FRANKHAM

Frankham Consultancy Group Building Services Engineering Services Strategy Report

Document Control

This document is CONTROLLED at the point of issue, thereafter, Readers should confirm that they have the current Revision prior to relying upon the contents.

Revision	Author	Details	Issue Date	Reviewed	Approved	Document Status
P01	DJ	Mechanical and Electrical Services Strategy Report	09/06/17	MJC	MJC	**PRELIM**
P02	DJ	Mechanical and Electrical Services Strategy Report	21/06/17	RH	MJC	**PRELIM**

Table of Contents

Copyright, Design and Patent Act 1988

Third Party Assignment

1.0 General Description of Works

1.1 General

The project includes all works necessary to form the complete refurbishment of No. 1/1a Montague Street, an existing British Museum property. No. 1/1a is two buildings which are being split into two separate office buildings that could be operated as a single office building if required. The buildings comprise of lower ground, ground, first, second and third floors with a pitch roof (roof void).

The buildings are being completely refurbished with new building services with a mix of retained and new incoming services. The external drainage connection shall be retained however new below ground drainage connections shall be required. However, the below ground drainage works falls outside of the scope of the Mechanical services.

2.0 Design Conditions & Criteria

The following design conditions and criteria have been used to for the design of mechanical services.

2.1.1 External design temperature

The following external design temperatures have been used:

- Summer - 29ºC (db) / 20ºC (wb)
- Winter - -4°C, saturated. Extreme -8°C.

2.1.2 Internal Design Temperature

The heating system to all spaces shall be able to achieve the following minimum room temperatures:

- Offices - 23ºC with +/- 2K tolerance.
- All other areas as per CIBSE Codes.

The cooling systems to offices areas only shall be able to maintain the following room temperatures:

- Offices - 26ºC with +/- 2K tolerance.
- All other areas as per CIBSE Codes.

2.1.3 Low Temperature Hot Water Temperatures

For the purposes of design, LTHW system has been sized and designed based on the following water flow and return temperatures, 75°C and 65°C respectively.

2.1.4 External and Internal Noise Criteria

All plant has been designed to meet the following external noise criteria requirements. Noise level measured at the site boundary shall not exceed that permitted by the Local Planning Authority.

All noise analysis shall be based on 24 hour operation of the plant and related to the night time background noise levels proscribed by the local authority.

All internal services have been designed and shall be installed to meet the following noise criteria requirements:

- Office, Conference, and Meeting Rooms - NR 40

2.1.5 Ventilation Criteria

The building shall use a mix of natural and mechanical means for ventilation. Where natural ventilation cannot meet Building Regulations the following mechanical rates shall apply:

- Office (Fresh Air) - 10 l/s/per person.
- Toilet (Extract) - 10 air changes per hour.
- Store Rooms (Extract) – 2 air changes per hour (minimum)
- Tea Point (Extract) - 15 l/s intermittent extract rate.

2.1.6 Heat Gain Loads

The systems have been designed and shall be installed on the following design criteria:

Load Type	Load
Equipment (Office)	25 W/sqm
Equipment (Other Areas)	12 W/sqm
Lighting (Office Areas	18 W/sqm
Lighting (Other Areas)	15 W/sqm

2.1.7 Occupancy Loads and Allowances

The following occupancy levels have been and shall be used to assess the building cooling loads, and the spatial requirements of the buildings.

- Occupancy of 1 person per 10m2

The systems have been designed and shall be installed based on the following occupant gain loads:

Load Type	Load
Sensible	80 W per person
Latent	40 W per person

3.0 Gas Service

The existing gas supply which enters the front vault of No. 1A shall be used to supply the boiler within No. 1A.

A new gas supply shall be provided to No 1 and shall be used to supply the boiler within No 1. Fir.

Two new gas safety systems and solenoid shut off valves shall be installed. The safety systems shall be a Medem type systems or equal and approved. The systems shall include gas knock-off, thermal link integration, carbon monoxide sensors, and fire alarm signal that shall disable the gas solenoid valves power supplies, isolating the gas services in the event of a leak or emergency. Each gas safety system shall be operated independently, with links to the fire alarm panel the respective building. The system shall monitor carbon dioxide levels within the plant spaces and perform two functions on receipt of a high level condition, firstly it should raise an alarm both locally and via the BMS connection (if provided), secondly it shall isolate the fuel supply via a gas solenoid valve on the incoming pipe feeding the plant room.

Each bulk gas meter shall be provided on the supply branch feeding the development. The meter shall have a pulsed output and shall be connected too and monitored by the site BMS. The meters shall be used by the landlord to monitor the total gas consumption in accordance with the Building Regulations Part L2. A sub meter shall be installed to monitor each new gas supply within the Boiler Room.

The vaults containing gas meters shall be naturally ventilated, via louvered doors, to the statutory requirements.

Each individual gas supply shall routed through the building to serve a floor mounted gas boiler, located within the boiler room of that building.

At each outlet an isolation valve shall be installed to allow connection and isolation of the gas boiler(s).

In addition to the above a BMS or local standalone monitoring panel shall also monitor plant room air quality in compliance with IGM11.

No gas leak detection system is required.

All gas meters and sub meters shall have a pulsed output to ensure that it can be connected to the BMS system for monitoring and data collection purposes.

Each new gas supply shall be installed complete with all necessary isolation valve, pressure regulation valves and test points.

4.0 Mains Cold Water Supply

The whole cold water services installation shall conform to the measures outlined in the 'Health & Safety Executives Legionnaires Disease – The Control of Legionella Bacteria in Water Systems' Approved Code of Practice L8, HSG274 and CIBSE TM13.

The Main Cold Water Services shall comply with all relevant current British Standards and Health and Safety Executive Regulations.

4.1 Incoming water supply

The existing incoming water supply which enters the front vault of No. 1 shall be used to supply the booster set for building No1.

A new supply shall be provided to building No. 1A, this shall be used to supply the booster set for building No. 1A.

A contamination test on the existing incoming lead piped service to No1 shall be undertaken. If the level of contamination are above a required standards, then it is proposed that a new supply from the street mains be requested from the utility provide (Thames Water).

The design intent is for the incoming positions to be within the existing vaults with utility meters installed within this area with check meters located within each plantroom.

The connection to each building shall be separately metered and billed by Thames Water.

Each new connection service shall enter the vaults via a fully insulated duct with a suitable water proof detail. All connections shall be fitted with a stopcock, double check valve, strainer and water meter. Each water meter shall have a pulsed output to enable monitoring by the utility and landlord.

Each supply shall incorporate an approved electromagnetic water treatment device to reduce build-up of scaling within the supply systems.

Each supply shall be connected to a booster set that shall ensure a minimum of 2 bar available pressure is provided to all outlets.

5.0 Boosted Cold Water Services

The incoming mains cold water supplies shall be routed to respective plantrooms containing the new break tank and booster set for that building, including controls and expansion vessel.

Each new booster set shall supply a Boosted Mains cold Water Service (BMWS) to the building via the riser. The system shall be extend to serve all outlets and hot water appliances inside the building.

The BMWS shall be fitted with a pressure reducing valve at each floor branch and hot water appliance.

The BMWS shall be fitted with bypass valve assemblies to ensure the supply of water should the pump set fail.

5.1 Water Treatment

Before each booster set an approved electromagnetic water treatment device to reduce build-up of scaling within the supply systems, will be installed.

5.2 Boosted Mains Water Services

A booster pump set and tank, for each building, will be installed which shall be located at lower ground floor level within the plantroom.

The tank and booster set shall be sized to ensure that the full design flow rate can reach all mains water draw-off points to suit daily demand.

The warning pipes and overflows from the tank shall be installed using copper pipework and shall discharge to a gully within the plant room. High and low water level sensors shall be fitted in each tank and monitored by the buildings BMS systems.

6.0 Hot Water Services

The hot water services shall be generated by electric water heaters located close to the point of use, as indicated on the drawings. All hot water for showers shall be provided via electric thermostatic showers.

