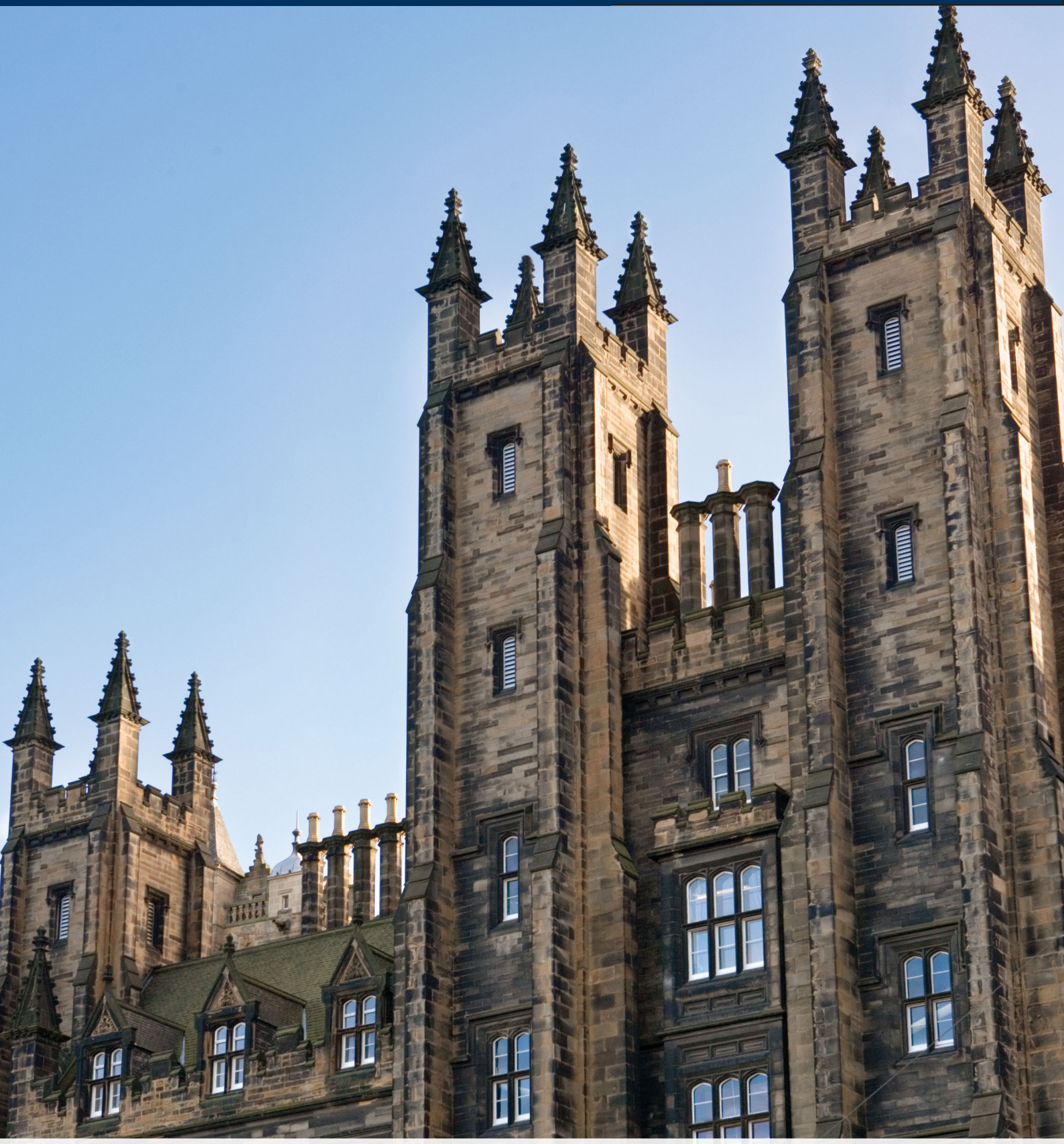
THE UNIVERSITY of EDINBURGH
Estates Department



Estates Design Guideline No. 4

Building Energy Management Services (BEMS)

Important Comment on Estates Design Guidelines, Assets & Standards

These Design Guidelines, Assets and Standards and the associated suite of documents have been produced in order to furnish external design consultants and contractors with guidance on required University standards for inclusion within their proposed project design.

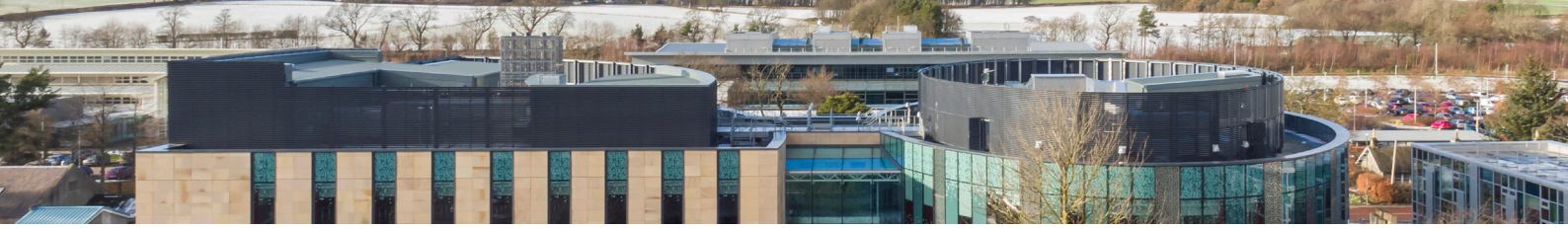
These guidelines are to be used as supplementary information during project design stage, and as such, detail the minimum standards expected from the University Estates Department.

Please note, these guidelines do not absolve the project design team including, sub-consultants and sub-contractors of their legal and contractual obligations under, design liability, statutory regulations and health and safety legislation.

EDG No. 4 - Building Energy Management Systems (BEMS) - Approval Procedure	
EDG No. 4 - Building Energy Management Systems (BEMS) Lead: Controls Systems Manager	Name Signed Off Date
EDG No. 4 - Building Energy Management Systems (BEMS) - Equality Check Lead: Building Services Group Manager	Name Signed Off Date
EDG No. 4 - Building Energy Management Systems (BEMS) - Check and Approval Lead: Director of Estates Operations	Name Signed Off Date
EDG No. 4 - Building Energy Management Systems (BEMS) - Approval by EMG	Name Signed Off Date
EDG No. 4 - Building Energy Management Systems (BEMS) - Approval by Estates Committee	Name Signed Off Date
EDG No. 4 - Building Energy Management Systems (BEMS) - Future review Lead: Controls Systems Team	Name Signed Off Date

Version Control for Estates Design Guidelines (Assets & Standards) No. 4 - Building Energy Management Systems (BEMS)

Version	Date	Nature of Revision	Author	Approved by	Signed
1.0	January 2019				
1.0	January 2020	General Updates			



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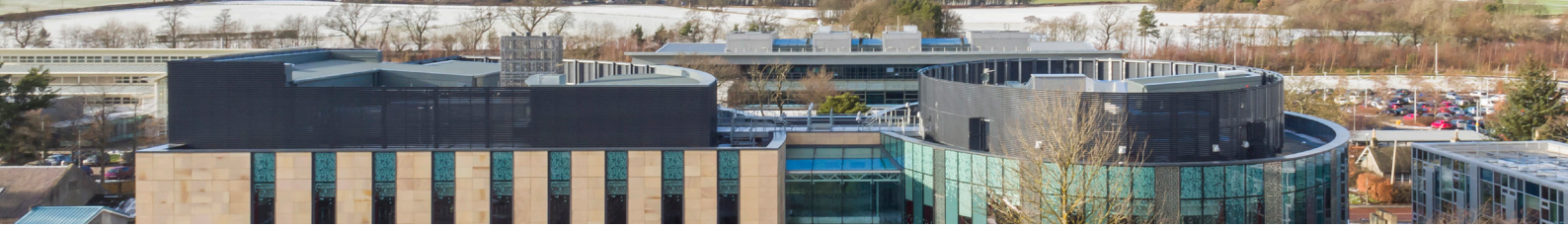

1.0 Introduction

The UoE Design Guidelines (as a whole), have been developed for employees of the UoE, Design Teams, Architects, Engineers, Project Managers, external consultants and contractors. This documentation has been developed to enable Design Teams and Contractors to have a broad understanding of the principles that the University of Edinburgh will require to be adopted for any future developments.

The guide is primarily designed to be used in conjunction with Royal Institute of British Architects (RIBA) stages. The actual extent and scope of the design guide to be incorporated for any future development will be based upon the specific projects requirements.

The UoE Design Guidelines aim to discuss strategic matters and does not provide an exhaustive treatment of statutory or best practice design and compliance requirements; its primary purpose is to establish a starting point for design briefs, support the consultation process and outline existing assets and standards. It is the responsibility of Design Team readers/duty holders to ensure subsequent designs are complete, compliant and able to meet the final approved brief when measured in use.

