MS02 Building Management Systems

UNIVERSITY OF LEICESTER

Document Control

Rev	Date	By	Comments
A	Jun'16	J. Hoare	Technical Review Update
B	Oct '17	J. Hoare	Technical Review Update
C	Dec 17	UoL	Sign off for release
D	Mar'20	J. Hoare	March 2020 Issue
E	April 2020	A.Singleton	General update to tracker and other minors.
F	June 20	A Singleton	Update with CPA and KRM
G	April 23	A Singleton	Reference to Uni Standard BMS Spec added
H	May 23	A Singleton	Framework suppliers schedule updated
I	Feb'26		Framework suppliers schedule updated
K	May 26	A Singleton	Tender specification details updated. BACnet/Modbus appendix and AHU appendix included. General Process for BMS projects appendix included.

Design Guidance

1. A detailed briefing should be undertaken with the Universities estates department for all elements of the BMS design during project design development. This briefing should be undertaken to extract key information from the University as regards controls and philosophies that should be employed within the project.
2. This document should be read in conjunction with the others in this series together with the University standard specifications. This shall include but not be limited to space heating, cooling, ventilation and renewables policies together with the outline UOL BMS guidance specification. Note firstly Appendix A, Appendix B and Appendix C to this document which give further details of the UoL preferences for BACnet/Modbus IP (appendix A) controls and also generic requirements for the larger main system AHUs that may be used on a project (appendix B). Appendix C details process expectations.
3. The University have declared a climate emergency and are therefore looking for buildings to operate in an efficient manner giving best energy and carbon performance commensurate with maintaining desired environmental conditions. The University therefore require the BMS to be designed and installed to
    a. Control the internal environment such that satisfactory internal environmental conditions are maintained.
    b. Allow temperatures to freely drift between lower and upper agreed limits before the services intervene to give optimum energy and carbon performance.
    c. Provide demand led ventilation responding to occupancy where possible and cost effective.
    d. Respond to departmental hours of use and not run plant when not needed.
    e. Modulate plant and equipment as necessary to match loads.
    f. Be used as a maintenance asset to allow monitoring and performance optimisation.
    g. Be used as a maintenance asset to allow scheduled servicing.
4. The BMS system shall be procured, designed, installed etc in accordance with the University Standard Specification titled "University of Leicester Standard Specification for BMS Controls Current revision"
5. All control sensors, actuators, valves, limit switches and the like listed within this guidance document shall be provided as specified. For all devices not specified, standard Schneider Electric al Struxtureware components shall be used. All shall be discussed with the University of Leicester BMS officer during the design period for comment.
6. Wherever practical, and on all larger projects, the University require the power distribution to plant and equipment to be by the direct use of field mounted MCB distribution boards with controls being mounted in separate field mounted ELV controls panels. This therefore means the following
    a. Power distribution is to be by MCB panels which are to comply with the requirements of the Electrical design guides. Spare ways to be provided as specified in the same at 25% spare non

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populated outgoing ways.

b. Separate ELV controls panels to be provided to house all BMS controls and interface equipment. Spare ways and capacity to be provided as noted later at 25%.
c. By exception, and on small projects only, where the above is not practical then the above may be combined into one panel with separate enclosures for power and controls.
d. All VSD drives to be field mounted.
e. All power to have local plant lockable isolation facility.
f. All rotating machinery to have local stop lock push buttons wired through auxiliary on the plant isolator.
g. BMS control of plant items to be by means of distribution board combined MCB/contactor or local field contactor unless the plant has packaged controls in which case the BMS is to interface with this.

7. So far as controls and power wiring is concerned.
   a. All containment and controls wiring from the controls panels onwards to field mounted devices shall be undertaken by the controls specialist.
   b. All containment, power and controls wiring from the combined controls/power panels onwards to field mounted devices shall be undertaken by the controls specialist.
   c. All containment and power wiring from the MCB distribution boards onwards to field mounted devices may be undertaken by the controls specialist or electrical contractor.
8. So far as weatherproofing is concerned
   a. Under exceptional circumstances it may be necessary to install control devices and panels externally in open weather conditions. This is to be avoided wherever possible but if unavoidable the fllowing must be adhered to.
   b. All external controls hardware (including, but not limited to detectors, valve actuators and damper actuators), and ancillary items must be rated for an outdoor environment and rated at IP54 minimum and then further provided with weatherproof bags.
   c. All external panels must be manufactured to IP56 and installed with internal thermostatically controlled anti condensation heaters. All external panels must have an overhanging roof to give shelter to maintenance technicians and also be complete with separate front glass door to enclose and fully cover the panel facia.
9. The Project design engineers shall ensure the following requirements are included within their tender documents before issue to the tendering contractors.
   a. Note firstly Appendix A and Appendix B to this document which give further details of the UoL preferences for BACnet/Modbus IP controls and also generic requirements for the larger main system AHUs that may be used on a project.
      i. Where the BACnet/Modbus document gives choices for the main plant controls interfaces these should be discussed on a project by project basis with the University before compiling the specification document and the designer should specify one choice that gives best value for money for the university.
      ii. Where only one choice of interface is given this philosophy must be adhered to.
      iii. See also Appendix C for process expectations.
   b. A full Description of Operation to detail how the controls are to operate the system, maintain an optimum environment, manage best use of energy, maintain safe conditione etc.
   c. A full set of detailed services schematic drawings showing the control points and all PID information to tie in with the schematic drawings.
   d. For refurbishment projects the above requirements must detail how the existing controls are to be modified and to also include a full detail of any temporary controls and/or power supplies needed to maintain critical plant operational during any refurbishment works.
   e. Any alarm matrix requirements.
   f. The requirement for the controls Specialist Contractor to allow in their contracted works a minimum

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of ten working days notice of the following key stages:

i. Production of their own Des Ops based on the tender documents
ii. Production of system graphics based on the standard UoL template
iii. Software "bench" testing ie a full check of the written software before it is delivered to site
iv. Familiarisation with almost complete installation, prior to formal commissioning (proposals for Graphics Slides, Software, Alarm Priorities, IP Addresses, head end networking, Alarm Routing and Logging for the Supervisory PC shall be tabled at this stage)
v. Production of alarm priorities and BMS handling processes which shall be submitted to the university BMS control officer prior to commissioning for approval.

g. Demonstration - the system shall be presented to the University's Project Manager and BMS/Controls Engineer after seven days of logged performance with all systems operating under fully automatic control under the dictates of the BMS. This demonstration shall include all software, completed Graphics Slides, Logging, Alarms, and control installation - using a laptop computer. A Snagging List of items that have still shall be completed shall be prepared with a timetable for completion.

h. Office Handover of As Fitted O&M Manuals and installation of completed software, Log Configuration, Alarm Routing and Graphics on to the Supervisory PC at the Works Division.

