pellet is commercially the most effective for projects in urban locations. The fuel can be delivered by tanker and pneumatically delivered into storage. Further, its calorific value is high, moisture content and chemical content is managed.

Wood chips are most commonly produced by chipping the waste timber and bark from newly felled trees and during routine thinning and maintenance. Short rotation coppice is an alternative source of wood chips where fast-growing trees such as willow are grown as fuel crop. The chips are dried naturally before use. The size of the chips can vary considerably.

In contrast wood pellets are a manufactured product, most commonly made from the saw-dust of saw mills. They are manufactured to close tolerances of size and moisture content. Preliminary discussions with suppliers indicate that secure supplies are available locally.

Biomass boilers operate on a limited turndown ratio of approximately 25%. They need a constant load to operate efficiently such as a thermal store or a high hot water demand.

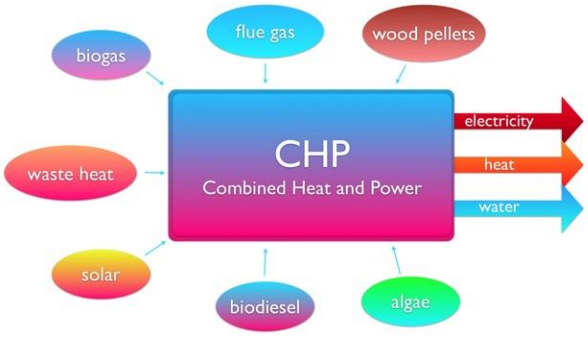
Underfloor heating in winter would provide a sufficient steady load, water heating however would be intermittent year round.

The implementation of a biomass boiler would require significant central plant space, large fuel store and regular wood pellet deliveries. The plants operation and regular ongoing maintenance would require management.

Although the burning of biomass is seen as carbon neutral the system still has a carbon footprint associated with its implementation due to the embodied carbon within the plant, the ongoing maintenance and delivery of biomass through transportation emissions.

Biomass is discounted for the above reasons.

Combined Heat and Power (CHP)



Combined heat and power is the site generation of electricity and the site use of the associated waste thermal energy. Electricity generation is selected against the building base load to maximise running hours. Thermal energy could be used for winter heating and domestic hot water generation.

The use of combined heat and power is recognised in the renewables sector. Whilst the energy source is not generally renewable, gas or oil, the overall performance improves the efficiency of power generation over grid supplied electricity from approximately 40% to 70% saving energy and reducing carbon emissions at source.

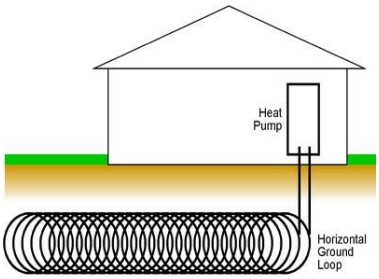
CHP plant relies on a stable, constant heat load to make maximum use of the thermal energy created. Without a constant load to heat, the waste thermal energy would be rejected into the atmosphere thus dramatically reducing the plants energy efficiency.

CHP plant in excess of 100kW (Thermal) is an attractive solution due to the low capital cost to the client. The client enters into an agreement with the CHP provider contracting to buy electricity from the supplier at an agreed tariff, the CHP supplier will provide and maintain the plant at their own costs.

The thermal load for our site will not reach the size where the supplier will fund the scheme also there is currently no permanent heat load, the CHP plant requires a large central plant area and can be noisy, therefore for these reasons and with it's high initial capital cost CHP is discounted.

Ground Source Water







Ground source water offers a more practical range of solutions.

Closed loop systems, where pipes are buried in the ground either linked with piles or bores or in a slinky arrangement, provide an energy source for a heat pump system. The heat pump system can then provide cooling in the summer and heating in the winter.

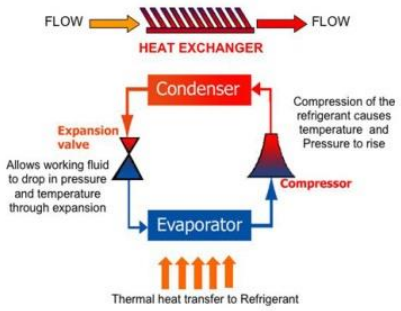
Open loop systems abstract water from bore holes and utilise its energy carrying capability as the closed loop system. The abstracted water can either be returned to the ground or to waste.