1.1 Important Notice - Essential Prior Reading

It is essential for readers of this document to first refer to the Guide No1 – entitled *"Estates Design Guidelines (Assets & Standards) Introduction and Application"* – which serves to provide the Principles and overview with vital information and context that apply to all projects.

1.2 Purpose of the University of Edinburgh Estates Design Guidelines (Assets and Standards) – UoE Design Guidelines

The purpose of the Estates Guidelines is to act as a briefing document to give designers an overview of the minimum design requirements, constraints and challenges presented by the University of Edinburgh's particular needs. It applies to all new-build and refurbishment projects controlling quality in the production of designs, specifications and the subsequent performance of buildings, developed to a consistently high standard

It applies to all new-build, refurbishment, minor works and change of use projects, including property leased by the University. These guidelines will aid in controlling the quality of design and installation of electrical services, ensuring continuity throughout the University Estate.

The University of Edinburgh encourages innovation; however, all project Design Teams should ensure that their proposed projects have end user considerations and ease of maintenance at its core.

The use of the University of Edinburgh Estates Guidelines, Assets and Standards will not take the place of, or remove, any of the professional responsibility from Design Teams and Contractors to fully comply with the requirements within this document. Given the complex, diverse and growing estate, not all eventualities can be fully defined within this document.

Should any projects deviate from these guidelines, a technical submittal outlining the deviation, reason why and impact to the University maintenance strategy should be prepared and forwarded to the nominated University project representative for liaison with the Building Services Group (BSG).

A review of this deviation shall be carried out by the BSG; a final decision on the deviation shall be communicated to the appropriate design/construction team.

1.3 Purpose of UoE Design Guideline No. 4

The purpose of this document is to set out the guidelines and standards that apply to University of Edinburgh (hereby referred to as UoE) Estate and its design requirement for Building Energy Management Systems (BEMS) as set out by the Controls Systems Team. This document will apply to newly constructed buildings and existing buildings scheduled to be refurbished. In some cases, this standard exceeds the Building Regulation requirements, as it represents good practice in the Higher Education sector.

The Building (Scotland) Regulations set out to ensure that new buildings and works achieve the objectives of the Building (Scotland) Act 2003 in terms of health, safety, welfare, convenience conservation of fuel, power, and sustainable development, and the purpose of this guide will be to provide a standard policy specifying the standard that is required by the UoE.

This UoE Design Guideline No. 4 is for designers, engineers, specifiers, installers and commissioning and maintenance engineers of Building Energy Management Systems (BEMS) for UoE Estates from the Developed Design Stage (RIBA Stage 3) to when the building is in use (RIBA Stage 7).

- To align the requirements of the Technical Standards (Scotland) Regulations/Building Regulations, CIBSE Guide H: Building Controls Systems and the University. There is potential conflict between these as the Technical Handbook/Building Regulations are generic and often prescriptive whilst Building Control Systems encourages creative solutions relative to actual use and management.
- To provide an indication of non-prescriptive preferred solutions and appropriate standards. The content is not a statement of requirements or intended to replace existing British or European technical standards or national guidance; reference to these will still be necessary.

If due to the nature of the project, certain aspects of Building Energy Management Systems are not covered in these guidelines and standards, the relevant codes of practices, British Standards and building regulations are to be applied and followed. For any general and specific queries, advice is to be obtained from the Controls Systems Team. In the event those documents referred to within this document, which have been superseded, then most recent versions are to be referred to.

Any other doubts, concerns or points of clarification on Building Energy Management Systems (BEMS), please contact the Controls Systems Team.

This document applies to all buildings managed or owned by the UoE. Any tenanted buildings must not have building works, adaptions or change any building or part of a building which will affect the Building Energy Management Systems or any other building without first receiving permission from the Controls Systems Team and the Landlord of the property or nominated agent and written in the respective lease.

This document indicates the University's generic Building Energy Management Systems (BEMS) Client requirements. Consultants must also refer to specific project requirements identified by the University's Project Manager and they must fully integrate any new design with the University's Schneider EcoStruxure, Sigma or Trend BEMS systems. Consultants and contractors must obtain approval in writing for any variation from these requirements from the Controls Systems Team.

Reference is made throughout to the nominated Field Equipment List attached at Appendix No.1.

Before incorporating these Client requirements in e.g. tender documentation etc., please always check with the undersigned that you have current Issues of both these Client requirements and the Field Equipment List.

Please always approach the University Engineers directly to discuss any point of clarification or possible improvement - and to obtain further copies of the Client requirements.

Controls Systems Team
Estates Department – Estates Operations
9 Infirmary Street,
Edinburgh EH1 1NP
General Enquires: 0131 650 9157

1.4 Interpretation

Any part of the Estates Design Guidelines may be referenced in project contractual documentation (Terms & Conditions) in order for the UoE to control quality. The following interpretations apply:

Glossary of Terms:

1.4.1 Enforced Requirements

The use of the word(s) 'shall', 'are required', 'is required' 'must' or 'will' denotes a requirement that is non- negotiable and shall be used as the basis for designs, technical submissions and/or activities. If such a statement conflicts with a statutory obligation then a technical submittal shall be issued to the University project representative for liaison with the BSG for their final decision regarding compliance with the documentation.

1.4.2 Requirements Needing Confirmation

The use of the word 'may' denotes a negotiable requirement or indication of a solution, where innovation and further calculation, design and discussion may be required to arrive at an optimised solution.

1.4.3 Quality

The Design Guide aims to arrive at the University of Edinburgh's highest design aspirations and standards. It may be that, at the University of Edinburgh's sole discretion, solutions are value managed and then value engineered during subsequent design iterations. Design Teams and Contractors are encouraged to consider where value management and subsequent value engineering may result in an improved financial performance should funding constraints occur. All mechanical and electrical value management and value engineering exercises carried out shall be forwarded to the BSG for review.

1.4.4 Assets and standards

The Design Guidelines endeavours to set out Assets and Standards that will maximise the benefits realisation for the UoE to achieve its strategic objectives and maximise value for money. This will involve coordinated and optimised planning in conjunction with Procurement, robust asset selection with particular reference to existing legacy assets and standards on the University Estate, for reasons of utilisation and continuity of maintenance, replacement of parts, renewal and ultimate disposal.

1.4.5 Currency of Third Party Documents

Where superseded standards and regulatory documents are referred to in the text, the reader shall apply current revisions and amendments to their project. Should there be any ambiguity, the BSG should be contacted for clarity.

1.4.6 Proof

Where the word 'proof' is used, e.g. 'proof is required', a written report or installation certificate must be produced for approval depending on context.

1.5 Review Design Data Process (RDD)

All proposed designs shall be submitted to the Project Manager and respective Estates Teams and Building Services Group for review and comments, the response will be categorised as follows:

A. Design Team to acknowledge comments and continue to develop the design to the next stage.
B. Design Team to acknowledge comments, update the design in accordance with comments, and resubmit for consideration before proceeding to the next stage.
C. Design Team to acknowledge comments and completely review and update the design in accordance to the agreed design principles and resubmit for consideration before proceeding to the next stage.

In addition to the above, the UoE may request specific technical submission to support the RDD and may include the request setting out with proof, e.g. calculations, drawings, etc.

The purpose of the RDD is to ensure designs meet the strategic requirements of the UoE and do not compromise the future operations and maintenance provision. The obligations owed by external architects, consultants and contractors to UoE and their liabilities to UoE is not in any way diminished or otherwise reduced by the RDD.

1.6 The Obligations Owed

By external Design Teams, consultants and contractors to University of Edinburgh and their liabilities to University of Edinburgh is not in any way diminished or otherwise reduced by the approval process. University of Edinburgh is not taking over the roles and duties of the external Design Teams, consultants and contractors who will remain legally responsible for the design and/or works carried out by them or on behalf of their staff, agents, sub- consultants and/or sub-contractors.

1.7 Version control and updates

The Estates Design Guidelines will be reviewed and updated at the end of January in each calendar year. The version number will, using 2018 as an example, move from 2018 V1.0 at the end of January to 2019 V1.0 for the following year.

The UoE Estates respective Project Management (PM) teams will send e-mail notifications to the Directory of current Design Teams and Contractors appointed, following any update or change.

Any updates to the Design Guidelines, which cause significant change to a project design should be discussed with the respective Project Management team and application of the Change Control Process will be required.

Any new items or amended content will be highlighted in yellow to enable identification of changes from previous versions.

2.0 Legislation and best practice standards for reference

The University will comply with all relevant legislation and regulations relating to the design and structure of the building. Academic, administrative buildings and all residential property are subject to the requirements of the Technical Standards (Scotland) Regulations / Building Regulations, CIBSE Guide H: Building Controls Systems.

These standards allow detailed professional knowledge and judgement to be applied in order to develop a final design solution, which will satisfy projects that are more complicated.