10. The project design engineer shall ensure that Seasonal commissioning and fine tuning of control systems for the first 12-month period post completion, in accordance with the BSRIA soft landings guidelines, is provided by the controls specialist and that this requirement is included within the contract. This requirement must be specifically written into the contract specification including the below.
    a. Seasonal commissioning cannot commence until all snags, control issues or associated plant are fully operational and all snagging items have been cleared.
    b. A minimum allowance of 3 days site attendance for the first quarter and 1 day per quarter thereafter shall be allowed to undertake assessment and adjustment of set points and control profiles to ensure optimum energy benefits and user profiles.
    c. A commissioning engineer will be required to attend as required to satisfy the above minimum requirements.
    d. Following each post occupancy evaluation (POE) amendments to the BMS commissioning shall be documented and corrective actions recorded. Comfort and performance improvements shall be monitored and any energy reductions noted also within the report. Final POE shall be completed just prior to the defects completion period where any defects or alarms and any non-performing plant or systems are recorded.

11. The Project contract specification shall ensure that the following works are undertaken by the services contractor and controls specialist subcontractor following contract award
    a. The services contractor shall organise a series of meetings with the University project team and BMS subcontractor to discuss the controls philosophies in detail and to develop the controls strategies prior to any commencement of software writeup and compilation. These discussions shall be based upon the detailed services schematic drawings provided by the services subcontractor.
    b. The meetings shall agree the following in the order noted
        i. A detailed plain English text write up of the controls strategies required by means of the specialists own updated des ops.
        ii. The system graphics showing schematic system details and all controls loops. All as based upon standard UoL templates. Field devices to have locations noted.
        iii. Any alarm matricies.
        iv. Compilation of panel wiring diagrams and hook up diagrams showing interface with all plant items. Plant item interfaces need to be agreed.
    c. The software then needs to be written and factory "bench" tested and the University engineers need to be invited to witness this testing works.
    d. Finally and only on completion of these meetings site controls works may progress.

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12. Areas where there is sensitive equipment such as Data Servers, critical freezers, critical laboratories etc and UPS equipment.
    a. Each area shall be monitored via room sensors which will raise a prioritised alarm when temperatures are exceeded within the space.
13. Third party controls equipment can be used within individual plant items and packaged plant (rather than general BMS). However, where they are used, these shall utilise BACnet/Modbus IP to connect to the site BMS controls.
    a. Care needs to be taken to interface, as a minimum, to all the required parameters as noted in the BMS specification plus others as may give benefit to the University. See the appendix document “MS02 Appendix A “
    b. There is a preference for the third party BACnet systems to include the provision of a front-end web based graphics driven arrangement to enable interrogation adjustment and trend logging by means of the building management system.
14. Module interface toggle switches shall be identified with a permanent label showing what is connected to assist in fault finding and servicing.
15. Each controller shall be clearly identified with a permanent label stating the controller number (where applicable), IP address and gateway address on the front to assist in fault finding and servicing.
16. Field equipment shall be fully accessible for inspection and maintenance and due consideration should be given to the CDM regulations when locating and installing equipment.
17. All sensors must be capable of being removed from ductwork / pipework for inspection and maintenance purposes. All water sensors shall be complete with suitable pockets.
18. Where plate heat exchangers are required on schemes these shall be standard units, not incorporating the manufacturers standard controls offerings, i.e. they shall be non-packaged and the BMS shall control the plate heat exchangers directly by BMS controlled temperature and limit sensors and valves.

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Design Components

Item	Manufacturer	Comments
BMS	Schneider Electric - StruxureWare Trend	Alternative controls installation contractors may be considered providing that they are accredited to install StruxureWare and providing written agreement has been given by the University Building Management Systems manager and endorsed by the Project manager. Proposed system must always have complete compatibility with Campus BMS, Struxureware. For buildings which are located away from the main campus and do not require complex control systems (such as residential buildings), a Trend system may be considered. However, any such system is to be integrated into the main campus BMS (Schneider StruxureWare) via BACnet, including graphics, logging and alarms etc.
Smaller Projects Only Combined BMS Panels with both Power and (Separate) Controls Sections		The University preference is to have BMS solutions employing an MCB distribution board for plant and equipment power distribution and then a separate BMS controls panel containing extra low voltage controls equipment. On very small projects and where the above is impractical then combined systems may be used as follows. Power and controls sections shall be in separate cubicles to allow more flexible maintenance but shall be interlinked. In such circumstances panel construction shall be Form 2 Type 1 with separate power and control sections and IP54 as a minimum, constructed of sheet steel 2mm thick. Bracing and stiffening should be used as necessary to take the weight of internal components and control assemblies. No sharp corners will be present and control panels weighing more than 50 Kg (including installed components) are fitted with eyebolts to facilitate delivery and installation. Ventilation of control panels and equipment shall be suitable for the location and environment in terms of performance and noise levels. Control panels shall be provided with LED indication, have a hand/off/auto switch function with key over-ride facility also. A F/A interlock facility shall be provided as standard. Local control shall be via a laptop. Outstations and all 24-volt control relays, switching modules with manual overrides etc shall all be located outside the power section.

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Design Components

Item	Manufacturer	Comments
		The power and control sections of the panel shall be lockable, the locks shall be compatible to other panels on the University campus and they shall be supplied with keys for every panel. Each section of the panel shall have a minimum of 20% useable surplus space on the back plate and 25% spare incoming terminal connections to allow for future modifications after handover. Allowance for providing and installing a system that has a minimum of 25% spare outstation capacity, including analogue and digital I/O's. All internal wiring shall be in LSF, multi strand/flexible cable. Control wiring shall be 0.75mm² minimum. Power cables shall be rated to the full load current according to the current IEE regulations. All cables shall be colour coded as per the BS 7671:2001 Amendment No2 – for Harmonised cable colours. Control panel fascia shall include a centralised plant reset facility and integral control panel lamp test function.
All other Projects Controls Panels		The University preference is to have BMS solutions employing an MCB distribution board for plant and equipment power distribution and then a separate BMS controls panel containing all the extra low voltage controls equipment. The controls panel specifications shall be as above.