The water heaters must be installed by competent persons and according to manufacturer's recommendations.

A cold water feed shall be connected to the water heaters. The water heaters will be then supply the local domestic hot water pipework and outlets. Due to the expected pipework lengths the domestic hot water pipework shall be trace heated, to prevent legionnaire risk.

The domestic hot water supply temperature from the water heaters shall be set to 50°C, and maintained at this temperature in the pipework by the trace heating system.

The design allows for adequate pressure reducing valves, balancing valves, and all other associated valves to complete the installation where required.

The hot water service to sinks and WHB's shall be fitted with a thermostatic mixing valves (TMV3) complete with a flat faced union coupling, strainers and integral removable check valves. The valves shall also be complete with 90 swivel elbow unions and combined isolation valve/removable basket strainers for easy routing valve maintenance.

The valves shall be supplied factory pre-set at 43°C for site adjustment to supply HWS at 41°C for WHB's.

Each hot water outlet without TMV shall have a label indicating 'Caution Very Hot Water' fixed adjacent. The label shall be a red on white 'traffolyte' label.

Each hot water system shall be a single pipe system with no recirculation.

It is expected that the local water heater shall be supplied with expansion vessels to maintain and manage the system pressure.

7.0 Domestic Pipework Services

7.1 Pipework

All pipework, fittings and equipment shall be WRAS approved.

BCWS pipework shall be positioned and sufficiently thermally insulated to prevent 'warming' from the heating pipework respectively.

All water systems shall be installed in compliance with the Health & Safety Executive publication 'Legionnaires Disease- The Control of Legionella Bacteria in water systems, approved Code of Practice and Guidance.

8.0 Heating Systems

A new heating system has been designed to each building by means of providing a Low Temperature Hot Water (LTHW) system, including a new set of modulating condensing boilers for each building. The boilers shall be connected to the LTHW systems including circulating pumps and all necessary associated items. The system shall have weather compensated LTHW systems. The LTHW systems shall serve new radiators, as per the typical schedules and schematics, in each building.

The radiators shall serve all areas of the buildings other than the offices as indicated by the drawings.

All distribution pipework and all pipework in the boiler room shall be thermally adequately insulated.

8.1 Gas Fired Boilers

A set of gas fired condensing boilers with new flue arrangement from the boilers to atmosphere shall be controls from new Mechanical Control Panels in each building. The boilers shall be interlocked with the gas supply and air quality of the plantroom.

8.2 Heating Pumps

A set of energy efficient circulation pumps for the LTHW systems shall be inverter driven, and installed in the plant room as indicated on the drawings.

All relevant pressure and temperature sensors to allow for the efficient running of the LTHW system shall be installed in the pipework system.

8.3 Air/Dirt Separator

Each LTHW system shall be have a line size combined air/dirt separator or equal and approved. These shall be installed in the flow pipe from the boilers. These shall also incorporate magnets to capture iron particles.

8.4 Pressurisation Unit

A pressurisation unit or equal and approved shall be supplied, to maintain pressure for each of the heating systems. The unit shall be supplied with a suitable expansion vessel/s to best suit the space available within the plant room.

8.5 Dosing Pot

A dosing pot or equal and approved shall be installed across each of the LTHW heating flow and return circuits to ensure the entire system is chemically protected from corrosion and subsequent damage due to untreated mains cold water.

8.6 Additional Components

In addition to major components listed the following will be provided:

- Strainer in the common pipework to protect the boilers from circulating debris.
- Pressure independent control valves to prevent energy loss when no heating is required, regardless of variations in pump speed or valve closures in other parts of the heating system.
- Controls to allow separate timer/ temperature stats, which energises the boilers and circulation pumps according to heating demand. As well as allow weather compensation
- Safety valves and drain off cocks in the pipework to provide pressure relief in the event of a malfunction.

8.7 Heat Emitters

8.7.1 Radiators

LTHW radiators shall be installed according to the manufacturer's recommendations.

Each radiator shall be fitted with an Oventrop AQ thermostatic radiator valve (or equal and approved) and lock shield valve, with the exception of the spaces fitted with the room thermostats, which shall have two lock shields. All valve connections shall be as scheduled.

The thermostatic radiator valve Oventrop "AQ" for automatic hydronic balancing shall be installed to provide pressure independent thermostatic control with infinitely adjustable pre-settings. Each value is set with the help of a pre-setting key and turning the hand wheel. The control range is visible from outside, the volume flow which is maintained even where high differential pressure variations occur is set directly.

A heavy duty drain cock shall be fitted to radiator/s at the lowest point of each system.

Towel Rail Heaters

A series of electric towel rail heaters shall be installed according to the manufacturer's recommendations.

The heaters shall be fitted with integral thermostatic controls, on/off switch and 24Hr 7 day programmable timers to allow user modulation of set point and operation. The heaters shall be dual fuel, with connection to both the LTHW system and local radial small power supplies.

All units to be IPX4 rated and incorporate a thermal cut out.

8.8 Pipework

The LTHW heating water distribution pipework shall be Geberit Mapress or equal and approved copper tube to BS EN 1057 - R250.

This pipework shall be concealed in floor voids and services risers.

Allowance shall be made for expansion of pipework in accordance with the manufacturer's recommendations and as described within the tender documents.

All pipework shall be insulated in accordance with the requirements of Approved Document L and the building services compliance guide and co-ordinated with other services to be installed within the service voids.

All pipework to be supported in accordance with the manufacturer's recommendations and as described in the tender documents.

All Pipework systems to allow for venting and drain down as described with the tender documents.

8.9 Water Treatment of Heating Systems

All heating systems are to be flushed and treated in accordance with BS 7593:2006.

A dosing pot shall be installed in the system for chemical treatment of the heating system water.

Details of the products used shall be provided to the CA, and included in the O&M manual provided to the employer.

8.10 Thermal Insulation

The pipework in risers and all horizontal runs shall be thermally insulated with rigid pre-formed non-combustive sections, canvas outer covered, secured in position with non-ferrous bands with reinforced foil face finish.

Thermal insulation thickness shall be as BS 5422:2009.

Pipework within boxing shall be thermally insulated with Kingspan Kooltherm FM pipe insulation or equal approved to suit ceiling void space constraints.

Thermal insulation thickness shall be required by Approved Document L.

All thermal insulation shall be glued and taped and then banded to identify the piped service as BS 1710/4800.

9.0 Comfort Cooling and Heating (Office Areas)

A comfort cooling and heating systems within each buildings shall be via a set of VRF/ VRV heat pump heat recovery systems.

The comfort cooling and heating shall be provided to office areas only.

The system shall be capable of providing simultaneous heating and cooling via branch selector boxes. There shall be a set of condensing units to serve each building. The condensing units shall be located externally to the building at ground floor level.

Refrigerant pipework shall run in the services zones to BC Controller boxes located in plant areas, risers or roof voids with the exact positions to be finalised on site. From the BC controller box individual flow and return refrigerant pipework shall run out to the individual Fan Coil Units in the spaces to be served. All refrigerant pipework shall be suitably insulated and run on suitable containment.

Within each space to be served, there shall be indoor units connected by flow and return refrigerant pipework to the BC controller box. The indoor units shall be the floor mounted concealed type units. Each space shall have a wall mounted controller, which in turn shall be linked to a central VRF system controller. The central controller shall be linked to the BMS for monitoring and control.

The indoor units shall circulate air within the space to the desired room temperature.

All indoor units shall have condensate drain lines to be run to suitable drainage positions. Condensate lines shall be complete with self-sealing waterless traps and shall be gravity type or mechanically pumped as required.

9.1 VRF System

The installation shall provide an energy efficient R410A Variable Refrigerant Flow (VRF) comfort air conditioning system(s) to the designated areas/zone utilising a simultaneous heating and cooling with heat recovery. The system shall be installed in accordance with relevant codes of practice and regulations.

The system shall be a VRF 3-Pipe Heat Recovery Condenser and multiple indoor units to provide simultaneous heating and cooling to each zone within the building. The system shall use non-ozone depleting HFC refrigerant R410A and be able to run with a minimum indoor cooling demand.