3.0 Design Consultation and Notification Process for Projects

The University of Edinburgh Controls Systems Team must be consulted by the Project Manager and Design Teams in regard to comments on the proposed Building Energy Management Systems (BEMS) and design proposals at an early stage and throughout the Plan of Work stages. The Controls Systems Team or other competent persons acting under the Controls Systems Team and authorised to do so, must approve the Building Energy Management Systems (BEMS) at appropriate stages of the design and construction process.

If any building or part of a building undergoes a change of use that might affect the Building Energy Management Systems (BEMS) and wider controls strategy. The Controls Systems Team must be consulted, to ensure that the Building Energy Management Systems (BEMS) proposals are reviewed and to confirm that they remain appropriate to deliver the Controls Strategy and overall building use philosophies.

The selection of appropriate options at design stage, through consultation with key stakeholders i.e. Architect, Consulting Engineer, M&E Engineers and the UoE Controls Systems Team, may serve to mitigate unacceptable functional risks to users or unacceptable on-going cost and managerial issues. Addressing issues at a late stage is likely to cause conflict, delay, additional expense or management burden and have a negative impact on environmental conditions and operation of the building.

Early and comprehensive consultation with the Controls Systems Team is key to achieving good cost effective Building Energy Management Systems (BEMS) standards compliant with relevant legislation. The Controls Systems Team and other relevant persons shall be consulted on a regular basis throughout, in an open transparent manner. Effective consultation should ensure that the potential negative operational legacy issues are mitigated and improvements can be considered for inclusion. Consultation should not cause any delay and is likely to reduce cost.

4.0 Technical Preamble

A Building Energy Management System (BEMS) is a computer based centralised system that helps to manage, control and monitor particular engineering services within a building or group of buildings. Use of a BEMS can limit energy consumption and labour requirements by improving plant efficiency and effectiveness. It can also provide a more comfortable environment for the building occupants and act as a focal point for alarms.

Some advantages that a BEMS can provide are:

- Reduce energy consumption through centralised control, monitoring and energy management programmes.
- Faster and better response to occupants needs.
- Pre-programming of heating and holiday schedules.
- Remote switching of plant.
- Remote adjustment of set points.
- Routine and repetitive functions can be programmed for automatic response.
- Better management of alarm reporting and log data for trend analysis.
- Graphical representation of plant operating conditions.
- Improved plant efficiency and life expectancy.
- Real time collection of building data viewable via a networked PC.

To maintain a successful BEMS installation:

- New systems need to be correctly specified, installed, commissioned and operated.
- Installers and operators must be skilled and fully trained on the use and operation of the University's preferred BEMS systems.
- It requires ongoing maintenance and periodic re-commissioning of existing installations to ensure the full benefits of the system are maintained.

4.1 General Arrangements

The University has adopted the following BEMS systems: - Schneider EcoStruxure, Schneider Sigma and Trend 963, which are connected to the University's IT network on a dedicated VLAN. All BEMS systems are hosted on virtual servers, to campus wide workstations.

4.2 BEMS System Installations

~~EcoStruxure Building Operation is Schneider's next generation BEMS system and the University is in the process of evaluating and upgrading the BEMS front-end system in 2018.~~

New build projects should specify the installation of EcoStruxure or Trend systems or other front-end systems under development evaluation, as published and with prior written consent by the Controls Systems Team.

Refurbishment Projects may consider the utilisation of the legacy Sigma system, subject to prior written consent by the Controls Systems Team.

4.3 General Client Requirements

The following Client Requirements are to be used by external Mechanical & Electrical consultants/ Supervising Engineers, and by University staff when specifying controls on either new build or retrofit installations. Reference is made throughout this document to the nominated Field Equipment List attached at Appendix No.1. It is the duty of the M&E Consultant to check, before incorporating these Client Requirements in tender documentation etc., that they have the current issue of both the Client Requirements and Field Equipment List.

- Building Energy Management Systems (BEMS) controls shall use the existing BEMS system types. The use of protocol interfaces to alternative BEMS systems must not be used.
- Use of protocol interfaces to plant items e.g., Bacnet, Modbus etc., must not be used for plant control and critical interlocks. However, they may be considered only with prior written approval from the University Control System Team, for monitoring purposes only.
- Building Energy Management Systems (BEMS) controls packages shall be installed by a Controls Specialist Contractor, normally as a subcontract of the Mechanical Services Subcontractor, and shall generally be in accordance with the Standard Form of Building Contract (all Editions).
- Building Energy Management Systems (BEMS) controls equipment - any potential near end of life products proposed, must be notified to the University's Controls Systems Team, for expressed approval.
- Building Energy Management Systems (BEMS) manufacturer controls equipment warranties and extended warranties must be provided to the University's Controls Systems Team, as part of the O&M's, to ensure that the University has the benefit .
- For each Ethernet type controller a University IT network point shall be installed within close proximity of the control panel or controller. The IT point shall be installed and commissioned by the appointed data network installer. The Controls Contractor shall be responsible for the connection between the IT point and controller.

4.4 Controls Contract Programme

The University requires timely opportunity for the University's Controls Systems Team to comment on proposals at each key stage of the Design Development of a project. The M&E Consultant shall provide a minimum of ten working days from ~~receipt~~ issue of the following documents to enable the University Controls Systems Team to comment as appropriate on each stage of the development of the scheme:

Pre Tender Stage:

- Draft Narrative on Mechanical Installation and Control Design Philosophy
- Draft Mechanical Layout drawings & Equipment List
- Draft BEMS Points List and Control Equipment List

Tender Stage:

- Narrative on Mechanical Installation and Control Design Philosophy
- Mechanical Layout drawings & Equipment List
- BEMS Points List and Control Equipment List

The Design Team Consultants shall copy relevant documents to the University Controls Systems Team at the same time as submitting them to the University's Project Manager.

Any exclusions or changes to the final tender documents, at any stage, must be reported to the University Project Manager.

~~Ten working days after receipt of an order,~~ The Controls Specialist Contractor shall submit to the M&E Consultant (with a copy to the University's Controls Systems Team) a Components List of all equipment required for the project, and a Programme ~~indicating the ten working days' periods~~ for client comment on the following:

- Wiring Diagrams and Control Panel Internal and Fascia Layouts
- Plant Schematic Layouts with Control Equipment Locations
- The Specialist Controls Contractor shall give the Mechanical Services Contractor and the University Controls Systems Team a minimum of ten working days' notice of the following key stages:
- Familiarisation with almost complete installation, prior to formal commissioning (proposals for Graphics Slides, Software, Alarm Priorities, Alarm Routing and Logging for the Supervisory PC shall be tabled at this stage)
- Demonstration - the system shall be presented to the University's Controls Systems Team only after seven days of logged performance has been completed, which met the specification to the satisfaction of the Supervising Engineer/Consultant. The systems must be fully complete prior to being offered for demonstration to the University Controls Systems Team. The O&M documentation and commissioning check sheets must be available at the demonstration. This demonstration shall include all software, completed Graphics Slides, Logging, Alarm Records, and control installation - using a laptop computer. A snagging list of items that have still to be completed shall be prepared with a timetable for completion. Partial demonstrations may be offered early for plant and control items where this is beneficial, e.g. underfloor items, items in ceilings etc.
- Handover of "As Fitted" drawings, O&M Manuals and installation of completed software, Log Configuration, Alarm Routing and Graphics on to the dedicated virtual server accessed from the Estates Office.

4.5 Designers' and Contractors' Responsibilities

The following Client Requirements have been prepared to indicate the University's generic requirements. If any situation appears to be not fully covered here then it is the responsibility of the M&E Consultant, Supervising Engineer, Main Contractor, Mechanical Services Contractor and the Specialist Controls Contractor to refer to specific project requirements, issued by the Project Manager and incorporated in the specific Client Requirements for any project. If in doubt please always ask for clarification.

It shall be the responsibility of the Specialist Controls Contractor to identify any potential or actual conflict or discrepancy between the proposed mode of operation and what is achievable for a specific project on site. The Specialist Controls Contractor shall report any such problems and provide proposed options to the appointed Mechanical Services Contractor and through the contract chain to the Controls Systems Team to ensure delivery of a “fit for purpose” robust and effective BEMS System.

4.6 Approved Specialist Controls Contractors

Schneider EcoStruxure and Trend and Schneider Sigma have been identified by the University as their preferred BEMS systems for all buildings maintained by the Estates Department. The following Client Requirements are generic and the systems shall be considered for any new stand-alone project. However, further advice should be sought from the Controls Systems Team on the most appropriate system where the project forms part of a refurbishment or extension of an existing building or complex. It should be noted that some university legacy buildings may require the supply and installation of a Schneider ~~Sigma~~ panel as an interface to the CHP system, when Trend is the selected BEMS system for the project. This should be supplied as part of the project.