Design Components

Item	Manufacturer	Comments
All other Projects MCB Power Distribution Boards	Schneider (Merlin Gerin) Acti9 Isobar P range	The University preference is to have BMS solutions employing an MCB distribution board for plant and equipment power distribution and then a separate BMS controls panel containing all the extra low voltage controls equipment. The MCB board shall be as follows. • Utilise the BMS system, with suitable control voltages, to give direct plant and equipment start/stop signals. • Panel construction shall Form 1 and IP54 as a minimum, constructed of sheet steel 2mm thick. • MCB's to be 10kA rated as a minimum • Dual earth bars to be provided for all high integrity earthing • All Distribution boards shall be fitted with a padlock facility • Spare outgoing ways to be provided as per the HV/LV distribution MCB Guidance documents.
Inverters	Schneider ABB Danfoss	Motor Speed Inverters with displays and keypads shall be field mounted and located locally adjacent to the equipment served. Inverter noise levels shall be suitable for the location specified and inverter fans shall switch off when plant is not operational. Normal interfaces to the BMS should include run command, speed command, speed feedback and fault conditions as a minimum.

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Design Components

Item	Manufacturer	Comments
BMS Outstations		All outstations shall have 25% spare capacity for each input/ output. Outstation memory shall, as a minimum, be sufficient to enable logging to be carried out on every sensor within that outstation at fifteen-minute intervals for a period of at least one rolling week. All outstations shall be enabled for Ethernet communications and shall operate at the highest Baud rate, which where possible, will be connected to the University IT network. RJ45 data outlets shall be provided at each outstation connected to the local area network within the building. Network outlets shall operate using a fixed IP address assigned by the UOL IT department following receipt of the MAC addresses from the BMS specialist. MAC addresses shall be provided a minimum of 30 days prior to commissioning commencing on site. For commissioning purposes, the contractor shall be expected to use a temporary hub where required ensuring the hub is removed at handover. All outstations/systems shall provide automatic time change from BST/GMT. Upon restoration of mains power all BMS devices shall automatically reset and start up under automatic control.

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Design Components

Item	Manufacturer	Comments
Motorised Valves Actuators Sensors Level Controls	Schneider	Generally use two port control valve technology and variable speed pumps for efficient use and best energy and carbon performance. Give consideration to Pressure Independent Control Valves on all variable flow rate systems. The selection of 2 port control valves shall be to current best practice, for example: • On/Off non-modulating control valves shall be line sized and present minimum resistance. • Combined DPCV/control valves (pressure independent control valves) shall be selected at near to unity control authority based on design flow rate and available pressure drop for valve. • In all other cases, the minimum and maximum pressure prior to the control valve shall be referenced and the control valve authority shall be in the range of 0.35 to 0.5 in all operating conditions without imposing excessive pressure drop. If mixing and diverting applications are required always use 3 port valves in a mixing mode. All mixing valves shall be selected to have a valve authority of at least 0.5 whilst not having a pressure drop of greater than 25kPa (if possible). Pipe sensors shall be immersion/pocket type. All mixing valves shall be rotary shoe or lift and lay type. Isolation valves shall be provided either side of control valves to allow valve removal without draining system and shall be provided with binder test points on or adjacent to each port. All valves shall be entirely suitable for the fluid being handled and shall generally as a minimum be PN16 rated (subject to specific project details).
High accuracy air pressure transducers (Laboratories)	CMR	P-Sensor range
Flow pressure Transducers	Electro controls	EWDT range
Steam control valves	Sarco	Spirax Std Steam range

Design Components

Item	Manufacturer	Comments
Steam control valve actuators	Sarco	Spirax Std Steam range
Liquid differential pressure switches	Bailey & Mackey	Standard range
Window Actuators	SE Controls	Where window control forms part of the ventilation strategy these shall be supplied, installed and commissioned as part of the BMS package.
Gas Solenoid valves	Black Teknigas or equal and approved	Gas solenoid valves may be manual or automatic providing BMS monitoring is installed. Particular application type shall be agreed with UOL maintenance engineer prior to specification.
Frost Protection		**Wet Heating Systems** 1st Stage - Switch all pumps on if outside air temperature falls below 3°C and switch off again at 5°C. All heating zone and AHU control valves shall be driven fully open during this frost period. 2nd Stage - Bring on the heating plant when the pumps are running under frost conditions and maintain the boiler return water at around 25°C until the 1st Stage Switches off or the next heating ON time. In this event the heating plant shall be held on for a minimum of 30 minutes to prevent cycling. All motorised heating zone and AHU control valves shall be driven fully open during this frost period. 3rd Stage - This occurs when internal space temperatures drop below 10°C. In this circumstance energise the pumps and boiler plant by overriding time routines and operate under normal parameters and keep energised until the space reaches 12c then switch off.
Time Schedules		Time schedules should be kept to a minimum for each building. In general, a building time Schedule shall be programmed for each main building and subsequent items of plant within that building shall be interlocked to this through demand points. This will enable complex plant extensions/adjustments to be made without excessive reprogramming of schedules. However, time schedule requirements should be discussed with the University Building Systems Manager for each individual project. Where such detailed information is undetermined for specification purposes refer to control profiles below. Holiday time schedules shall be included for each building.

Design Components

Item	Manufacturer	Comments
Control Profiles	Offices, libraries & smaller (less than 20) teaching areas	Standard occupancy times for these areas are 08:00 to 18:00 hours Monday to Friday, the time schedule should be linked to a common holiday schedule for each building or area. Plant shall be initiated to give a desired wintertime minimum room temperature of 19°C at building occupancy time. Start/stop functions of the plant shall be provided via Optimiser control with integral room low limit for fabric frost protection during "plant off" periods of 10°C On / 12°C Off. Once occupancy time or temperature is achieved, whichever is first; compensated mixing valves or local zone valves shall take control of the building room temperatures to maintain a wintertime minimum heating temperature of 20°C. "Optimum Off" temperature shall be 19°C. (Always noting, irrespective of these operational requirements, that the heating emitters shall be designed to maintain a temperature as detailed on the room data sheets which is likely to be higher than these temperatures noted) Where the temperature is not achieved before occupancy time, compensated mixing valves or local control valves shall continue to be controlled by the optimiser in run-up mode while automatically adapting for the next day / run-up period.