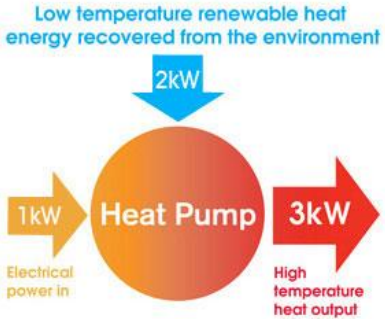
A further potential benefit is the use of bore hole water (private water supply) for domestic usage, producing savings against water charges. This is optimum rain water recycling.

The primary energy source for all of these systems is electricity, however because of stable ground temperatures coefficient of performance, particularly in winter, are enhanced against air source heat pumps.

A closed loop ground source heat pump solution is not a viable option for this project due to the area of pipework required to be installed below the ground. The site location on the range is sensitive to what lies undisturbed in the ground and the site also lies within an SSSI area, any ground works have to be minimised. The heating and cooling solution proposed for the building also would not require the use of a ground source heat pump.

Air Source Heat Pump





Air source heat pumps are recognised as a renewable energy source by the European performance directive.

A heat pump is a device for transferring heat from a lower temperature heat source to a higher temperature heat sink. This is opposite to the natural flow of heat from a hot source to a cold sink, but is made possible by the application of an external energy source to drive a thermodynamic refrigeration cycle. The important characteristics of a heat pump is that the amount of heat that can be transferred is greater than the energy needed to drive the cycle.

Air source heat pumps absorb heat from the outside air. This heat can then be used to warm water for radiators or underfloor heating systems, or to warm the air in buildings.

Air source heat pumps rely on the latent heat energy in the air, whilst seasonal C.O.P's of 2.5-3.0 are achievable C.O.P.'s can drop considerably at lower external ambient temperatures. A typical seasonal C.O.P. of 2:1 is normal.

Air source heat pumps have a lower capital cost, are easy to install and are considerably less intrusive at installation stage than Ground source heat pumps making them ideal solutions for smaller developments with limited space and refurbishment projects. The latter however offers more stable winter performance and better C.O.P's.

Air source heat pumps are a viable heating and hot water solution.

4.5 CONCLUSION

The previous sections have discussed the various energy and renewable options available and have highlighted the advantages and disadvantages of each system as applicable to the project. The site offers two main options with regards to implementing renewable technologies as previously reviewed, photovoltaics and air source heat pumps.

5.0 INCOMING SERVICES

5.1 WATER

An existing main runs through the site to feed the onsite EWS tank. It is anticipated that a new mains water supply shall be taken from the existing main to serve the new BM21 facility.

Potentially this supply is non-potable.

5.2 ELECTRICITY

An existing HV/LV step down transformer and LV switch board is located immediately adjacent to the site.

The intention is to take a new LV supply from the existing switch board to serve BM21.

Site facilities team has confirmed that 50kVA 3 phase is available for BM21.

5.3 TELECOMMUNICATIONS AND DATA

Comms duct network is onsite serving the existing facility at BM21. The intention is to extend the duct network into the new BM21 facility.

5.4 FIRE ALARM AND PAVA

Similar to the data network, the fire alarm and PAVA network already exists on site serving the existing facility, this shall be extended into the new facility.

5.5 BMS

Similar to the data network the BMS network already exists on site serving the existing facility, this shall be extended into the new facility. Currently there is no operational requirement for connection to the BMS.

6.0 MECHANICAL SERVICES

Below is a description of the Mechanical services systems proposed.

6.1 HEATING AND COOLING

The classroom shall be afforded simultaneous heating and cooling via a variable refrigerant volume (VRV) comfort cooling system with heat recovery.

In ceiling ducted fan coil units will serve ceiling mounted air grilles to provide warm or cool air to heat/cool the space as required by local room controls.

All other ancillary areas that have a heat loss will be provided with heating via local electric panel heaters complete with thermostatic and timed controls.

6.2 HOT AND COLD WATER SERVICES

A new mains water supply will be provided to the building as stated in item 5.1 above.

The supply will be routed below ground and rise within the WC to serve the WC only.

Hot water and drinking water shall be provided via bottles.

A water treatment plant could be provided to suitably treat the existing mains water non potable supply, to make it suitable for consumption. Tests on the existing water quality could be carried out to assess the suitability of providing a water treatment plant.

6.3 VENTILATION

Ventilation will be provided to the following areas as defined below:

Area	Requirements	Control
Classroom	Mechanical Ventilation with heat recovery	Automatic on/off with air quality sensors providing speed control
Tea Room	Mechanical Ventilation with heat recovery	Automatic on/off
Toilets	Mechanical Ventilation Local Intermittent Extract	On/Off via the light switch with run-on timer

The classroom and tea point shall be provided with local heat recovery air handling plant located in the ceiling void to provide tempered supply and extract air to the space. Incoming fresh air and exhaust air will be ducted to louvres in the façade.