Any Schneider EcoStruxure ~~/Schneider Sigma~~ control system shall be designed around the current Schneider EcoStruxure ~~/Sigma intelligent~~ controllers, controllers and gateways, to be installed by the current appointed Schneider EcoStruxure ~~/ Sigma~~ maintenance contractor.

- Any Trend control system shall be designed around the current Trend ~~963,~~ IQ4 Series intelligent controllers, to be installed by either of the current appointed Trend maintenance contractors.

- The controls wiring installation shall be carried out under the direction of the Controls Specialist Contractor as an integral part of the controls package.

- Any part of the contract which is being sub-contracted by the Controls Specialist requires formal approval from the University Controls Systems Team prior to commencement and engagement. The Controls Specialist will be requested to provide full QA documentation and certification of any sub-contractor works, including warranty agreements.

- All software, upgrade and licence costs associated with a project shall be allowed for and included within the Controls Specialists’ package. The University Controls Systems Team must be advised of changes required, on engagement.

- The University Controls Systems Team will always be the formal lead in selection and approval of future potential Controls Specialists, to ensure consistency of integration with existing legacy systems, certification, warranties, quality control and standards etc.

5.0 Controls Philosophy

5.1 General

The University controls philosophy is to provide safe, healthy, comfortable environmental conditions for its building users. The emphasis is placed on implementing Energy Conservation measures at all stages, from the initial design of a system through to final commissioning and thereafter during planned maintenance and servicing of the plant.

The diversity of the University buildings and the differing requirements of the end users, make it challenging to generalise on the required approach for controlling specific items of mechanical plant or on all control systems. However, the following typical plant types can be specified and should be strictly adhered to unless otherwise instructed by the University Project Manager. If in doubt ask!

5.2 Offices and Standard Teaching Areas with Natural Ventilation

Standard occupancy time for these areas is 09:00 to 17:00 hours Monday to Friday. Plant shall be initiated to give a desired room temperature of 20°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.

During Optimiser run-up or boost periods, all mixing and local zone valves shall be driven to the full heat position to achieve the desired occupancy temperature in as short a period as possible, except when supplied from one of the university CHP systems, in which case valves will be kept under normal day control during Optimiser Boost periods.

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 temperature of 20°C plus or minus 1°C. “Optimum Off” temperature shall be the same as occupancy temperature.

5.3 Lecture Theatres and Seminar Rooms with Mechanical Ventilation & Radiators

Occupancy times for these areas are normally 09:00 to 17:00 hours Monday to Friday.

Theatres and Seminar Rooms should normally be designed with enough radiator capacity to allow optimisation to desired room temperature of 20°C without the use of ventilation plant. (Refer to Estates Design Guidelines No.3). However, where this is not achievable, then ventilation will be required for optimisation of the space as follows:

Plant shall be started via Optimiser control for a boost period to achieve the desired room temperature of 20°C. During this boost period the extract fans shall be kept off (on full fresh air systems only), the supply fans and heating medium shall be initiated, and any mixing dampers shall be forced to full recirculation position to achieve the desired occupancy temperature in as short a period as possible.

On termination of the optimised boost period, microwave occupancy sensors (see Appendix No.1) shall take control of the start/stop function of the ventilation supply and extract fans.

If occupancy is not sensed, the fans will switch off, dampers will stay in full recirculation, or drive to fully closed on full fresh air systems, and the space temperature will be allowed to drop to a setback temperature of 4°C below the normal day control set-point.

At this setback temperature, the plant shall be started again to raise the room temperature back up to 3°C below the normal day set-point and then switch off again i.e. keep the space at a 1°C differential.

If occupancy is sensed, by the microwave sensor program for a continuous period of more than thirty seconds, then a twenty-minute, delay-off, software timer shall be initiated. The supply and extract fans shall be started and the heating battery and control dampers initiated to control the room temperature at 20°C with a minimum fresh air supply.

After the last occupancy is sensed the plant will continue to run for the twenty minutes. This will allow for any periods of relative inactivity within an occupied room e.g. during examinations when occupants make minimal movements.

Where two-speed fans are fitted, natural cooling shall be achieved by switching the fans to high speed if the room temperature rises above 24°C and reverting back to normal speed below 22°C. Where inverters are installed, natural cooling shall be achieved via the space temperature control loop acting on the supply and extract fan speeds.

Cooling will normally be by ventilation, but where mechanical cooling is installed then cooling shall normally only be enabled if the room temperature rises above 24°C and switched off again when temperature drops to 22°C.

BEMS interface cards shall always be provided for cooling cassettes, fan coil units, heat recovery units, VRV units etc. to enable remote hard-wired start/stop, run and trip facilities. These cards must be supplied by the cassette manufacturer/installer and do not form part of the controls package. Plant not selected with these interfaces, shall be replaced or adapted by the plant supplier.

Carbon dioxide (CO2) sensors should be installed to control ventilation of spaces with over 100 seats. Approved sensors (see Appendix No.1) in the extract ducts, shall override the normal damper and temperature controls and try to maintain CO2 levels below 0.1% (1000ppm) by opening the fresh air dampers. If the ventilation system has two-speed or inverter controlled fans, then the CO2 sensor shall be used to change the fans to either the high speed or ramp up the inverter speed to achieve this value.

Lighting in lecture theatres shall be integrated into the H&V control strategy, being disabled when the occupancy sensor twenty-minute timer program has timed out. Lighting should be "local manual on/local manual off/BEMS auto off" via a pulsed relay output from the BEMS system interfacing with the manufacturer's lighting control panel.

5.4 Biological Research Facilities (BRF’s)

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 facility and should therefore be set only after consultation with the University Project Manager. In general, room temperatures are normally controlled at 21°C +/- 2°C and humidity is normally 55%RH +/- 10%RH.

All temperature and humidity sensors should be set-up with the facility for high and low alarm limits and allowance should be made within the control system for a common alarm signal to be generated to a remote monitoring facility.

This facility shall be either a volt free pair of contacts at the control panel terminal rail, interfacing to the University's iStar system or by email to dedicated addresses. The exact method of remote alarm monitoring used may differ for each project and so guidance should be sought from the Controls Systems Team before engineering this facility.

Stock Holding Room temperature alarm conditions are normally set to - High Temp Alarm 24°C, Low Temp Alarm 17°C with a transient delay time into alarm condition of 20 minutes.

Stock Holding Room humidity alarms are set at two different levels. Level 1 has a High Humidity Alarm of 75%RH (but below 85% RH), and a Low Humidity Alarm of 35%RH (but above 25%RH) with a transient delay time into alarm condition of 12 hours. Level 2 has a High Humidity Alarm of 85%RH and a Low Humidity Alarm of 25%RH with a transient delay time into alarm of 20 minutes.

All equipment in BRF control systems must be capable of being manually overridden.

A facility for the printing of continuous logs of daily environmental space conditions to meet Home Office requirements shall be provided. This will take the form of daily printouts of temperature and humidity graphs for all designated animal holding and research rooms as specified by the design team. All of this environmental data will also be saved on the host BEMS server and be accessible to end users through Client PCs or local servers.

6.0 Control Panels

6.1 Panel Body

The control panel ~~shall be~~ shall typically be Form 2, unless instructed otherwise, constructed of sheet metal of 2mm minimum thickness and be of the totally enclosed, floor and/or wall mounting cubicle type suitable for front access, and constructed to comply with all relevant British Standards. All door sections are to be hinged vertically.

The power supplies for the mechanical equipment shall derive from a separate distribution board mounted adjacent to the control panel. The provision of the distribution board and wiring of outgoing ways shall be incorporated within the controls package. This installation must comply with UoE Estates Design Guideline No.6, Electrical Engineering Services. Further consideration may be required for certain power supplies, such as immersion heaters, DOL equipment etc. The controls section shall be fitted with a local mains isolator, in this application there is no requirement for the isolator to be interlocked with the panel doors.

Alternatively and with the approval of the Controls Systems team, the control panel may be constructed ~~construction shall typically be Form 2, unless instructed otherwise,~~ with separate power and control sections linked together.
The power section shall be door isolator interlocked with override facility. Door isolators shall be self-supporting and must engage without obstruction when closing the cabinet door.

The power section shall not contain any item of equipment which may have to be accessed, for maintenance or monitoring purposes, during normal running of the plant. Controllers, Motor Speed Inverters with displays and keypads, all 24-volt control relays, switching modules with manual overrides etc. shall all be located outside the power section. Motor Speed Inverters should normally be fitted out with the control panel to keep panel size to a minimum.

~~Removable gasketed gland plates shall be provided on control panels as either top or bottom entry - the Controls Systems Team must approve location. Gland plates should be removed for any on-site drilling, to prevent ingress of metal cuttings into contactors and relays. If this is unavoidable then~~ Care must be taken when drilling ~~gland plates~~ panels in situ by protecting all internal controls equipment. The installation electricians must plug any unused holes left in the control panel ~~gland plates~~ to maintain the IP Rating of the panel.