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Design Components

Item	Manufacturer	Comments
Control Profiles	Research Facilities & Laboratories	Although these areas are normally occupied 24 hours, they shall be programmed with a time schedule and holiday schedule set initially for 24-hour continuous running to allow flexibility should their occupancy requirements change. Individual temperature and humidity requirements will vary depending on the type of establishment and should therefore be set only after consultation with the University Building Systems Manager. Generally speaking, room temperatures are normally controlled between 21c in winter and 24c in summer (data sheets may give other parameters). Humidity is not normally controlled in these spaces. All temperature and humidity sensors should be set-up with the facility for high and low alarm limits and allowance shall be made within the control system for a common alarm signal to be generated to a remote monitoring facility. This shall be a volt free pair of contacts at the control panel terminal rail. The exact method of remote alarm monitoring used may differ for each project and so guidance shall be sought from the University Building Systems Manager before engineering this facility. Consultation with the University Building Systems Manager may highlight the requirement of a facility for the printing of logs of environmental space conditions. This environmental data will also be saved on the host server BMS PC and be accessible to end users through Client PCs or local servers.

Design Components

Item	Manufacturer	Comments
Control Profiles	Lecture theatres Larger teaching spaces (30, 60 and 120 person) PC Clusters (30, 60 and 120 person) Seminar spaces. Catering Facilities	Occupancy times for the lecture theatre, teaching, Clusters, and catering areas are set on a weekly basis through room bookings, however, nominal times should be set for 08:00 to 17:00 hours Monday to Friday. In addition to the time scheduling PIR control is required to enable and disable the ventilation systems when the room are not in use. Catering facilities however do not need PIR control and need to run to time schedules to be agreed project by project. Ventilation plant shall only be run during occupied periods. It shall not be used for fabric heating. Lecture theatres, Seminar Rooms and catering facilities should be provided with radiator/fan convector capacity and should have optimisation to the desired room temperature of 20°C without the use of AHU ventilation plant. Heating Plant shall be started via Optimiser control for a boost period to achieve the desired wintertime room temperature of 20°C. (Always noting, irrespective of these operational requirements, that the heating emitters shall be designed to maintain a temperature as detailed on the room data sheets which is likely to be higher than these temperatures noted) During this boost period, the AHU fans shall be kept off. On termination of the optimised boost period ventilation plant shall be energised. The AHU ventilation system shall then achieve the desired wintertime room temperature of 20°C in parallel with the fabric heating system.. Where inverters are installed, natural cooling shall be achieved via the space temperature control loop acting on the AHU supply and extract fan speeds. Cooling will normally be by the AHU ventilation installation (no local cooling coils, DX). Where mechanical cooling is installed (cooling coils or DX) then cooling shall normally only be enabled if the extract/room temperature rises above the data sheet summertime temperature limits. The summertime temperatures in lecture theatres will normally be a maximum of 24c during occupancy. The summertime temperatures in other areas will normally be a maximum of 26c and/or TM52 requirements.

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Design Components

Item	Manufacturer	Comments
		Ventilation and cooling should be de-energised if spaces are not occupied. Carbon dioxide (CO_2) sensors should be installed to control mechanical ventilation. Approved sensors shall override the normal AHU damper and temperature controls and try to maintain CO_2 levels between 600ppm-1000ppm. If the AHU ventilation system has two-speed or inverter controlled fans, then the CO_2 sensor shall be used to change the fan speed to achieve this value. VAV systems should normally be considered for these types of spaces by means of a single room zone and fan speed control or where there are multiple spaces by VAV boxes and fan speed control. Generally large lecture theatres utilising dedicated air handling units shall incorporate variable speed fan drives to vary the amount of fresh air introduced into the lecture theatre space to maintain CO_2 dilution.

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Design Components

Item	Manufacturer	Comments
Controls Profiles	Residential Accommodation	Standard occupancy times for these areas are continual use with structured holiday profiles. Plant shall be initiated to give a desired continual wintertime minimum room temperature in bedrooms and lounges of 20ºC. (Always noting, irrespective of these operational requirements, that the heating emitters shall be designed to maintain a temperature as detailed on the room data sheets which is likely to be higher than these temperatures noted) Normal running, as noted, is continual use during 24 hour occupancy however optimisation facilities shall be provided but normally not used. (The facility shall be provided via Optimiser control with integral room low limit for fabric frost protection during "plant off" periods of 10°C On / 12°C Off and left as a background facility which may be employed if required.) If, and only if used, when occupancy time or temperature is achieved, whichever is first; compensated mixing valves or local zone valves shall take control of the building room temperatures to maintain a wintertime minimum heating temperature of 20°C. "Optimum Off" temperature shall be 19°C. Where the temperature is not achieved before occupancy time, compensated mixing valves or local control valves shall continue to be controlled by the optimiser in run-up mode while automatically adapting for the next day / run-up period.

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Design Components

Item	Manufacturer	Comments
Control Profiles	Leisure facilities	Standard occupancy times for these areas are 06:00 to 22:00 hours Monday to Sunday. Ventilation plant in pool halls shall run continually to provide dehumidification whereas changing room and gymnasium ventilation plant should only be energised during occupancy hours (unless the changing room ventilation plant also provides barrier dehumidification protection) Plant shall be initiated to give a desired wintertime minimum room temperatures as detailed on the room data sheets which will normally be swimming pool hall air temperature 29ºc (which is the water temperature plus 1ºc), changing room accommodation 24ºC and gymnasiums 18ºC. Plant shall be initiated to give a desired wintertime minimum room temperature of set point at building occupancy time. Accommodation can set back out of hours by 1ºC in the pool hall and with low limit fabric protection in other areas of 16ºC in changing rooms and 10oC in gymnasiums. Start/stop functions of the plant shall be provided via Optimiser control with integral room low limit for fabric frost protection during "plant off" periods of the above conditions °C On / above conditions plus 2°C Off. Once occupancy time or temperature is achieved, whichever is first; compensated mixing valves or local zone valves shall take control of the building room temperatures to maintain a wintertime minimum heating temperature as given above. "Optimum Off" temperature shall be less 2°C. (Always noting, irrespective of these operational requirements, that the heating emitters shall be designed to maintain a temperature as detailed on the room data sheets which is may be higher than these temperatures noted) Where the temperature is not achieved before occupancy time, compensated mixing valves or local control valves shall continue to be controlled by the optimiser in run-up mode while automatically adapting for the next day / run-up period.