The air conditioning system control functions shall be accessible through the centralised controller and touch screen interface.

The equipment must be suitable for operating on a 220-240 volt, single-phase, 50 Hz supply for indoor units and a 380-415 volt, three-phase, 50 Hz supply for the outdoor units.

9.2 Outdoor Units

Each outdoor unit shall be factory assembled, pre-wired, works tested, supplied with a refrigerant pre-charge and complete with fully sealed pipe work connections. The access panel shall be easily removable for servicing. The condensing unit shall be fitted with its own electrical compartment with all necessary electrical and control components. An oil management system is to be fitted, to allow oil transfer between connected outdoor units, thereby ensuring that adequate lubrication is provided to every compressor.

Each separate system shall be capable of simultaneous heating and cooling.

The external heat pump condenser units for the buildings shall be installed as per the drawings, and manufacturer's requirements. External Condensers shall be arranged to ensure the minimum maintenance clearance spaces around the units are achieved as defined by the manufacturer literature.

The heat pump units shall sit on anti-vibration pads mounted either directly onto the floor finishes, or as part of the structural support system, to limit the effect of plant vibration noise. The outdoor units shall then connect to the indoor heating/cooling units via a copper refrigerant pipework system distributing primarily via the buildings plant risers and the ceiling voids. All pipework shall be mounted on cable ladder or tray, all laid to the full length of the pipe route.

Where pipework enters the building from external areas shall provide via pre formed opening in the structure which provides and waterproof connection

Pipework in risers shall drop or rise on cable ladder/tray and then distribute at each floor level within the ceiling void again mounted on cable ladder/tray. The routing of pipework shall be in accordance with the drawings and installed with ease of maintenance in mind.

The outdoor units shall provide a common fault signal to the BMS / MCC.

9.2.1 Indoor units

Each indoor unit shall be floor standing concealed, type unit from the selected manufacturers' R410A VRF range of units and must operate on 220-240 volt, single-phase, 50 Hz supply.

Space heating and cooling shall be provided to all offices spaces by VRF floor mounted fan coil units, to meet the internal environmental requirements. The Fan Coil Units shall be supplied with heating and cooling energy via the outdoor units.

Make up air to the indoor units shall be drawn directly from the room via an opening within the casing, as shown on the drawings.

All indoor units shall incorporate a condensate drain connection that shall be required to run to either foul or surface waste down pipes. Each unit shall be provided with a condensate pump and drain pipe, the drain pump shall lift the condense to a suitably elevated level permitting it to then fall at a suitable gradient to a local soil vent or rainwater pipe, via a waterless drain trap. The condense lines shall be installed using uPVC pipework. Where insufficient fall is available to route the pipework to drain via gravity, intermediate condensate pumps shall be fitted to ensure all condensate achieves draining.

9.3 Controls and Monitoring

The outdoor units and distribution boxes shall be monitored by energy monitoring software to allow the landlord to bill the each tenant for the energy used by the FCU located within the individual tenant areas.

Operating temperatures for the various systems shall be adapted to suit individual zone requirements as stated in the design criteria.

Each space shall have a wall mounted controller, which in turn shall be linked to a central VRF system controller. The central controller shall be linked to the BMS for monitoring and control.

Local controls of the VRV system shall be provided by a hard wired remote control units. The controller shall provide basic on/off control with set point adjustment, fault code diagnosis and time clock configured. The controller shall also be capable of being connected to remote temperature sensors to suit various interior design options.

A central intelligent touch controller shall also be provided. This controller shall be linked to each local controller and have the capacity to control each local unit. The system shall have capacity to allow floor-by-floor energy use metering.

Each thermal zone shall be provided with a local wall mounted controller that shall permit user modulation of temperature set point, time control (including optimised control), fan speed and operating mode. Fault indication dirty filter to interlock with ventilation unit. Temperature control shall be via air temperature sensors located within the room wall mounted controller so that units control to meet a room temperature, not a return air temperature.

9.4 Pipework Insulation

All Refrigerant pipework to be insulated with slip-on close cell elastomeric pipe insulation, with a fire performance rating class "O" of the 1985 Building Regulations, having a wall thickness of not less than 13mm.

After commissioning, all joints to be properly sealed to provide an adequate vapour barrier and clearly marked for ease of identification.

Insulation shall be continuous throughout the pipework length, including insulated brackets.

9.5 Acoustic Requirements

Each outdoor VRF unit shall be provided with speed control (using a PAC-SA89TA-E 3-wire adapter, supplied by Mitsubishi) to reduce the condensing unit fans speeds to achieve the required sound level outlined in the Environmental and Acoustic Consultants report. The outdoor unit fan speed control will be activated via the BMS.

However, assessment needs to be undertaken by the Acoustic Engineer to determine if additional inlet attenuation is required to the outdoor VRF units.

Allowance should therefore be made for the each outdoor VRF unit to have a full acoustic kit installed on it.

9.6 Energy Monitoring and Sub Metering

The VRF heating system shall be linked to the building management system with energy monitoring, controls and alarm facilities.

10.0 Fan Coil Unit (Air Conditioning)

A combination of concealed and exposed Fan Coil Units (FCUs) to all office areas as shall be provided as defined on drawings, to control the temperature within the office areas of the buildings.

All units shall be recirculation only and operate in rooms that are naturally ventilated.

Each fan coil unit shall comprise of an inlet plenum, case with filter, direct drive fans with variable speed DC motors, VRF heating/cooling coil, and drip tray.

The fan coils shall be positioned in such a manner that they can be accessed and maintained easily, via dedicated access panels within the casings. The filter and unit controls shall be accessed via this panels.

The cooling coils shall be connected to the local VRF circuit, as described in the VRF section of this specification.

Drip trays shall be provided below all heating/cooling coils, the drip trays shall generally be required to connect to the foul drain by a pumped system (as described in the VRF section).

Each FCU unit shall be control together with other FCU's within the same thermal zone, and shall be used to temper air supplied to the thermal zone.

The fan coils shall supply treated air into the space through a series of diffuser, slot connection depending on the location built within the FCU cases.

Local controls shall be provided in each zone controlling a group of fan coils.

An air flow failure shall be provided on all fan coil units linked back to the central control system to alert facilities management to unit failures and maintenance requirements.

11.0 Ventilation

11.1 Mechanical Ventilation (Extract Only)

A series of local mechanical extract ventilation systems in the buildings shall be utilised for the toilet areas, showers, cleaner cupboards and kitchenettes. Air shall be extracted via ceiling or wall mounted air grilles and ducted to atmosphere.

Galvanised sheet metal distribution ductwork shall be manufactured, installed and supported in compliance with HVCA DW/144 and shall be leak tested in compliance with HVCA DW/143.

The extract ventilation rates shall comply with building regulations part F.

Make up air shall be provided by natural ventilation means from adjoining spaces via undercut doors.

11.1.1 Toilet Systems

All extract systems for toilet and cleaner's cupboard areas shall be via twin extract fan system. These systems shall operate on space occupancy only activated by PIR sensor located in each space. The systems when activated with operate for a prescribed time frame (to be agreed with the client) and shall also have an automatic changer over (run/standby) facility.

The system shall with makeup air from the adjacent spaces, shall allow the creation of a negative pressure regime to prevent the egress of smells and moisture to surrounding areas.

11.1.2 Kitchenette Systems

The extract fans shall be controlled via manual switching with a run-on timer to comply with Building Regulations.

The systems shall allow the creation of a negative pressure regime to prevent the egress of smells and moisture to surrounding areas.

11.1.3 General Items

The use of flexible ductwork shall be permitted for final connections to ceiling diffusers / valves but must be kept to a length of 0.5m or less to avoid excessive pressure loss within the ductwork system.

All ventilation ductwork linked to the external environment shall be insulated for the first 0.5 meters Cladding shall be applied to all exposed ventilation ductwork or where it routes externally from the building.

11.2 Natural Ventilation

All windows to office areas shall be openable to provide natural ventilation to the building and make up air to the extract systems.