All ~~doors, mounting and gland plates~~ control panels shall be earth bonded in accordance with the current edition of the IEE Regulations.

The ~~power and~~ control sections of the panel shall be lockable and must be supplied with the same key number for every panel (key numbers Rittal 3524 or Eldon M21323). This will allow controlled access for the University Estates and Service Company engineering staff.

Each panel shall have a minimum of 10% surplus space on the backplate and 10% spare incoming terminal connections to allow for future modifications.

Each panel shall have a fixed document holder fitted on the inside of the control section door. This shall be large enough to accommodate the soft-backed O&M Manual supplied for that panel.

On completion of commissioning, the panel shall be cleaned, inside and out, and all redundant drawings and equipment removed before presentation for handover.

Control panels shall be labelled using traffolyte labels fixed with plastic studs. Adhesive labels shall not be used.

6.2 Control Panel Circuitry

Rigid, slotted plastic trunking, capable of accepting an additional 25% volume of wiring, shall be used for internal wiring. Incoming field wiring must not be routed through this trunking. However, where applicable, e.g. on larger panels or panels with vertical termination blocks down the side of the panel, additional slotted plastic trunking shall be provided by the panel manufacturer to accommodate the incoming field wiring.

DIN Rail mounted terminals shall be provided as required, each individually numbered with clip-on permanent markers, to correspond with the panel wiring diagrams. Sufficient space shall be left above the terminal rails for incoming cable looms and trouble-free connection of terminations. The smallest terminal must be capable of accepting a 2.5mm² conductor.

Mains and three phase conductors shall be segregated from extra low voltage conductors. Under no circumstance should “banked” terminal rails be installed. Both panel and field terminals should be easily accessible at all times. Knife type terminals shall be provided for all low voltage field power supplies and input/output signals such as actuators, temperature, humidity sensors, pressure transmitters etc.

All control circuits shall be extra low voltage (ELV) 24 volts AC, supplied via a transformer ~~with a minimum rating of 500VA to ensure proper operation in the event of a power-off / power-on situation~~ rated accordingly, with 25% spare capacity for future expansion. A separate 24 volt transformer shall be provided for equipment power supplies e.g. actuators, sensors etc.

All ELV power supplies shall have “panel healthy” lamps and be BEMS monitored. Transformers shall be protected by MCB’s on the primary and secondary sides. The secondary side shall be appropriately earthed. No other fusible protection such as packaged internal fuses shall be acceptable.

Controller power circuits shall be wired from the “live” side of the main panel isolator, with appropriate protection. Other circuits shall not be from the “live” side, unless it is a specified requirement of the installation i.e. critical plant. Plant that will automatically reset on resumption of power or gas circuits feeding such items do not require to be permanently “live”. All permanent live circuits should be properly shrouded and identified with "white on red" traffolyte warning labels.

All control circuits and transformers shall be fed from the Brown (red) Phase.

All internal wiring to be in LSF cable. Control wiring to be 0.75mm² minimum. Power cables to be rated to the full load current according to the current IEE regulations. All cables to be colour coded as per the BS 7671:2001 Amendment No2 – for Harmonised cable colours. (Old colours in brackets):

- 3 Phase: Brown (red), Black (yellow), and Grey (blue)
- 230 / 240 volt Neutral: Blue (black)

- Control Wiring: 24V AC White, 0V AC Blue
- ELV DC Supplies: +ve Violet, -ve Blue
- Care must be taken to ensure low voltage neutrals are clearly distinguished from 230 / 240 volt neutrals by alpha-numeric cable ferruling.

24-volt control circuits shall be wired in LSF cable with a cross sectional area capable of carrying the higher currents associated with ELV control circuits, in the event of a power-off / power-on situation.
Where multiple 24-volt AC control circuits are supplied from the same transformer, then the 24-volt and zero-volt leg of each circuit shall be protected by a two-pole MCB.

Critchley type ferrule markers shall be used to identify all control panel terminations in line with the panel wiring diagrams supplied by the Controls Specialist Contractor, the markers must be fully visible, readable and logically installed.

All internal cables shall be crimped at both ends and any screened cable insulated with Neoprene type sleeving to prevent accidental earthing.

All exposed live electrical connections and terminations within both the power and control sections shall be shrouded against accidental contact.

Schneider EcoStruxure ~~/ Sigma~~ panels - Critchley type markers shall identify the "Controller Point Number" or Input / Output reference at the point of termination i.e. on the signal wire as it terminates at the controller. The outer sleeve of the cable inside the controller trunking is not acceptable; as it is not visible once, the wiring loom is in place. Control panel drawings shall have these point numbers clearly identified to allow panel manufacturers and site electricians to label correctly.

Trend panels - Critchley type markers shall identify the "Controller Input/Output" reference numbers at the point of termination i.e. on the signal wire as it terminates at the controller. The outer sleeve of the cable inside the Controller trunking is not acceptable; as it is not visible once the wiring loom is in place. Control panel drawings shall have these Input/output reference numbers clearly identified to allow panel manufacturers and site electricians to label correctly.

Critical plant interlocks shall be designed such that all protection is hard-wired and fail-safe. These interlocks shall be duplicated on the BEMS system as software alarms, but never used as a substitute for hard-wired interlocks. E.g. fire alarm, pressurisation units, airflow switches, water flow switches, damper end switches etc. must be hard-wired.

Each control panel shall have a 13Amp RCD switched socket outlet, supplied from the "live" side of the main panel isolator, fitted inside the control section to power a laptop computer for commissioning and service engineers. Socket to be labelled "For Laptop Computer Only".

6.3 Panel Equipment

Motor Starters shall be of the non-enclosed type with coils rated at 24 volts AC. No motor starters should be switched directly from a control circuit in the field, due to potential volt drops. These should be fed via pilot relays.

MCBs shall provide electrical protection for all fans, pumps, and control circuits. Fuses shall not be used. Motor rated MCB's should be used throughout.

An MCB identification chart shall be supplied and permanently fitted inside a plastic wallet and lodged within the control section inside door panel.

Fixed engraved traffolyte labels shall be used to identify all equipment within the control panel: relays, contactors, MCBs, thyristors, timers, inverters, transformers and associated equipment.

All control items shall be labelled in a consistent manner, both in the panel and on drawings/documentation, in a sequential manner, using the following conventions:

- Relays R1, R2
- Fire Relays FR1, FR2

If additional relays are necessary with the same function they should use an alphabetical suffix i.e. FR1A, FR1B etc.

- Starters S1, S2
- MCB's MCB1, MCB2
- Contactors C1, C2
- Transformers TX1, TX2

Controllers should be identified by their network and IP addresses.

~~A hard wired 10 second delay timer shall be fitted in the control panel to prevent all the commands within a controller switching on instantaneously after a power off / power on or fire alarm. This timer shall then initiate software hold off timers within the controller to facilitate a staggered start sequence of plant.~~

Control relays shall be Omron or approved equivalent with 8 or 11 pin plug in bases.

Relay coils shall be of a suitable size so that induced voltages or leakage currents do not maintain the relay when de-energised. All control relays shall have visual LED indication to show they are energised and must have a "manual override lever" for test purposes and emergency overrides.

Where there is a combination of different coil voltages for plug-in relays within a control panel then the relay bases shall be of a different pin configuration to avoid the possibility of inadvertently plugging in a relay of one voltage into the base of another voltage.

Should the anticipated electrical load of the control panel exceed 10kW, an electrical Modbus meter shall be installed to monitor the power consumption. This meter shall be connected to the BEMS to provide the following values:

- Instantaneous power
- Hourly power usage
- Daily power usage
- Weekly power usage
- Monthly power usage
- Instantaneous running current (Amps)

These values shall be displayed on a graphics page.

All metering shall comply with the current Estates Design Guidelines No.5 – Metering.

6.4 Fascia Equipment

All fascia switches and indicating lamps shall be identified with fixed engraved black on white traffolyte labels. The name of the University project and the Building Number and the Schneider/Trend Project Number shall be engraved on a fascia plate located at the top centre of the power section door.

Fascia switches to override automatic functions of plant shall have "HAND/OFF/BEMS" engraved on their fascia plates. For duty/standby plant items a single 5 position selector switch "No1/Off/BEMS/Off/No2" shall be provided.

All field equipment must be capable of being operated via fascia mounted HAND override switches in the event of BEMS controller failure. Some field equipment will therefore require a 0-10v DC potentiometer fitted on the panel fascia to override BEMS analogue output signals. These will only be required where local control of equipment is not possible. E.g. thermal wheels or small EC type motors.

A common fascia lamp test push button shall be provided on the panel door.

Panel fascia lamps shall be provided to display all run and fault conditions of the plant and panel power supply status. These shall be duplicated on the BEMS as software alarms and digital inputs. Where starters are provided, the run signal shall be from an auxiliary contact.