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Framework Contractors (only these contractors to be used)		
Service	**Specialist**	**Address & Contact Details**
BMS Upgrades - EcoStrxure	Adi Electrical Ltd	David Williams dwilliams@adiltd.co.uk 07989 655132 01214512255
	AES Control Solutions Limited	Craig Mason craigmason@aescontrols.co.uk 07720 739695
	Kendra Energy Solutions Ltd	Matthew Pugsley mpugsley@kendraenergy.co.uk 01295 556980
BMS Upgrades - Trend	Automated Building & Energy Controls Ltd	Paul Whitticase Paul.Whitticase@abec.co.uk 07436401994
	AES Controls	Craig Mason craigmason@aescontrols.co.uk 07720739695
	Building Controls Specialists Ltd	Darren Hughes dhughes@bcspecialists.com 07740 733206
	Kendra Energy Solutions Ltd	Matthew Pugsley mpugsley@kendraenergy.co.uk 01295 556980

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MS02 Appendix A BMS Plant Controls Interface Philosophy Rev B

Type of Plant (Generic Types)	Normal Generic Controls for Plant	Which solution to Choose	Typical Location	Type of Controls UoL Required			
				Major interfaces such as enable switching on/off, fault monitor status, running monitor status, and proportional control etc. Thus high level operational interfaces (hard wired to BMS controller I/O).		Discreet running, operational and performance parameters (hard wired to BACnet/Modbus communication protocol)	
				Needed or not needed	Description	Needed or not needed	Description
Packaged Water Chiller	Fully packaged by Manufacturer with Control Interfaces		Outdoor in Plant Area	Required	Full BMS wired control and status from BMS control panel.	Required	Full two way interface to monitor all parameters available on plant by wired Modbus or BACnet.
Packaged Heat Pump	Fully packaged by Manufacturer with Control Interfaces		Outdoor in Plant Area	Required	Full BMS wired control and status from BMS control panel.	Required	Full two way interface to monitor all parameters available on plant by wired Modbus or BACnet.
Gas Fired Boiler	Fully packaged by Manufacturer with Control Interfaces		Indoor in plantroom with (assumed) BMS panel locally.	Required	Full BMS wired control and status from BMS control panel.	Required	Full two way interface to monitor all parameters available on plant by wired Modbus or BACnet.
Bare plate heat Exchanger	Separate BMS controls inc valves and detectors		Indoor in plantroom with (assumed) BMS panel locally.	Required	Full BMS wired control and status from BMS control panel.	Not required	
Packaged Plate Heat Exchanger	Smart fully packaged plates with all controls skid mounted		Indoor in plantroom with (assumed) BMS panel locally.	Required	Full BMS wired control and status from BMS control panel.	Required	Full two way interface to monitor all parameters available on plant by wired Modbus or BACnet.
Pumps, Dumb	None		Indoor in plantroom with (assumed) BMS panel locally.	Required	Full control and monitor interface by wired BMS	Not required	
Pumps, smart with inbuilt or separate inverter	Packaged by manufacturer with smart interfaces		Indoor in plantroom with (assumed) BMS panel locally.	Required	Full control and monitor interface by wired BMS	Required	Full two way interface to monitor all parameters available on plant by wired Modbus or BACnet.
Water boosters fo domestic systems	Fully Packaged by Manufacturer with Fault and Status Interfaces		Indoor in plantroom with (assumed) BMS panel locally.	Required	Full monitor interface by wired BMS.	Required if available	If available then monitor additional parameters by wired Modbus or BACnet
Pressurisation Unit	Fully Packaged by Manufacturer with Fault and Status Interfaces		Indoor in plantroom with (assumed) BMS panel locally.	Required	Full monitor interface by wired BMS. Interface to main plant to prevent operation on faults.	Required if available	If available then monitor additional parameters by wired Modbus or BACnet
Fans, local eg bathrooms in residences or simillar	Wired locally to PIR or lighting etc		Various	Not Required		Not required	
Fans Ductwork, Dumb	None		Any Locations	Required	Full control and monitor interface by wired BMS	Not required	

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Fans, smart eg plug fans with EC motors	Integral in unit		Any Locations	Required	Full control and monitor interface by wired BMS	Required	Full two way interface to monitor all parameters available on plant by wired Modbus or BACnet.
Inverters, stand alone or integral	Integral in unit		Any Locations	Required	Full control and monitor interface by wired BMS	Required	Full two way interface to monitor all parameters available on plant by wired Modbus or BACnet.
Large Air Handling Unit	Bare Unit with No Controls		Indoor in plantroom with (assumed) BMS panel locally.	Required	Fully BMS controlled and monitored with BMS hardware and software and all fully wired.	Required	Provide Modbus or BACnet interfaces to any plug fans or inverters
Smaller Packaged AHU	Bare Unit with No Controls		Indoor in plantroom with (assumed) BMS panel locally.	Required	Fully BMS controlled and monitored with BMS hardware and software and all fully wired.	Required	Provide Modbus or BACnet interfaces to any plug fans or inverters
Smaller Packaged AHU	Bare Unit with No Controls	Choose the solutions which give best cost benefit to the University	In remote location in Building	Required	Fully BMS controlled and monitored with BMS hardware and software and all fully wired.	Perhaps	If there are EC fan motors then maybe required, consult University.
Smaller Packaged AHU	With manufacturers packaged controls including hardware and software		In remote location in Building	Not required		Required	Full two way interface to fully control and monitor all parameters available on plant by wired Modbus or BACnet.
Room Packaged MHRVU	Bare Unit with No Controls	Choose the solutions which give best cost benefit to the University	Ceiling Void in Room	Required	Fully BMS controlled and monitored with BMS hardware and software and all fully wired.	Perhaps	If there are EC fan motors then maybe required, consult University.
Room Packaged MHRVU	With Manufacturers packaged controls including hardware and software		Ceiling Void in Room	Not required		Required	Full two way interface to fully control and monitor all parameters available on plant by wired Modbus or BACnet.
Room Fan Coil Unit	Bare Unit with No Controls	Choose the solutions which give best cost benefit to the University	Ceiling Void in Room or in room itself	Required	Fully BMS controlled and monitored with BMS hardware and software and all fully wired.	Not required	
Room Fan Coil Unit	With Manufacturers packaged controls including hardware and software		Ceiling Void in Room or in room itself	Not required		Required	Full two way interface to fully control and monitor all parameters available on plant by wired Modbus or BACnet.
Electrical Generator	With Manufacturers packaged controls including hardware and software		Major Plant Areas	Required	Full BMS wired status from BMS control panel.	Required	Full two way interface to monitor all parameters available on plant by wired Modbus or BACnet.
Electrical UPS, larger more centralised systems	With Manufacturers packaged controls including hardware and software		Local Plant Rooms	Required	Full BMS wired status from BMS control panel.	Required	Full two way interface to monitor all parameters available on plant by wired Modbus or BACnet.
Electrical Solar PV Inverters Systems	With Manufacturers packaged controls including hardware and software		Roof Plantrooms	Not required		Required if available	If available then monitor performance and status parameters by wired Modbus or BACnet