11.3 External Vaulted Areas

Ventilation to the vault areas shall be via louvered doors provided by others.

12.0 Automatic controls

A complete controls system in line with the specification has been designed and a Controls Specialist shall undertake these works.

12.1 Performance Objectives

A new mechanical control panel providing power and control wiring between this panel to the boilers, control valves, pumps, sensors, etc. shall be installed

The design shall allow for all new interconnecting control and plant wiring, including all 230/400 Volt motive supplies. Trend Controls to be supplied, installed and commissioned by a Control Specialist making due allowance for the installation of motors, activators, protection devices, thermostats/sensors and pockets, together with full testing and commissioning and the provision of panel wiring diagrams. The controls shall contain the provision for future remote monitoring.

12.2 Design Parameters

The controls shall comply with all current British Standards, Health and Safety Executive Regulations and Guidance documents.

12.3 Control Panel

The new control panels shall contain the control elements required to provide energy efficient control of the plant listed above.

Fascia switches giving 'on' 'off' and 'automatic' control together with indicator lamps giving run and trip condition of all pumps shall be incorporated in the panels, for example.

Inside the panel all components shall be labelled and all terminals numbered with labels made from traffolyte. Labels shall be secured with self-tapping screws or bolts and nuts. Labels on the console face shall be of equal standard. The panel shall accommodate all the necessary new equipment to satisfy the control strategy, including pairs of DOL starters for single or three phase, as appropriate, for pumps complete with thermal overload fuses on/off control switch, run and trip lamps etc.

A new RCD protected 2-gang switched socket outlet box shall be fitted to the side of, or adjacent to, the new control panel.

12.4 General Overview

A Building Management System (BMS) and Local Controllers shall be provided to monitor and control the various building services installations, across both the buildings.

The BMS shall be open protocol based and shall be agreed with prior to adoption, as part of the BMS Technical Submission.

All elements shall capable of acting in a standalone operation manner, but have the ability to be linked to a wider monitoring system, for at least fault alarm signalling.

12.4.1 Control Strategy

The BMS and local controllers shall be used to monitor, control and operate all plant and accessories shown on drawing, given in schedules or described within this specification.

The system shall be used to monitor and/or control the following items:

- Meters & Sub Meters
- Cold Water Booster Sets
- Pressurisation Units
- LTHW Boiler and Hot Water Generation
- Circulation Pumps
- Local Extract Ventilation
- Fire Alarms,
- Local Heating and Cooling (VRF FCUs)
- VRF Energy Monitoring
- Other Miscellaneous Plant

In general the control strategy of the equipment located in the plant room shall be agreed with the Client.

The design allows for all related electrical and mechanical works required for the complete installation.

12.5 Sequence Control

Sequence control routines shall be included to automatically sequence the operation of plant by monitoring load parameters and efficiently match the plant to the load, with the facility to programme different automatic sequences of control. The operator shall have the facility to override the automatic sequence and programme an alternative sequence. Set point values for each control action shall be variable and adjustable by the operator.

An operator adjustment shall be included in routines for switching control differentials to prevent short cycling. When the maximum number of start/ stop cycles for a particular plant is reached ensure routines automatically modify it's schedule, eg: - by rotating standby equipment or changing the lead machine.

12.6 Weather Compensation Control

Weather compensation routines shall be provided to control the space conditioning systems in relation to external weather conditions and shall include optimum start. The operator shall have the option to adjust settings for the systems to re-define the weather compensation.

Automatic adjustment to the weather compensation shall be by comparing measured and required space temperatures with the outside conditions and correcting the compensation where a significant difference between the two space temperatures occurs. Ensuring abrupt changes in the heating system performance or space temperature do not adversely affect the automatic adaptive compensation process. A single weather compensation curve shall be used for each zone irrespective of the number of temperature sensors provided in that zone. The routines shall respond to the reset signals arranged to achieve boost, night set back and boiler safety.

12.7 Office Areas / Common Plant BMS

A fully networked BMS with VRF Energy Monitoring shall be installed, within the office development. This system shall come with a full graphics package and shall be fully compatible and allow the Client to link to any external systems, for a potential estate wide facilities management response system.

The BMS system shall be networked, with the primary interface device located within the LV plant room, with similar secondary interfaces located within the subbasement plant room and roof plant area.

The interfaces shall be installed within the control boards, with the primary interface location also having a PC / Laptop interface for more detailed interrogation of the systems.

In general the system shall include the following functions:

- Optimum stop/start routines
- Multiple time programmer
- Primary energy consumption monitoring [Energy Metering and VRF Usage Monitoring] with modem facility to the clients energy manager
- Weather compensation control
- Run time summation
- Duty cycling of plant
- Sequence interlocking
- Fan inverter control and monitoring [If not part of local system controllers]
- Pump inverter control and monitoring [if not part of local system controllers]
- Show plant operating set conditions
- Show faults and undertake Alarm handling [with general fault alarm repeater within the office reception area]
- VRF Boiler, and Hot Water Storage control and monitoring
- VRF control and monitoring
- Fire Signal interface (Automatic Shut Down / Smoke Control Activation]

12.8 Ventilation Systems

All twin fan toilet extract systems shall be provided with duty/standby auto change over facilities to alternate the two fans every 24 hours, controlled by a local controller. This should also automatic switch fans if a fault is detected.

All other fans shall operate by local controllers.

12.9 VRF Systems

A dedicated system controller, shall be provided by the manufacturer, and set to work by the specialist, in line with the thermal control zones of the building and energy monitoring requirements. Each thermal control zone shall have a local controller for local FCU set point adjustments. The system controller shall also enable central set point adjustment and energy monitoring.

12.10 Fire Signal interface

The system(s) shall be configured so that the fire detection and alarm system shall, when activated, give an input signal to the BMS. For each development, mechanical plant within that development shall be switched off in the event of a fire signal (as necessary under the fire strategy).

BMS or Local Controllers shall automatically "re-set", to re-start plant in the appropriate and scheduled manner once the Fire Alarm system has given the "all clear". The interface shall also give information to the central operator facility, on the status of the fire alarm. The BMS shall not input to the fire systems.

A facility to override this function is provided during fire alarm testing, generally this shall be provided via a key switch at the fire alarm panel.

The fire alarm system for each development shall be interlinked. In the event of an alarm signal being raised, in either development, both developments shall be made aware of this fire alarm signal and can respond appropriately.

In addition the BMS shall, advise users of the reason for plant and equipment stopping and that they may need to reset some items once the situation is over.

The fire alarm signal shall be give directly to the motor control panel(s), not via the BMS, a signal via volt-free contact(s) in the MCP, to stop all plant and equipment powered from that panel.

12.11 Gas Safety for Boilers

All installed gas fired boiler shall be operated locally.

However gas shut off valves shall shut off the gas supply under the following conditions:

- If the building/residence fire alarm operates (but not in a fire alarm test condition)
- If an emergency shut off button is operated
- If the water supply fails
- If the electrical supply is lost

The gas valves shall automatically re-open as soon as all of the above conditions are rectified.

A lamp indicator in the control panel door shall indicate when the main gas shut off valve is closed.

The common alarm shall be activated for fault conditions (ii), (iii), (IV) or (v).

12.12 Metering

The controls system shall be able to review and monitor the incoming services reading from the utility meters and check meters.

12.13 Boiler Control

The boilers shall be installed and controlled using a unison control strategy.

This method of control steps each boiler module on at its lowest rate until all boiler modules are firing and then modulates all boilers modules simultaneously to higher rates to match the system load.

This shall allow higher operating efficiencies, by taking advantage of the higher part load efficiency of the boiler at lower firing rates.

12.14 Circulating Pumps Control

The speed of the pumps shall be modulated to maintain the required water flow rate in the boilers according to the output of the boilers.

The controller shall monitor the condition of each pump set, indicating if the pump is on, off or in trip condition.

All pump pairs shall rotate pumps on a changeover schedule and shall also automatically change over pumps when a fault condition occurs on any one of the pump pairs. This facility shall be provided in all cases.