Field equipment such as Inverters, Boilers, Chillers, VSD pumps etc. shall have a "true run" signal provided with an indicating lamp on the panel fascia. Fascia indication lamps must not be switched directly from circuits in the field; pilot relays shall be used where necessary.
LED type lamps shall be used for panel fascia indication in the following colour configuration:

- Green True Run indication for fans, pump motors, chillers, boilers etc.
- Red Trip/fault indication for fans, pump motors, filters, fire alarms, flow fail, frost etc.
- White 24 volt control circuit live indication
- Amber Power supplies/ Enable Signals to boilers, humidifiers, chillers etc.

6.5 BEMS Systems Hardware

Controllers shall be complete with all necessary input/output cards, modules etc. required to provide a fully operational controls package. Care shall be taken during tender and design to ensure critical plant is controlled within a single Controller and global traffic is kept to a minimum.

All Controllers shall have 10% spare capacity for each point type.

The Controller's power supply shall be fed from the live side of the main panel isolator, through a discrete MCB, to enable the Controller to remain on line when opening the power section of the panel.

Trend Controllers are to be mounted within the control section of the panel and pre-wired to terminal rail.

~~Schneider Sigma UNC 696 type controllers are to be mounted within the control section of the panel and pre-wired to terminal rail. UNC 632 type controllers shall be mounted inside the control section or on the panel door fascia, pre-wired to terminal rail.~~

~~Where a Schneider Sigma project requires three or more UNC 632 adjacent controllers, then a UNC 696 controller shall be used to preserve Node capacity on the LAN.~~

EcoStruxure Controllers are to be mounted within the control section of the panel and pre-wired to terminal rail.

LAN and Sub-LAN design shall be tendered and engineered to current manufacturer's recommendations and shall be the responsibility of the Control Systems Contractor. All Controllers /systems shall provide automatic time change from BST/GMT.

Command interface toggle switches shall be identified with a permanent label to assist in fault finding and servicing.

Where keypads/Network Display Pads are fitted, the display window shall be at 1500 mm above floor level, to enable local operator interrogation of the system.

Each Controller shall be capable of local communication via a laptop computer without any reconfiguring.

Each Controller shall be clearly identified with a permanent label stating the Controllers, LAN numbers and IP Address on the front to assist in fault finding and servicing.

Controller memory shall be sufficient to enable logging to be carried out on every sensor within that Controller at fifteen-minute intervals for a period of at least one week.

Where UoE BEMS approved Controllers are supplied and mounted within other Original Equipment Manufacturers' supplied package plant (A/C Units, AHUs, Fan Coils etc.), the Controls Specialist shall complete all the necessary work to connect into the networks, commission the communications and provide the necessary displays. They shall not change any pre-configuration of the OEM supplied control/monitoring strategies without written permission of the unit manufacturer. All OEM software strategies and flow charts must be made available to the university and included in the final As Fitted Controls O&M Manuals.

~~Where Schneider Sigma Unifact type network controllers are to be used, then there shall be no more than 20 controllers connected to the one IC Gateway controller to allow a minimum of two points per Unifact to be logged in the one Log Configuration Set.~~

Where Trend IQ4 Xcite controllers are used on any project, then the University Controls Systems Team must have full access to all software strategies to enable them to monitor, fault find and modify software as required.

7.0 Field Wiring and Equipment

7.1 External Wiring

The Controls Specialist Contractor shall install all controls wiring between Controllers, control panels and field equipment as an integral part of the Controls Package.

The installation shall comply with the current IET Wiring Regulations and the University's Electrical Specification. These shall be adhered to in conjunction with the following requirements.

All BEMS control cabling shall be installed and mounted on, or within, its own separate containment. No other cabling is to be installed within this containment. Mechanical and Electrical Consultant/Contractor shall ensure separate containment is provided as part of the project design. Departure from this requirement shall be agreed in writing from BSG prior to tender/construction stages.

Critchley type ferrule numbers shall be used to clearly identify all field wiring at both the equipment and control panel ends. The numbers shall match the terminal numbers shown on control panel drawings.

All field cables must be crimped and ferruled at both ends with the exception of 'push-in' type terminals, which achieve a better electrical contact without crimped connection. Any deviation from this must have prior agreement from the University Controls Systems Team.

Communication cables between Controllers shall be clearly identified at both ends with Critchley type ferrule numbers and Dynotape label stating cable destination. All LAN and WAN drawings shall be provided/updated with this information after each project.

Electrical isolation of field equipment shall ensure complete isolation of ELV control circuits in addition to Phase power supplies. E.g. 24-volt control circuits to boilers, chillers, pressure units etc. Sufficient poles shall be provided to meet any design requirement.

Inverters shall be installed with full isolation on both the input and output sides. An early break contact on the output side should be allowed for as a fourth pole in accordance with the manufacturer's recommendations. All control circuits must be isolated on the input side through additional poles on the local isolator.

All low voltage input/output wiring from Controllers to field equipment shall be wired in screened, twisted-pair cable (see Appendix No.1 for exact specification) with the screen grounded to earth at the Controllers end only. The field end of the cable shall have the screen removed and the cable end insulated with Neoprene type sleeving to protect against inadvertent connection to earth.

Controllers communication cable (see Appendix No.1 for exact specification) shall be installed in two core, twisted pair screened cable as standard with the screen earthed in accordance with the Control Specialist's recommendations.

Where field equipment is supplied with "flying leads" attached, e.g. damper actuators, valve actuators etc., these must be left intact and joint boxes used for final terminations.

7.2 Field Equipment General

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.

All field equipment shall be installed to the manufacturer's recommendations. The designer, mechanical contractor and the Control Specialist Contractor shall liaise in order to identify and implement the optimum position of all field equipment at the appropriate time in the contract. The mechanical contractor shall liaise with the Control Specialist Contractor regarding items that are pre-drilled by the manufacturer, and must be considered before approval, to ensure necessary fixings are provided for control equipment e.g. tank level switches, DHW cylinders etc.

Special consideration should be given to the IP Rating of field equipment located externally. The Controls Specialist Contractor shall include for weatherproof boxes/housings to protect all actuators, sensors, duct thermostats, pressure switches etc. which shall be installed outside the weatherproof envelope of the building.

Any new or refurbished wet system which is to be connected to any of the University's CHP Systems shall incorporate two-port valve control in any diverting application to assist in keeping return flow temperatures to the CHP to a minimum. Rotary shoe valves shall not be used in these applications.

All modulating control valves shall have characterised ports. Rotary shoe valves should not be used for control of coils or heat exchangers. Installed valves and actuators should meet the design requirements of temperature, medium, pressure and speed of control.

All field equipment, sensors, actuators, pressure switches, thermostats, VAVs, FCUs etc shall be clearly identified with a fixed traffolyte engraved label or pre-approved alternative such as Cembre Genius II. These should be engraved as per the control drawing description and reflect mechanical plant references and UoE appointed room numbering.

Safety interlocks to field equipment such as pressurisation units shall be designed and installed as hard-wired, fail-safe, to ensure panel interlocks are operated during local isolation. Sufficient poles shall be supplied on local isolators for this purpose.

Field switches where positive operation is required shall be designed as "normally open" i.e. makes on operation. E.g. airflow prove, water flow prove etc.

All system AHUs, pumps and fans shall be positively monitored by Differential Pressure switches or other appropriate equipment. Current proving devices may be used where differential pressure is not an option e.g. kitchen extract fans or faceplate extract fans, but differential pressure should be used where possible. These switch signals shall be duplicated in software on the BEMS system with indicating lamps on the control panel fascia to indicate flow fail conditions.

Automatic gas valves should be of the 230-volt solenoid type with provision of an auxiliary contact for individual BEMS status and control panel fascia lamp indication to indicate a valve open condition. Gas valves shall auto reset.

Safety knock-off buttons shall be fully shrouded to prevent accidental operation. They shall not require a key reset.

Ventilation Filter Dirty conditions shall not normally be monitored by the BEMS system or control panels. Indication of standard AHU bag and panel filter conditions will be by good quality local Magnahelic gauges and will not form part of the Controls Package. However, where HEPA filters are installed in AHU's (e.g. in BRF's or laboratory facilities) then these shall be monitored on the BEMS system via analogue pressure differential transducers in addition to local Magnahelic gauges. (Refer to University Mechanical Guidelines).

AHUs and zone re-heats/re-coolers shall have temperature sensors fitted after each heating/cooling/humidification stage.

Where humidification is used in an AHU then, as a minimum, duct fresh air, extract and supply air temperature and humidity sensors must be used.

All field keypads and local indication displays shall be installed at an approximate height of 1500mm above floor level to facilitate safe access and ease of maintenance by university operational staff. E.g. motor inverter keypads, controller displays, humidifier displays, heat meters etc.

7.3 Actuators

Actuators for all modulating valves and dampers shall have a power supply voltage of 24 volts AC and a control voltage of 0-10 volts DC. Actuators shall be fully open at 10 volts DC and fully closed at zero volts DC. On/off applications may use digital actuators in conjunction with auxiliary switches as appropriate. "Pulsed Pair" actuators shall NOT be used for modulating control.