MS02 Appendix B.	**Generic AHU Controls Specification for larger AHUs**	

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Not all items will apply to all AHUs but the below details show generic solutions needed for the majority of components likely to be included within the design. Please note on smaller local AHUs (as against main plantroom large system AHUs) many components may not be included within the design. Note also Appendix A which details plant interfaces by traditional and BACnet/Modbus Ip philosophy.

Supply AHU Component	**Functionality Required**	**Additional notes**
Motorised Inlet damper	Damper motor to fully open the damper when AHU needs to run. Damper to close at other times	Motor to be complete with open and shut end switches to give status. Alarms to be raised when damper malfunctions in either status. Fan to be interlinked to fully open position and cannot run until damper proved fuly open.
Frost coil (variable volume constant temperature)	Discharge detector. To be fully modulated with 3 term control to give constant discharge. If no heat recovery set to 10c discharge, if heat recovery set to 4c discharge.	Take great care with detector position as larger coils (set to lower temperatures) might be subject to possible freeze under light loads.
Frost coil (constant volume variable temperature) with injection loop. Only used with large coils and heat recovery.	Discharge detector. To be fully modulated with 3 term control to give constant discharge. Heat recovery so set to 3c discharge.	Local pump on injection loop to only run when there is a call for heat.
Local pump for frost coil injection loop (constant volume variable temperature)	Fixed speed pump complete with starters and switches.	Panel on/off/auto swith with run and trip lights. Pump failure monitor via pump pressure switch in series with contactor.
Frost coil hold off detector	Lace on analogue detector to monitor frost coil discharge temperature.	If any point on capillary drops below 2c then airhandling system to be held off to prevent a coil freeze and dampers to shut. Alarm to raise on head end BMS.
Pre Filter	Analogue pressure detector to monitor filter condition.	Alarm light to be raised on panel and alarm raised on BMS head end on pressure drop exceeding set point. Alarm also to be raised on swift increase in pressure drop indicatig filter freeze up. AHU to continue to run on alarm.
Preheat Coil	Common discharge detector. To be fully modulated with 3 term control in series with cooling, reheat and heat recovery to maintain a set discharge set point.	Common discharge temperature will depend upon application. Generally will be a set point that will be adjustable in a linear line dependant upon outside temperature say 20c winter and 18c summer. However in some circumstances the common discharge temperature may need to be reset dependant upon several internal space temperature reading.
Heat Recovery Device (plates)	Common discharge detector. To be fully modulated with 3 term control in series with preheat, cooling and reheat to maintain a set discharge set point.	Plates controlled by modulation of separate face and bypass dampers. Motors to be complete with open and shut end switches to give status. Alarms to be raised when dampers malfunction.Common discharge temperature will depend upon application. Generally will be a set point that will be adjustable in a linear line dependant upon outside temperature say 20c winter and 18c summer. However in some circumstances the common discharge temperature may need to be reset dependant upon several internal space temperature reading.
Heat Recovery Device (thermal wheel)	Common discharge detector. To be fully modulated with 3 term control in series with preheat, cooling and reheat to maintain a set discharge set point. Supply needed to wheel motor and fully interface to wheel motor controls.	Thermal wheel controlled by modulation of motor speed. Common discharge temperature will depend upon application. Generally will be a set point that will be adjustable in a linear line dependant upon outside temperature say 20c winter and 18c summer. However in some circumstances the common discharge temperature may need to be reset dependant upon several internal space temperature reading.
Heat Recovery Device (run round coils)	Common discharge detector. To be fully modulated with 3 term control in series with preheat, cooling and reheat to maintain a set discharge set point. Supply needed to wheel motor and fully interface to wheel motor controls. Run round pump will need normal motor controls and pump only runs when calling for heat. Three port valve modulated to suit.	Run round system controlled by valve modulation. Common discharge temperature will depend upon application. Generally will be a set point that will be adjustable in a linear line dependant upon outside temperature say 20c winter and 18c summer. However in some circumstances the common discharge temperature may need to be reset dependant upon several internal space temperature reading.
Supply Fan	This may be single, twin or multiple motors.	Interlink to dampers and frost coil failure as noted elsewhere. See below for types of motor controls.
Cooling Coil	Common discharge detector. To be fully modulated with 3 term control in series with preheat, reheat and heat recovery to maintain a set discharge set point.	Common discharge temperature will depend upon application. Generally will be a set point that will be adjustable in a linear line dependant upon outside temperature say 20c winter and 18c summer. However in some circumstances the common discharge temperature may need to be reset dependant upon several internal space temperature reading.
Humidifier		
Reheat Coil	Common discharge detector. To be fully modulated with 3 term control in series with cooling, preheat and heat recovery to maintain a set discharge set point.	Common discharge temperature will depend upon application. Generally will be a set point that will be adjustable in a linear line dependant upon outside temperature say 20c winter and 18c summer. However in some circumstances the common discharge temperature may need to be reset dependant upon several internal space temperature reading.