12.14.1 Control Override

The control panel shall incorporate a control override facility to bring on plant including boilers, booster set and pumps.

12.14.2 Mode of Operation

The mode of operation for the premises shall be as follows:

In addition to the items mentioned elsewhere the design shall ensure the control panel has provision for the following:

- Monitoring of the flow and return temperatures
- Automatic changeover of the heating pumps
- Night set-back facility to heating system
- Frost protection
- New sensors, thermostats etc. to suit the new controller shall be utilised including new cabling

The Control system shall be a DDC system based on the Trend IQ range of programmable controllers. A suitable modem shall be allowed for to enable remote communications facilities.

13.0 Above Ground Drainage

The new above ground drainage systems to suit the new architectural layouts and drainage positions shall comply with building regulations part H.

A separate CCTV survey and below ground drainage report dated 07/10/2016 has been issued by Aquaflow.

The above ground foul and waste drainage system shall connect to all sanitary appliances, showers, basins, sinks, floor gullies, and condensate drains.

The drainage system has been designed and installed to achieve the following:

- Prevent the transmission of foul air in to the building
- Minimise the frequency of blockages and provide adequate pipe access to enable the effective clearance of any blockages
- Minimise the risk of flooding to any part of a building, especially where the floor level is located below normal ground level
- Pipework has been kept as short as possible, with the fewest number of bends, and installed with an adequate gradient.

Air Admittance valves have been used within parts of the above ground drainage installation, but will need to be confirmed against the required ventilation regime for the below ground drainage system.

14.0 Fire Stopping

All penetrations in the building fabric made during the course of the works shall be fire stopped in accordance with Building Regulations Part B and with BS5588-1.

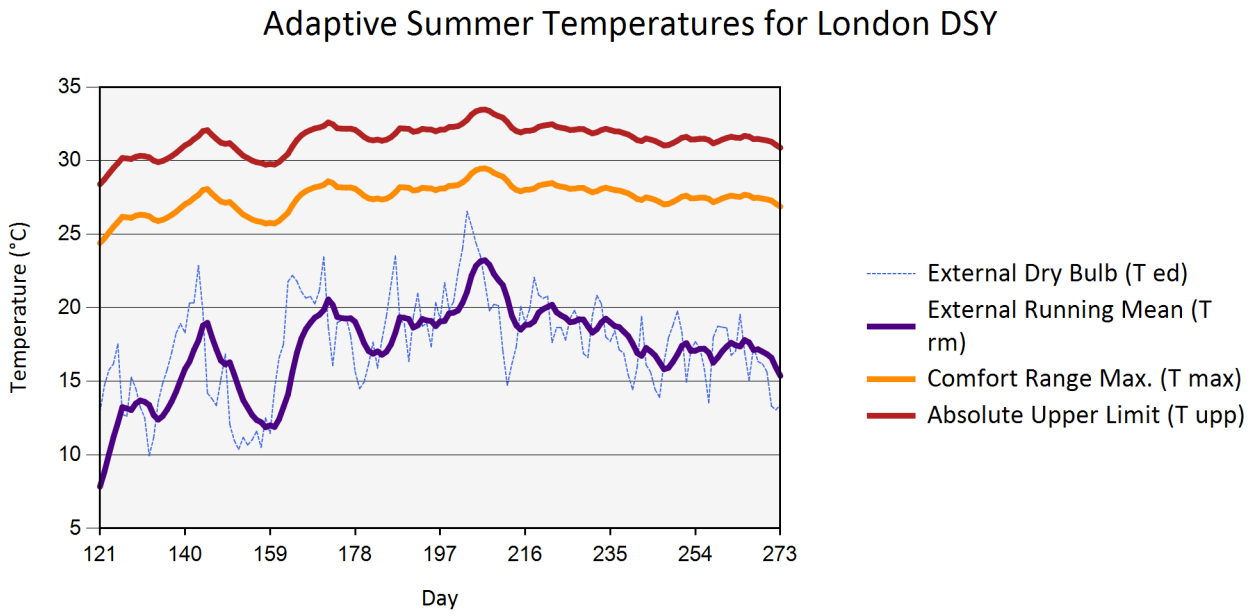
15.0 Testing and Commissioning

Before any project can be handed over it is essential that all systems and equipment installed are tested and commissioned to ensure that they are safe, working at optimum efficiency and meet the design requirements specified for the project.

All systems shall be tested and commissioned in accordance with Approved Document L, CIBSE commissioning codes, BSRIA and BESA best practice guidance.

Appendix 1 – Overheating Report Without Comfort Cooling

Adaptive Overheating Report (CIBSE TM52)



The adaptive overheating assessment tests rooms against three criteria. If a room fails any two of the three criteria then it is said to overheat.
1. The first criterion sets a limit for the number of hours that the operative temperature exceeds the comfort temperature by 1°C or more during the occupied hours over the summer period (1st May to 30th September).
2. The second criterion deals with the severity of the overheating within any one day. This sets a daily limit for acceptability.
3. The third criterion sets an absolute maximum daily temperature for the room.

Project Details

Building Designer File (.tbd): 1-1a Montague Street - Overheating Analysis.tbd
Simulation Results File (.tsd): 1-1a Montague Street - Overheating Analysis.tsd
Date: Friday, May 12, 2017
Building Category: Category II
Report Criteria: TM52

Results

Zone Name	Occupied Summer Hours	Max. Exceedable Hours	Criterion 1: #Hours Exceeding Comfort Range	Criterion 2: Peak Daily Weighted Exceedance	Criterion 3: #Hours Exceeding Absolute Limit	Result
Office (5-6 Desks) - 1MS/1/015	1060	31	0	0.0	0	Pass
Office (6 Desks) - 1MS/1/014	1060	31	0	0.0	0	Pass
Office (1 Desk) - 1MS/1/012	1060	31	0	0.0	0	Pass
Office (8 Desks) - 1AMS/1/002	1060	31	36	8.0	0	Fail
Office (6 Desks) - 1MS/2/006	1060	31	433	21.0	166	Fail
Office (6 Desks) - 1MS/2/005	1060	31	279	23.0	31	Fail
Office (2 Desks) - 1MS/2/004	1060	31	186	24.0	4	Fail
Office (7 Desks) - 1AMS/2/013	1060	31	395	22.0	94	Fail
Office (13 Desks) - 1MS/3/002	1060	31	384	20.0	107	Fail
Office (4 Desks) - 1MS/3/003	1060	31	399	27.0	86	Fail

Adaptive Overheating Report (CIBSE TM52)

Results

Zone Name	Occupied Summer Hours	Max. Exceedable Hours	Criterion 1: #Hours Exceeding Comfort Range	Criterion 2: Peak Daily Weighted Exceedance	Criterion 3: #Hours Exceeding Absolute Limit	Result
Office (9 Desks) - 1AMS/3/005	1060	31	472	25.0	168	Fail
Office (4 Desks) - 1MS/4/008	1060	31	319	24.0	71	Fail
Office (5 Desks) - 1MS/4/004	1060	31	310	26.0	48	Fail
Office (5 Desks) - 1MS/4/005	1060	31	387	24.0	81	Fail
Office (8 Desks) - 1AMS/4/011	1060	31	418	26.0	114	Fail
Office (6 Desks) - 1MS/5/013	1060	31	445	21.0	201	Fail
Office (5 Desks) - 1MS/5/009	1060	31	452	24.0	157	Fail
Office (7 Desks) - 1MS/5/010	1060	31	455	24.0	184	Fail
Office (9 Desks) - 1AMS/5/001	1060	31	406	20.0	130	Fail

Appendix 2 – Ventilation Analysis

Office Air Change Rates - Tas Simulation based on Peak Pollutant Days (R2)