The WC will be provided with an extract fan located in the ceiling void to provide extract air. Make up air will be from adjacent spaces. Extract air will be ducted to an external louvre in the façade.

6.4 ABOVE GROUND WASTE DISPOSAL

A fully vented system of above ground waste disposal pipework will be provided to serve all sanitary appliances. Main vertical stacks will be installed in uPVC pipework.

The above ground drainage system will connect to the below ground drainage system, the below ground drainage system will be designed by others.

7.0 ELECTRICAL SERVICES

7.1 LV DISTRIBUTION

A new 100A 3 phase LV supply shall be brought into the new facility from the existing LV switch board adjacent the site by the onsite INDO.

The onsite INDO will terminate the supply with a 100A rated cut-out and meter.

7.2 DISTRIBUTION

From the meter, tails will feed a distribution board to serve the new facility.

7.3 WIRING

Final circuit wiring will be concealed within the building fabric and distributed along galvanised cable tray utilising 6242B twin and earth cabling. Cable drops to accessories and outlets within walls shall be via galvanised conduit.

7.4 SMALL POWER

All power supplies, outlets and connections as necessary to facilitate the electrical and mechanical installations and as required shall be provided.

Circuits shall be ring or radial final type, and all 13A sockets shall be protected via RCD devices. All sockets shall be the switch type.

Within the classroom a 3 compartment dado trunking shall be provided to the perimeter.

An allowance for tea point, WC and mechanical services shall be included.

Socket outlets and power supplies shall be expanded on during RIBA stage 4.

WC shall be provided with a hand dryer.

7.5 SWITCH PLATES AND ELECTRICAL ACCESSORIES

Within the classroom all outlets and switches shall be plastic type, and subject to building control conformation if charcoal finish is required.

White plastic type accessories shall be provided internally where not charcoal.

External outlets shall be rated to a minimum IPX5.

7.6 LIGHTING

Luminaires

Luminaires throughout will be LED source and selected in accordance with CIBSE and SLL guidance.

Recessed downlights will be provided to all corridors, WC's and tea points.

Lay in modular 600x600 flat panel luminaires shall be provided to the classroom and shall have a glare rating index UGR<19.

External walkways to the perimeter shall be provided with IP rated wall lights incorporating 3hr battery backup.

A luminaire schedule will be produced for sign off by the client team.

Controls

PIR controls will be used wherever possible and practicable to all corridors and WC's.

Classroom lighting shall be controlled via a retractive wall switch to turn on or off the lights in the space, an absence detector shall turn the lights off if no movement is detected after a set period. Luminaires shall be dimmable with the sensor adjusting the brightness of the luminaires to take account of the available daylight.

Some podium lighting can be provided. This can be developed over RIBA stages 3 and 4.

External lighting will be controlled via a time clock and photocell with manual override.

7.7 EMERGENCY LIGHTING

An emergency lighting system will be provided in accordance with BS 5266-1. Emergency lighting shall generally be provided via the main building luminaires incorporating 3hr battery backup.

All final doors from the building will also be illuminated in accordance with the standard, either via a bulkhead above the door or part of an emergency lighting scheme to the building rear and side of the building. External walkway/escape route lighting required for safety and emergency lighting requirements.

Directional escape signage will be provided as self-contained maintained luminaires with pictograms indicating the emergency exits and exit routes.

7.8 FIRE ALARM

An analogue addressable fire alarm system shall be provided throughout the building in accordance with BS5839-1.

ADT are retained on site and are DSTL's nominated fire alarm contractor. ADT provide a design and install service. ADT to develop fire alarm design for inclusion in the works.

Protection level to be advised by ADT.

7.9 DATA NETWORK

The site data provider Datanet shall be consulted to provide a data wiring solution to suit the VVRM requirements.

Containment, wireways and power supplies to be provided to enable Datanet to complete their works.

7.10 ACCESS CONTROL

Access control requirements are provided by KABA. KABA carry out the design, and power supplies, wireways etc are provided under the contract, with wiring and install by KABA. Currently within the VVRM there is no requirement for access control.

7.11 SECURITY SYSTEM

Security requirements are provided by SSG (security services group). SSG carry out the design, and power supplies, wireways etc are provided under the contract, with wiring and install by SSG. Currently within the VVRM there is no requirement for security/intruder alarm systems.

7.12 LIGHTNING PROTECTION

A lightning protection risk assessment will be undertaken to ascertain if a lightning protection system is required for the development.

7.13 EV CHARGERS

No EVC's are proposed at this time.