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Secondary Filter	Analogue pressure detector to monitor filter condition.	Alarm light to be raised on panel and alarm raised on BMS head end on pressure drop exceeding set point. AHU to continue to run on alarm.
Motorised Outlet Damper	Damper motor to fully open the damper when AHU needs to run. Damper to close at other times	Motor to be complete with open and shut end switches to give status. Alarms to be raised when damper malfunctions. Fan to be interlinked to fully open position and cannot run until damper proved fuly open.
Fire interlinks		
Extract AHU Component		
Motorised Inlet Damper	Damper motor to fully open the damper when AHU needs to run. Damper to close at other times	Motor to be complete with open and shut end switches to give status. Alarms to be raised when damper malfunctions. Fan to be interlinked to fully open position and cannot run until damper proved fuly open.
Inlet Filter	Analogue pressure detector to monitor filter condition.	Alarm light to be raised on panel and alarm raised on BMS head end on pressure drop exceeding set point. AHU to continue to run on alarm.
Extract Fan	This may be single, twin or multiple motors.	Interlink to dampers as noted elsewhere. See below for types of motor controls.
Heat Recovery Device	Covered within supply AHU component section.	
Motorised Outlet Damper	Damper motor to fully open the damper when AHU needs to run. Damper to close at other times	Motor to be complete with open and shut end switches to give status. Alarms to be raised when damper malfunctions. Fan to be interlinked to fully open position and cannot run until damper proved fuly open.
Fire interlinks.		
Fan Motor Controls		
Single motor	Safety interlocks, as above notes, plus interlink to fire system as needed. Remote stop/start with run and trip status. Local stop lock isolation.	
Twin motors	As for single motor plus no1/no2 selection with automatic changeover on failure and fan operation rotation.	
VSDs to motors	As above plus set volume, set pressure or occupancy CO2 sensing or simillar for demand driven control. Remote speed command, speed feedback and fault condition.	
Multilpe motors (plug fans)	Safety interlocks, as above notes, plus interlink to fire system as needed. Remote stop/start with run and trip status if possible or as a minimum common fault alarm. Local stop lock isolation. Plus set volume, set pressure or occupancy CO2 sensing or simillar for demand driven control. Remote speed command, speed feedback and fault condition.	
Energy Monitoring		
Power consumption monitoring	All motors are to be provided with power monitoring to UoL standard specification with remote read out.	

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Action	Owner	Comments
Do we really understand the services system philosophies fully such that we are sure we know how we want to control the systems?	Mechanical Designer, BMS Designer	If Planned project, where scope and programme don't allow then this step might be skipped.
If not we need to all meet and discuss to assemble knowledge including undertaking any further surveys and if required conduct test shutdowns.	Project Manager, with input from whole team.	Who are the key stakeholders for the space? Essential to discuss to arrange shutdowns.
Are such shutdowns acceptable or do we need some form of temporary supplies, if so record in transition report.	BMS Engineer	PM issue update to stakeholders.
Do we have the original design data for flow rates for air and water in case we need to set anything?	Mechanical Designer, BMS Designer	Only on complex buildings where we need to validate the existing and improve it where possible
Have we a full record of all system set points for temperatures, pressures etc?	BMS Engineer	If these are not available what is the next step? Can we find out through a survey? Who would we be instructing to do this?
Where we have VSD drives have we set points for all conditions eg full speed and setback?	BMS Engineer	If these are not available what is the next step? Can we find out through a survey? Who would we be instructing to do this?
Have we got existing fully detailed Des Ops?	BMS Engineer	
Have we got fully detailed graphics?	BMS Engineer/BMS Designer	
Have we got the services schematic drawings?	PM & BMS Engineer	If we don't have these or struggle to find them, how can we find them or produce them? Need to ask UoL Property Data Management Officer and Cad Engineer.
Are there any projects ongoing or coming up that will be altering the systems or impact our ability to do the job?	Project Manager	

Testing of Existing Documentation		
Undertake a detailed review of the Des-Ops: - Have we got all of the above, if not we need to draft what is missing in particular for the Des Ops and system graphics. -Are all of the above up to date and correct? If they are not correct we need to alter them accordingly. -We need to bring the above documents up to date and alter to align with any such alterations. -What alterations have we made to the systems in terms of the physical services and software since the above documents were initially drafted. - Do the existing software philosophies run the plant as we would wish or can we better or make more energy efficient. We need to draft any such alterations required. -We then should have a good set of documents	Mechanical Designer, BMS Designer	It is important to understand that the existing UoL Des Ops are often outdated and will not always reflect how the buildings are required to operate for a balance of comfort and economy, efficient running and environmental conditions.
Issue updated Des-Ops	Mechanical Designer, BMS Designer	This should be communicated with the whole project team with version control
Initial communication with Stakeholders	Project Manager	

RIBA Stages Three to Four

Actions		
Action	**Owner**	**Comments**

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Undertake any site surveys/shutdowns required to firm up tender information	Project manager/Senior Electrical Asset Manager/BMS Designer	Shutdowns to be agreed within DTM and coordinated heavily with End Users/Ops Managers.
Write up summary of actions & implications from the above.	Project Design Team	To be discussed in a separate meeting and actions formatted into the tender documents.

Tender Documentation		
Action	**Owner**	**Comments**
Original Des Ops	BMS Designer	Essential these are properly dated with version control
Revised Des Ops	BMS Designer/Mechanical Designer	
BMS Schematics	BMS engineer	
Transition Report inc Points Schedules	BMS engineer/Contractor	Where appropriate - on direct awards the project team may ask the contractor to produce this.
Details of critical systems, what can't be shutdown etc. Include temporary supplies requirements	BMS engineer/Senior Electrical Asset Manager	What are the End User specific, quantifiable requirements (specialist kit/safety)
Alarm matrix requirements	BMS engineer	Standard documentation
Building Analytics Requirements	BMS engineer	Standard documentation
Additional design considerations document (Matts document in email 24th Jan 2025)	BMS engineer	Standard documentation
Schedule of works required on panels following the panel surveys	BMS engineer/Senior Electrical Asset Manager	Where there is disagreement on the action required on a panel, this is to be escalated.
Standard UoL Design Guides	Project Manager	Standard documentation: ESHP007, LV design guide, Containment, BMS Design guide, any others relevant.
Standard UoL BMS Specification	BMS engineer	Standard documentation - Current Risk, this is understood to be out of date and requires an update. AMC to review any changes.
Existing schematic drawings of systems (if available)	Mechanical Designer/Delivery Project Engineer	Mechanical biased team members to pick this up. Resourcing to be disucssed.
Quality questions	All Design Team	Agree Quality Questions and who is marking them. Also agree Price/Quality breakdown.
End User requirements document	All Design Team	Are there any end user items that will constrain the works that need to be allowed for within the tender?
Standard UoL Tender Documents	Project Manager	JCT info, General Information, ITT etc
Contract Sum analysis	Project Manager	Are there any items that need a line adding in for? Data Points? Builders works? Always have a line for temporary supplies.
PCI	Project Manager	Asbestos survey? Access or lab induction requirements, UoL H&S induction etc…
Key Date/Programme for Tender	All Design Team	