Space	Volume (m^3)	Occupants	Required Air Change Rate (ACH based on 10l/s/p)	Required Air Change Rate less Infiltration @1.75 ACH (ACH)	Air Change Rate from Apertures (ACH)										Peak Pollutant Day
					08:00-09:00	*09:00-10:00*	*10:00-11:00*	*11:00-12:00*	*12:00-13:00*	*13:00-14:00*	*14:00-15:00*	*15:00-16:00*	*16:00-17:00*	*17:00-18:00*	
Office (5-6 Desks) - 1MS/1/015	125	6	1.73	-0.02	0.41	0.59	0.58	0.50	0.22	0.25	0.15	0.12	0.29	0.59	185
Office (6 Desks) - 1MS/1/014	116	6	1.86	0.11	1.03	1.23	1.20	1.04	0.56	0.65	0.42	0.33	0.78	1.22	185
Office (1 Desk) - 1MS/1/012	24	1	1.50	-0.25	1.06	1.37	1.15	0.67	0.98	0.77	0.55	0.31	1.45	1.50	162
Office (8 Desks) - 1AMS/1/002	159	8	1.81	0.06	0.95	1.15	1.12	0.98	0.51	0.60	0.39	0.30	0.72	1.14	185
Office (6 Desks) - 1MS/2/006	154	6	1.40	-0.35	0.77	1.25	1.01	0.61	0.13	0.84	0.93	1.05	0.96	0.61	220
Office (6 Desks) - 1MS/2/005	149	6	1.45	-0.30	0.85	1.14	1.38	1.04	0.92	0.86	0.85	0.64	0.86	0.23	219
Office (2 Desks) - 1MS/2/004	67	2	1.07	-0.68	0.34	0.73	0.90	0.69	0.61	0.57	0.56	0.42	0.56	0.13	219
Office (7 Desks) - 1AMS/2/013	165	7	1.53	-0.22	1.61	1.95	1.54	2.14	1.63	1.19	1.11	1.90	1.71	2.02	192
Office (13 Desks) - 1MS/3/002	306	13	1.53	-0.22	1.56	2.32	1.55	2.41	2.34	2.62	2.28	2.06	2.08	2.22	144
Office (4 Desks) - 1MS/3/003	113	4	1.27	-0.48	0.89	1.53	1.08	1.68	0.89	0.75	0.98	0.35	1.47	1.49	263
Office (9 Desks) - 1AMS/3/005	209	9	1.55	-0.20	1.60	2.37	1.56	2.48	2.49	2.64	2.30	2.18	2.25	2.31	144
Office (4 Desks) - 1MS/4/008	102	4	1.41	-0.34	0.78	0.99	0.91	0.59	0.17	0.95	0.74	0.88	0.77	1.29	169
Office (5 Desks) - 1MS/4/004	124	5	1.45	-0.30	0.80	1.13	0.98	0.91	0.69	0.61	0.21	0.87	0.76	0.80	249
Office (5 Desks) - 1MS/4/005	113	5	1.59	-0.16	1.02	1.34	1.15	1.08	0.82	0.73	0.25	1.04	0.90	0.95	249
Office (8 Desks) - 1AMS/4/011	148	8	1.95	0.20	1.92	1.90	2.82	2.78	1.03	3.04	2.45	2.37	1.83	3.04	165
Office (6 Desks) - 1MS/5/013	120	6	1.80	0.05	0.93	1.18	1.09	0.99	1.02	0.54	0.82	0.48	0.24	0.44	199
Office (5 Desks) - 1MS/5/009	89	5	2.02	0.27	0.85	0.99	1.24	0.77	1.14	1.50	0.81	0.05	1.36	1.09	179
Office (7 Desks) - 1MS/5/010	124	7	2.03	0.28	2.50	3.13	1.54	3.27	3.19	3.62	3.08	2.74	2.87	2.96	144
Office (9 Desks) - 1AMS/5/001	168	9	1.93	0.18	1.96	1.96	2.88	2.84	0.92	3.14	2.51	2.39	1.32	3.21	165

Aperture Functions:

- The Office apertures will begin to open if the pollutant level in the adjacent zone exceeds 700 ppmv(CO_2). It will be fully open if the pollutant level reaches 1200 ppmv(CO_2). This overrides all other concerns.
- The apertures will begin to close if the wind speed exceeds 10.0 m/s.

PLEASE NOTE: Infiltration decreased from 2-1.75 ACH for Offices & 2-1 ACH for all other spaces. Aperture openings remain at 200mm

Appendix 3 – Acoustic Report

CST Environmental & Acoustic Consultants

Proposals for Installation of fixed a/c plant
Planning Noise Assessment

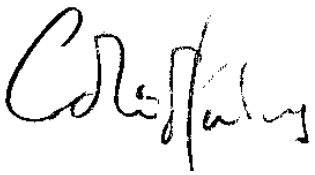
1/1A Montague Street
London
WC1B 5BU

Prepared by Colin Stanbury
MCIEH.AMIOA.FRSH.DMS

June 2017

15 Picquets Way, Banstead, Surrey SM7 1AB
Telephone: 01737 373868

Contents **Page**



Report Prepared by:.....

Checked by:.....LDS

Date:.....20th June 2017

Version 1.3

1.0 Executive Summary

1.1 This report has been commissioned by Frankham Consultancy Group Ltd. in support of a forthcoming application for the installation of external condensing (VRV) plant to the rear of the subject building as part of a renovation and upgrade scheme for existing offices for the British Museum.

1.2 The site comprises the end building of a substantial terrace of similar properties constructed in the 17th and 18th Century. Although originally built for residential use the subject building along with all of the rest of the terrace is now part of the British Museum office and research department.

1.3 As part of a comprehensive refurbishment of the premises it is proposed to locate HVAC plant externally to the rear of the properties at ground floor level. The proposed locations for the external plant can be see at Appendix 3 (design scheme extract).

1.4 A number of technical terms are referred to both in this summary and in the main report. A glossary of acoustic terms is to be found at appendix 4.

1.5 The results of the baseline survey show that the local sound environment is materially influenced by HVAC plant (chillers) located along the southern site boundary. We understand these serve the Hirayama Studio; the plant is accessed via a CAT ladder in the garden of 1 & 1A.

1.6 The nearest potentially sensitive residential receptor was identified as the rear facade of The Grange White Hall Hotel (2 -5 Montague Street) located 11.5 metres from the proposed installation.

1.7 The type and numbers of proposed external plant are listed below. Noise data for the plant have been taken from manufacturers' data sheets, extracts of which are to be found at appendix 1.

1.8 Schedule of Proposed External Plant (Total 4 items)

- Building 1 System 1 - 1No. Outdoor Unit – PURY-EP450YLM-A1.
- Building 1 System 2 - 1No. Outdoor Unit– PURY-EP350YLM-A1.
- Building 1A System 1 - 1 No. Outdoor Unit– PURY-EP250YLM-A1.
- Building 1A System 2 -1No. Outdoor Unit– PURY-EP250YLM-A1.

I.9 By reference to manufacturers' sound data it will be possible to meet L.B Camden's local noise standards with mitigation, as proposed.