All actuators shall be capable of manual override with provision of a manual lever for this purpose.

Actuators fitted to valves greater than 25mm which require ~~requiring~~ isolation of the 24-volt power supply for manual override shall have a local isolator installed for this purpose.

Fresh air dampers on full fresh air systems shall have 24-volt AC shut off damper actuators complete with end switches. Each end switch shall energise a dedicated relay in the control panel. One pole of this relay will interlock with the fan starter circuit and another pole will provide a dedicated damper open / closed signal to the BEMS system for software interlocking and graphic indication.

Where the actuator is required to be overridden open in a duct frost condition then a separate 10-volt DC supply unit mounted in the control panel shall supply it.

7.4 Sensors & Thermostats

All sensors and thermostats must be capable of being removed from ductwork/pipework for inspection and maintenance purposes without electrical disconnection, removal of ductwork, pipework or thermal insulation.
All wet system sensors/thermostats must be installed within the appropriate approved manufacturer's pockets.

All sensors and thermostats shall be installed to operate within the design range of the controlled medium and as close to the middle range as practicable. Thermostats must be capable of manual thermal testing within the range of their normal operating environment. All sensors must be suitable for their operating environment, installed in the optimum position for control and calibrated as appropriate.

Where over-boiler high heat sensors are fitted, then these shall be of the manual reset type.

Strap-on type sensors/thermostats are not acceptable.

Thermostats shall be auto reset except on steam or high temperature systems, or on approval of the Control Systems Team.

Duct thermostats should be adjustable without the need to access ductwork hatches or AHU chambers.

7.5 Utility Metering (Please read in conjunction with guide No.5 - Metering of Utilities and Energy)

Water, gas, electricity and heating/cooling meters shall be monitored by a separate Automatic Meter Reading (AMR), Monitoring & Targeting (M&T) system (not normally the BEMS although some may be required in both systems, eg, leak detection, heat/cool stations) located in the Estates Energy Office. However, all metering wiring and final connections on any project shall form part of the Controls Contractor's package. Metering gateways as necessary, shall be supplied, installed and commissioned, and set up on the AMR, as part of the Controls Contractors package. Gateways shall normally be installed adjacent to the main BEMS control panel. The water, gas, heat/cool and electricity meters are to be wired back and final terminations made at the meters and gateway. At the design stage, a schedule of meters will be provided by the design team for each project. The university energy office will confirm exactly which meters should be brought back to the university's gateways and/or BEMS. (Note that not all meters on a project will be connected to these gateways - some meters may be left as manual only reads).

Each metering gateway will require a 230 volt unswitched fused spur (with neon indicator) power supply and a twin data port adjacent. The power supply shall emanate from a distribution board not from the MSCP.

Electrical meters shall be fitted with Modbus interfaces, and pre-wired to outgoing terminals accessed without having to power down the main board. Meters must be selected from the Estates Design Guidelines No. 5 Appendix 1, for both main and sub-meters.

Electrical boards shall be fitted with suitable fuses, shrouds, links and means of isolation so that meters can be replaced without having to power down the board or essential supplies.

Heating/cooling meters shall be Kamstrup 602/603/801 series or approved by the University Energy Office, and be supplied with Modbus and pulsing interfaces suitable for connection to either the BEMS or AMR systems. Meters shall have a permanent power supply with local isolation.

All heating/cooling meters shall be individually commissioned, and a site verification certificate produced with the O&M documentation.

All meters shall be mounted in easily accessible positions, out with hazardous areas, at heights where they can be clearly read without the use of ladders or access equipment.

As a minimum, sufficient metering shall be allowed to incorporate separation of monitoring of individual buildings utility consumption, without the use of inter meter calculations. Where sub-metering is used for analysis of consumption across different zones then each sub-circuit will require a separate meter in addition to the main meter.

8.0 Programming

8.1 General

Programming of the controllers shall be carried out in a consistent, structured manner using existing University standard programs/strategies for: e.g. pump changeovers, compensated slopes, plant rotations, sequencing etc. Global network communications should be kept to a minimum. In particular, global references should not be repeated throughout controller programs when one common global reference will suffice. Plant systems must be grouped within one controller unless prior written approval from the University Controls Systems Team is obtained.

Each controller shall incorporate a software hold-off timer circuit to prevent all digital outputs from switching on simultaneously after a power-off / power-on or fire alarm situation. The hard-wired timer previously described in the Panel Equipment section shall initiate this software timer.

A “dead band” shall be programmed, to allow economical running of plant and prevent continual cycling between heating and cooling for example, whilst still maintaining temperature and humidity control within the desired limits for a given project. Consideration should also be made where a space contains two different systems. E.g. where radiators are fitted together with chilled beams or cooling fan coil units. Radiator TRVs (as detailed within Mechanical Services Guidelines ref No. 3 will have a maximum setting of 22°C whilst any cooling will have a start set point of 24°C minimum.

All control loops requiring set points shall be fully adjustable within fixed sensible engineering limits, in graphical and text format, using standard set points. E.g. all compensated/reset slopes should be fully adjustable without having to access engineering programming levels.

Where control sensors exceed their design ranges, e.g. static pressure surges, temperature overshoots etc., then the software program shall be capable of returning the control loop to a stable condition by returning sensible default values for that specific application. Sensors must not "lock out" control loops due to unrealistic default values.
All Trend knobs must represent the actual value visible to the user in the user pages and user schematics. E.g. when a return pipework second stage frost setting of 10°C is required, then the knob value shall be 10°C and not the midway value of a differential logic block.

~~Schneider Sigma Control Systems: Each UNC 696 controller shall have its own ‘Controller Monitor’ Index Level containing Door Monitor, Mains Monitor and Eeprom Backup points.~~

Any additions or alterations made to the Schneider Sigma system must be replicated in the Schneider EcoStruxure system.

8.2 Time Schedules

~~Trend Control Systems:~~ Time ~~Zones~~ schedules should be kept to a minimum for each building. ~~In general, a Global Time Zone shall be programmed for each main building and subsequent items of plant within that building shall be interlocked to the Global Time Zone 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 Controls Systems Team for each individual project.

~~Schneider Sigma Control Systems: Time Schedules should be kept to a minimum for each building. In general, a Master Time Schedule shall be programmed for each main building and subsequent items of plant within that building shall be interlocked to the Master Time Schedule 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 Controls Systems Team for each individual project.~~

Calendar and Holiday Schedules shall be incorporated and set up as part of the contract to allow all items and groups of plant to be pre-programmed up to one year in advance for conference bookings/ Festival events/exams etc.

~~Trend: Holiday Schedules shall be incorporated for each building or site.~~

~~Schneider Sigma Control Systems: Holiday Schedules shall be programmed for each building or site and placed in their own index segment, one stage below the building name index level. e.g. 0_MLB_HOL_nnn, where nnn = point number.~~

8.3 Frost Protection

Frost Protection shall be divided into two main categories – namely plant which is served via standard boiler systems and plant served by one of the university CHP systems. Both of these categories will have four stage frost protection as follows:

Heating Circuits Supplied from Standard Boiler 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 pumps and heating plant if return boiler immersion temperature sensor, or any other heating pipe sensor, falls below 10°C and switch off again when it reaches 30°C. In this event the heating plant shall be held on for a minimum of 30 minutes to prevent cycling of boilers on shunt loop systems where the return temperature would rise very quickly. All motorised heating zone and AHU control valves shall be driven fully open during this frost period.
- 3rd Stage - This occurs when fabric space temperature drops below 10°C. VT heating circuits will be initiated under boost control to fully open any VT valves. VT circuits should switch off once space temperature reaches 12°C.
- 4th Stage - Bring on the pumps and heating plant if the outside air temperature falls below -10°C and switch the plant off again when the outside air reaches -5°C.

Heating Circuits & AHUs Supplied from CHP Systems:

- 1st Stage - Switch all VT, DHW and CHW pumps on if outside air temperature falls below 3°C and switch off again at 5°C. All AHU heating and reheat valves to be opened to a fixed setting of 20% during this 1st stage frost period.
- 2nd Stage – This occurs when VT water temperature drops below 10°C. VT valves will open to control flow temperature at 30°C. Software timer will be programmed to give a fixed run period set to 30 minutes, adjustable through BEMS. Note that 2nd stage frost can only occur when 1st stage is active.
- 3rd Stage – This occurs when fabric space temperature drops below 10°C. VT heating circuits will be initiated under normal control to achieve calculated flow set point. VT circuits should switch off once space temperature reaches 12°C.
- 4th Stage – On outside air temperature dropping below -10°C, all heating circuits to be initiated under normal control operation and switch the plant off again when the outside air reaches -5°C.

Air Handling Units Supplied from Boilers or CHP Systems:

AHU heating batteries will be protected from frost damage by a hard-wired, automatic reset duct frost thermostat wound across the battery face. This will be set to 3°C and when initiated, will fully open the heater battery valve actuator(s) via a hard-wired, dedicated 10volt DC power supply unit, mounted inside the control panel.