Tender Return		
Action	**Owner**	**Comments**
Probe for compliance with the tender documents	All Design Team	Pull together list of qualifications and clarifications: what have they missed? How can we resolve issues?

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Price impact of clarifications	All Design Team	As per marking agreed at design
Scoring	All Design Team	Agree scoring panel
Tender Interviews	All Design Team	

RIBA Stages Five - Seven

Contractor Design Phase		
Action	**Owner**	**Comments**

Post Contract & Contractor Design meetings	Project Manager	PM to book in as soon as project is awarded - these need to be regular (weekly or bi-weekly) and structured with notes and action list.
Intial Design meeting Interogation	Contractor/PM/ BMS Engineer/Mechanical Designer	BMS contractor team to ensure that they have received and fully understand the scope of works within the tender documents
Key Milestones	Contractor/PM	PM's at the start of each project are to ask for the contractor to provide the following milestones via a programme; - Period needed for contractor design progression - DesOps, Graphics development, software development(bench testing) -Expected period for site works. -Completion date for each panel -A date for each panel for witnessing (including graphics) to put in peoples diaries. Following this meeting a sign off sheet will be issued from the internal BMS engineer confirming completion and any notable snags. If BMS Engineer does not feel on witnessing the panel is safe or can be put into operation they are to escalate immediately. -Issue date for the O&Ms
Contractor Des-Ops	Contractor/PM/BMS Engineer/Mechanical Designer	Contractors issue of Des Ops showing they have fully understood what we are looking for. This is to be reveiwed and signed off by the design team prior to site works. PM to ensure meetings have been planned out into peoples diaries upon contractor appointment
Contractor System graphics.	Contractor/PM/BMS Engineer/Mechanical Designer	This is to be reveiwed and signed off by the design team prior to site works. PM to ensure meetings have been planned out into peoples diaries upon contractor appointment
Revised panel drawings and panel wiring diagrams	Contractor/PM/BMS Engineer/Mechanical Designer	This is to be reveiwed and signed off by the design team prior to site works. PM to ensure meetings have been planned out into peoples diaries upon contractor appointment
Bench Testing	Contractor/PM/BMS Engineer	Contractor to conduct a bench review of a software demo before installation, BMS Engineer to review and sign-off or provide comments. Extent of testing to be discussed with parties at initial meeting with the Contractor and needs to be proportional and realistic. 30% rule of thumb for the UoL.

Installation & Commissioning		
Action	**Owner**	**Comments**

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Commissioning visit element 1: Panel Installations	Contractor/PM/BMS Engineer	Full operation of Panel, field devices and graphics to be demonstrated covering 30% of the points and 100% of any life safety systems. BMS Engineer to review and confirm they have witnessed or provide comments. Signed Panel Sign-off sheet to be provided to Project Manager. This is to be done panel by panel throughout the project. If the BMS Engineer upon witnessing identifies extensive snags restricting panel operation they are to escalate immediately to wider group
Commissioning visit element 2: Programming & Software checks	Contractor/PM/BMS Engineer	Review of software operation to consider 30% of the points and 100% of any life safety systems. BMS Engineer to review and witness and provide comments. Feedback to be provided to the Project Manager. This is to be done panel by panel throughout the project.
Commissioning visit element 3: Graphics	Contractor/PM/BMS Engineer	As per the above, BMS engineers to review the graphics and provide comments against the graphics for each panel following the witnessing of each panel, this is not to be left to the end. PM to ensure BMS Engineer has allocated sufficient time.
Commissioning visit element 4: Alarms	Contractor/PM/BMS Engineer	We must agree alarm categories and how these are marshalled. To be checked as part of the same visit as the above where possible.
Snagging	Contractor/PM/BMS Engineer	There will be issues that arise during commissioning that may lead to minor software and graphics alterations and these must be recorded. The PM to then coordinate with the Contractor and BMS Engineer to ensure these are signed off. Head of Carbon and Energy to escalate to Assistant Director of Estates and Contractor Directorate if action is not been taken timely
Legacy Defects	PM/ BMS Team	The scope of a project may not include the rectification of other defects found in the BMS network e.g. defective sensors. Critical safety works however must be included. Projects if finding legacy defects are to log them in a schedule and provide them to the Head of Carbon and Energy and the Head of Maintenance and Engineering.
Fans & Pumps	Contractor/Design Team	We must ensure that flow rates for air and water are correct and that fans and pump ASDs are at the correct settings. This may need a services commissioning engineer. (project-specific and dependant on complexity)

Handover		
Action	**Owner**	**Comments**

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Contractor to issue final set of Des Ops and graphics updated to include the alterations during installation (O&M pack).	BMS Engineer	BMS Engineer to review and provide comments. PM to chase actions. If this is not concluded within 6 weeks of site works completion - PM to escalate to Head of Projects and Assistant Director of Estates
Contractor to issue final set of wiring diagrams and panel drawings	BMS Engineer/PM	PM to ensure that all documents are saved down and issued to UoL Property Data Management Officer and Cad Engineer.
Make sure old outdated documents are archived.	BMS Engineer/PM	PM to coordinate with ECS Service and UoL Property Data Management Officer and Cad Engineer.
Issue PC Cert to contractor	PM	
Ensure all Snags are closed out and recorded	PM	
Issue close out report alongside approval of final invoice	PM	

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