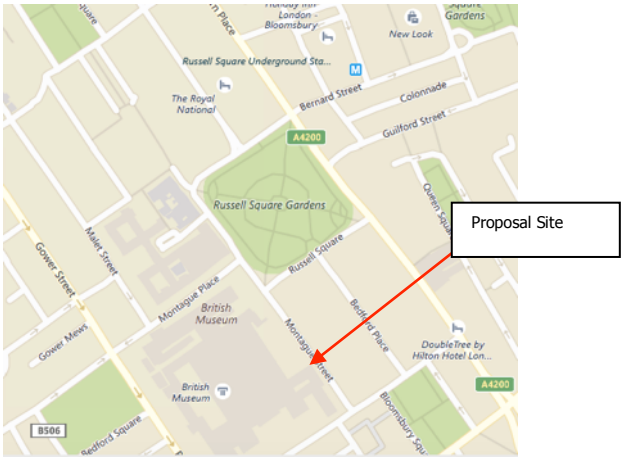
2.0 Objectives of Report

2.1 The objectives of this report are:

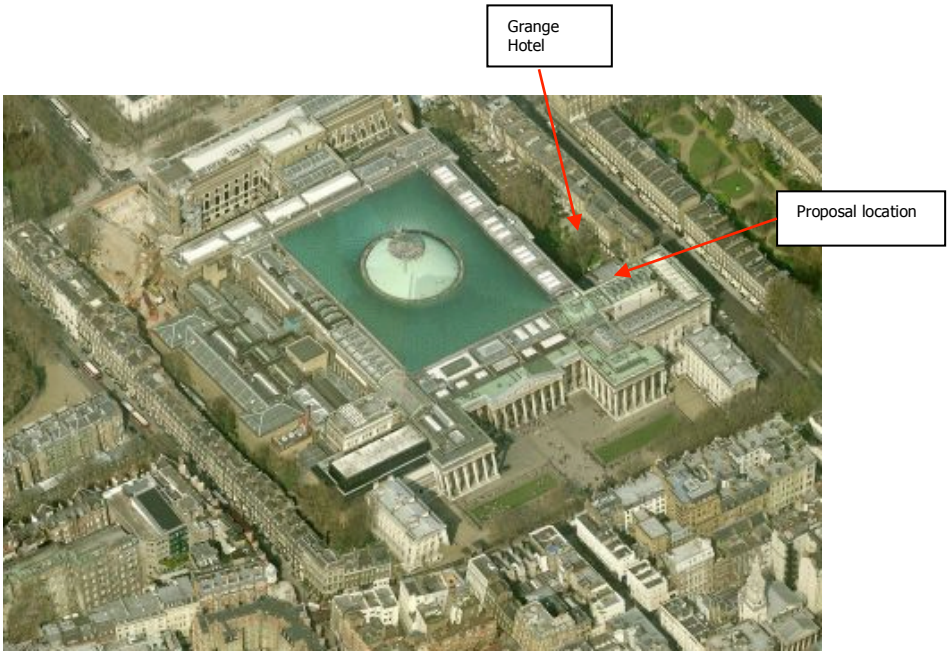
- To establish representative baseline sound levels for the proposal site.
- To assess the extent to which the proposed plant can comply with LB Camden local noise standards (with mitigation if required).

3.0 Description of Site

3 .1 The site is to be found at approximate grid reference 530144(E): 181763(N). It is further identified by an extract of the location plan below:



3.2 The aerial photograph below shows the proposal location in relation to its surroundings. The nearest residential accommodation was identified as The Grange White Hall Hotel which is some 11.5 meters from the proposal location.



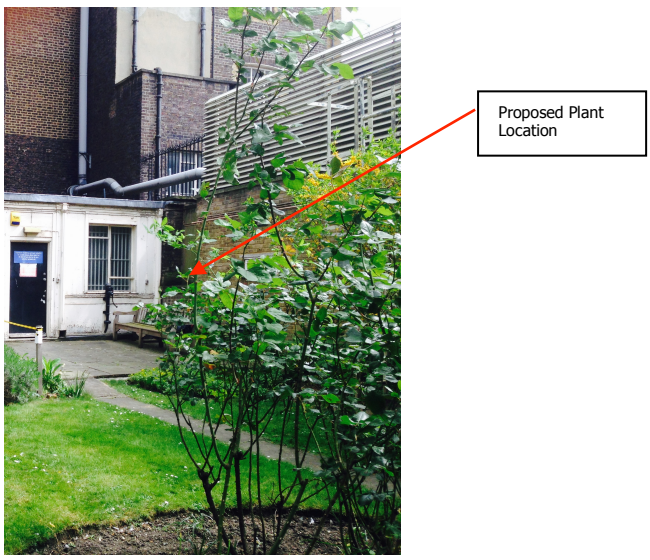
4.0 The Survey

4.1 A single survey position was established at ground floor level in the rear garden of the subject building. The survey equipment and survey location can be seen in the photograph below:

View of Survey Position (Looking north)

4.2 A Svantek 959 precision grade sound level meter was used to objectively measure the local sound environment from around 11:30 hrs on 20th April 2017 to 12:30hrs on 22nd April 2017. The meter was mounted on a tripod at a height approximately 1.5m above ground level.

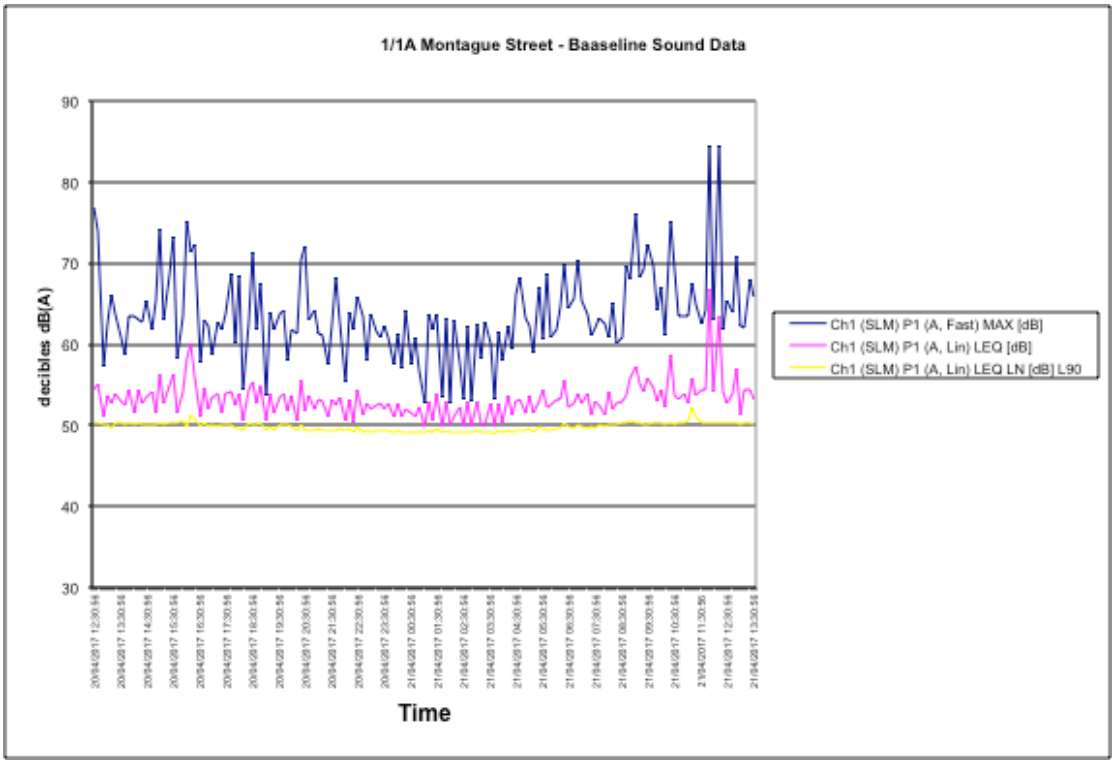
4.3 The memory features of the meter were used to automatically capture and store sound energy data every 10 minutes. The meter (Serial number 11229) was calibrated on site prior to the commencement of the survey to 104dB using a Castle Associates acoustic calibrator (serial number 0500301). A calibration check was also performed at the end of the survey period. No drift in calibration was observed. The weather was fine and dry throughout the survey with a light south westerly breeze (less than 5m/s).



View from Garden No.1 to proposed plant location

5.0 Discussion of Results & Calculations

5.1 The following graph, compiled from the raw survey data shows the time / sound level history recorded at the survey point.



5.2 For town planning purposes the baseline sound levels are summarised in table 1 below:

Time	Measured $L_{Aeq\ 16/8\ hr}$	Measured $L_{A90\ 16/8\ hr}$
07:00 – 23:00 hrs	55	50
23:00 – 07:00 hrs	50	49

Table 1

5.3 Local Authority Requirements

5.4 The table below sets out the most recently published requirements for noise fixed plant:

Table E: Noise levels from plant and machinery at which planning permission will not be granted

Noise description and location of measurement	Period	Time	Noise level
Noise at 1 metre external to a sensitive façade	Day, evening and night	0000-2400	5dB(A) <LA90
Noise that has a distinguishable discrete continuous note (whine, hiss, screech, hum) at 1 metre external to a sensitive facade	Day, evening and night	0000-2400	10dB(A) <LA90
Noise that has distinct impulses (bangs, clicks, clatters, thumps) at 1 metre external to a sensitive façade	Day, evening and night	0000-2400	10dB(A) <LA90
Noise at 1 metre external to sensitive façade where LA90 >60dB	Day, evening and night	0000-2400	55dB $_{LAeq}$

Table 2 – LB Camden Local Noise Standards (Fixed Plant)

5.5 Reference to the above requirements indicates that it will be necessary to demonstrate that:

- The combined effects of all the proposed units will not exceed the measured night time LA90 levels by more than 5dB
- The combined effects of all the proposed units will not exceed 55dBLAeq at 1m from the nearest facade of the nearest sensitive receptors

5.6 The starting point for the calculation process is to identify the baseline background (L_{A90}) level in the area.

5.7 The lowest day and night time background noise recorded during the survey over a 10 minute average was 41.9 dBL_{A90}. The sound environment in the rear garden of No.1 / 1A Montague place is materially impacted by the Hirayama Studio plant.

5.8 Having established the baseline background noise environment it is possible to calculate the noise impact at specified distances from the proposed installation and compare these levels with the baseline L_{A90}. This process is set out in the following table (Table 3). Standard acoustic prediction techniques and formulae have been used in the calculations.

5.9

Table 3 – Calculation of Noise Impact – Ground & First Floor (rear) receptors Grange White Hall Hotel

Receptor	Design Calculations
1st Floor rear bedroom & G/F conservatory windows Rear of Grange White Hall Hotel	LBC requirements – to meet lowest LA90 minus 5dB @ 1m from sensitive facade (Plant does not exhibit noticeable tonal / impulse characteristics). Background Sound Levels recorded: Lowest Background Levels = 41.9dBLA90(10min) Day & Night Required Sound Levels therefore = **36.9dBLAeq @ 1m** from nearest sensitive receptor Proposed Plant – Building 1 1 No. Mitsubishi PURY EP350 - Sound Pressure Level @ 1m = 62.5dB(A) 1 No. Mitsubishi PURY EP450 – Sound Pressure Level @1m = 62.5 dB(A) Combined Source Sound Pressure Level (Lp) = 62.5+ 62.5 = 65.5dB(A) [full power] @1m Distance to Receptor = 11.5 metres. Distance Attenuation – 21dB(A)* = Result = **44.5dB(A)** **Result: Predicted +7.6 dB(A) above LPA requirements** Mitigation Proposal: Acoustic Enclosure. To install "Ambient Acoustics" enclosure to 2No. chillers providing 12dB(A) attenuation @ 1m. With mitigation resultant impact at nearest receptor = **32.5dB(A)** **Result: Meets LPA requirements** Building 1A. Proposed units 2 x Mitsubishi PURY EP250 Combined Source Sound Pressure Level (Lp) = 60.0+ 60. = 63.0dB(A) [full power] @1m Distance to Receptor = 22.5 metres. Distance Attenuation = 27dB(A)* Less Barrier Effect of Building = 10dB(A)** Result = 63-27 = 36dB – 10 = **26dB(A)** **Result: Meets LPA requirements** Combined Effects – Building 1 and Building 1A plant working Total Emission at nearest receptor 32.5dB(A) + 26dB(A) = **33.4dB(A)** **Result: Meets LPA requirements**
* Attenuation for a point source given by formula Attn = 20*log d1/d2 ** Reference see: BS 5228:2009 Part 1 Ref: F.2.2.2.1	

5.10 Discussion of the Survey Results

5.11 The local sound environment is materially impacted by day and night from the adjoining chiller plant. Reference to the above graph shows there is very little diurnal variation in either the ambient (L_{Aeq}) or background (L_{A90}) noise levels.

6.0 Conclusions

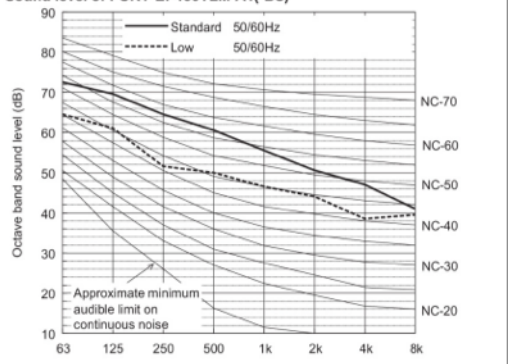
6.1 A baseline assessment of the local sound environment has been carried out.

6.2 By reference to manufacturers' sound data it will be necessary to enclose the proposed plant using bespoke attenuators fabricated by Ambient Attenuators Ltd. in order to meet L.B Camden's local noise standards. A typical design solution for the attenuators is shown at appendix 2.

6.3 With attenuators fitted, the combined effects of all the proposed plant are predicted to meet the LPA requirements.

7.0 Appendix 1 - Manufacturer's Sound Data

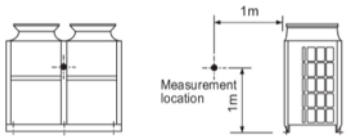
Sound level of PURY-EP450YLM-A1(-BS)



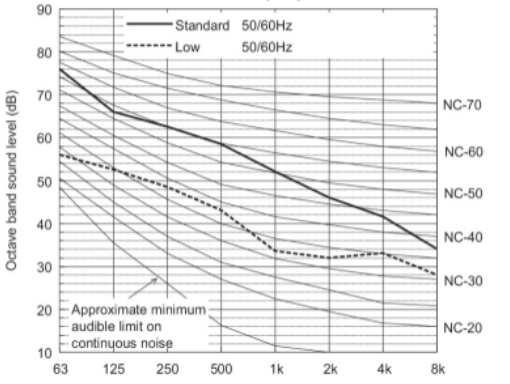
		63	125	250	500	1k	2k	4k	8k	dB(A)
Standard	50/60Hz	72.5	69.5	64.5	60.5	55.5	50.5	47.0	41.0	62.5
Low noise mode	50/60Hz	64.5	61.0	51.5	50.0	46.5	44.0	38.5	39.5	53.0

When Low noise mode is set,the A/C system's capacity is limited. The system could return to normal operation from Low noise mode automatically in the case that the operation condition is severe.

Measurement condition
PURY-EP400, 450, 500YLM-A1(-BS)



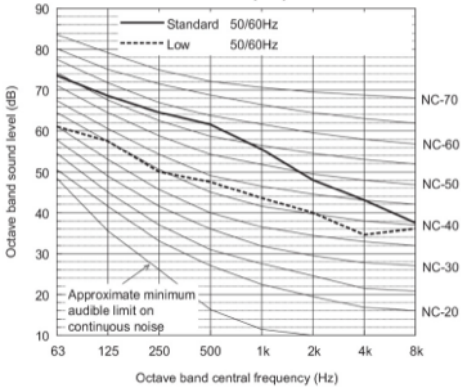
Sound level of PURY-EP250YLM-A1(-BS)



		63	125	250	500	1k	2k	4k	8k	dB(A)
Standard	50/60Hz	76.0	66.0	62.5	58.5	52.0	46.0	41.5	34.0	60.0
Low noise mode	50/60Hz	56.0	52.5	48.5	43.0	33.5	32.0	33.0	28.0	45.0

When Low noise mode is set,the A/C system's capacity is limited. The system could return to normal operation from Low noise mode automatically in the case that the operation condition is severe.

Sound level of PURY-EP350YLM-A1(-BS)



		63	125	250	500	1k	2k	4k	8k	dB(A)
Standard	50/60Hz	73.5	68.5	64.5	61.5	55.5	48.0	43.0	37.5	62.5
Low noise mode	50/60Hz	61.0	57.5	50.0	47.5	43.5	40.0	34.5	36.0	50.0

When Low noise mode is set,the A/C system's capacity is limited. The system could return to normal operation from Low noise mode automatically in the case that the operation condition is severe.