University ~~preference~~ requirement is for AHU cooling coils to be sited after a heating coil, ~~however where this is not the case then consideration must be given to protect the cooling coil e.g.~~ if the frost thermostat is activated 5 times in a day then the AHU shall be disabled for the remainder of the day, unless reset by means of a software switch from the graphics page. A suitable alarm shall be generated and displayed on the BEMS.

On system start up the control strategy shall include measures to prevent AHUs going into a frost condition.

8.4 Optimisation

During optimiser boost periods, all compensated heating valves associated with that optimiser shall be driven fully open until boost termination, after which they will return to normal compensated slope. The only exception to this is where the VT circuit is fed from a CHP system, in which case it will maintain normal compensated slope control during the boost period to prevent sudden surges of demand on the CHP plant.

Optimiser reports shall be programmed to record Run-Up, Occupancy, Run-Down, Fabric Frost and Occupancy Off conditions to allow plant performance to be analysed.

Optimisers shall incorporate Space Fabric Protection during Occupancy Off periods to switch on the heating plant if the space temperature drops below 10°C and then switch off when the temperature reaches 12°C. Please also see Controls Philosophy section for requirements of specific accommodation.

8.5 Domestic Hot Water

In addition to normal controls regimes, the following strategy shall be incorporated for systems supplied from the district heating network:

Once flow is established on both the secondary and transfer pumps, the temperature control loop is enabled and operates as follows:

The control shall utilise the buffer vessel sensor to modulate the control valve to maintain the set point 60°C (user adjustable) providing the primary return temperature is less than 50°C (user adjustable). If the LTHW primary return temperature sensor (from the PHE) rises above 50°C, then the control shall transfer to the primary return temperature sensor, to maintain the primary return at its setpoint until the buffer vessel temperature drops to 5°C below the buffer vessel setpoint.

If the CHP heat station flow temperature is below the buffer vessel temperature then the control valve shall close until the CHP flow temperature rises to 5°C above the buffer vessel temperature.

If the buffer vessel temperature falls below 50°C then the electric immersion heaters shall be enabled by the BEMS and control via their in-built thermostats, set at 60°C. In this instance an alarm shall be generated to the BEMS. This should also appear on any graphics page which displays the DHW buffer vessels. When the buffer vessel temperature reaches 55°C the immersion heaters shall be disabled.

8.6 Naming of Points

Point Labelling, Controller and LAN numbering, IP Addressing and UDP details shall be agreed with the University Controls Systems Team as part of the project.

~~Schneider Sigma Control Systems: Proposals for Mnemonic Structure, controller Node and LAN numbering and IP addressing shall be submitted, along with the proposed programme, for comment by the University's Controls Systems Team prior to starting the project.~~

~~Naming of the points for programming and graphic slides shall be as consistent as possible with each point type identified as in the following chart:~~

~~Point Type~~	~~Examples of Point Title Description~~
~~Command~~	~~Pump No. 1 Cmd Boiler No. 1 Cmd~~
~~Status~~	~~Pump No. 1 On/Off Supply Air Prove~~
~~Analog Input~~	~~Boiler Flow Temp Outside Air Temp/Room xxx Temp~~
~~Analog Output~~	~~Htg Valve O/P AHU Electric Thyristor O/P~~
~~Control Point~~	~~Compensated Control AHU Control~~
~~Set point Adjust~~	~~Compensated Set point Reset Air Set point~~
~~Rotation~~	~~Pump Rotation Boiler Rotation~~
~~Optimiser~~	~~3rd Floor Optimiser~~
~~Time Schedule~~	~~AHU Time schedule~~
~~Holiday Schedule~~	~~Htg Holiday Schedule DHW Holiday Schedule~~

8.7 Compensation Slope

Compensation slopes shall normally be engineered with the following Outside Air and Radiator Flow Temperature settings:

Outside Air Temperature	Flow Temperature
-5°C	80°C
0°C	80°C
20°C	20°C
25°C	20°C

8.8 Heating Economy Hold-Off on Warm Days

Heating circuits shall be disabled if outside air temperature rises above a set value, normally 16°C, for a period of one hour. They shall be enabled again if the outside air temperature drops 1°C below this set point.

The Outside Air Hold-Off set point must be fully adjustable to the user through a set point.

Any optimisers that relate to these disabled heating circuits should have their self-adaption facility inhibited during this period to prevent false adaption slopes being generated.

8.9 Alarms

Alarms shall be set up and agreed with the University Controls Systems Team prior the site/controller being added to the University BEMS System. A schedule of alarm priorities/routing and optimiser event reports shall be submitted for comment to the University Controls Systems Team ten working days prior to final commissioning of the project. Consideration should be given to networked or local displays and BEMS clients.

Controls Contractors must fully check their systems for any spurious alarms at time of commissioning. They must demonstrate to the University Controls Systems Team that there are no unnecessary alarms transmitted to the BEMS front-end servers at the handover stage by means of an Alarm Report for the specific project being commissioned.

Alarms deemed critical by the university on each specific project should be routed via one of the university's alarm transmission systems e.g. E-mail or iStar. Project Managers, Designers and Controls Contractors should therefore discuss alarm monitoring with the University Project Team to establish which alarms require to be added to the relevant system.

8.10 Logging

Logging requirements shall be discussed with the University Controls Systems Team, however as a minimum logging shall be set on every analogue input and output value and set points at an interval of fifteen minutes and available for a minimum of the previous 10 days. Provision shall be made and agreed for the setup of multi-point graphs during the project.

9.0 Retrofits and Additions to Existing Systems

Where retrofit work is carried out in existing control panels and plant rooms, the following shall be closely adhered to in addition to the standard requirements:

9.1 Removal of Redundant Equipment and Software

The Controls Specialist Contractor shall remove all redundant cable, thermostats, sensors, control panel fascia switches and identification labels, panel indicating lamps, relays and relay bases from site. Any holes left in control panel doors shall be covered with permanent traffolyte labels. Adhesive labels are not acceptable. Holes left in trunking or ductwork shall be plugged.

The Controls Specialist Contractor shall decommission all redundant software and graphic slides from the BEMS network once the redundant equipment has been removed. These actions shall be reported and confirmed to the University Controls Systems Team.

9.2 Full Integration Required

All new controls within a given building shall be seamlessly integrated with existing controls at each stage of any phased work.

All new and re-used relays, switches, indicating lamps and command interface labels shall be clearly identified with permanent traffolyte engraved labels. Components shall be kept consistent with the existing installation where possible.

Where an additional interface panel is required to house new relays, transformers and command modules for the additional controls, then it shall be of similar construction to the existing control panel i.e. metal construction with a hinged lockable door, (key numbers Rittal 3524 or Eldon M21323), with a permanent traffolyte engraved identification label attached.

Revised wiring diagrams, flow charts, strategy diagrams, graphic slides, controls descriptions and O&M manuals shall be presented as an indexed suite of separate pdf files to the University Controls Systems Team on practical completion of works. In addition control panels drawings must be placed within the control panel document holder and any locally stored documentation. These requirements are in addition to the provisions made for the O&Ms for the principal contractor. Revision dates shall be clearly indicated on all documents. (See O&M Manual Section)

All retrofit and additions O&M documentation shall be integrated into the existing O&M manuals for any given project.

New graphic slides shall be generated for all amendments unless existing graphics can be modified to incorporate the additional work. Allowance shall be made for full integration with existing plan and plant graphics.

Additions to existing systems shall be engineered to enable full integration with the existing plant e.g.:

- Boiler interlocking for heat demands and Chiller interlocking for cooling demands

- Frost protection requirements to start pumps and boilers and open zone valves and AHU valves
- Interlocking of Time Schedules, Holiday Schedules and Calendar Schedules in existing buildings.

10.0 Active Graphics

Graphic Slides shall be supplied for each project in a consistent, structured two-dimensional format. Slide contents and structure shall be provided for comment to the University Controls Systems Team as detailed in the Preamble Section.

Slides shall be structured in such a way that University Operations staff can be guided through to the chosen building and its individual room temperatures or plant status, using 'Hot Key Buttons' on every slide. Buttons should enable the operator to work forwards and backwards through the slides without having any prior knowledge of the building or its HVAC plant.

The University "Home" slide shall offer a list of each principal building, grouped in Sites. The next layer down shall provide hot keys to individual buildings. Third layer shall start with one initial building "Home" slide listing each main Floor Plan slide on left side of screen and each HVAC Plant slide on right. All slides shall contain the University building reference number.

Each Floor Plan slide shall display location of room sensors, outside air sensors, zone valves and control panels / controllers, with a display of calculated or actual set point, together with the actual temperature sensed. Floor plans shall contain correct room numbers/names. Floor plans should be colour coded with areas highlighted in accordance with plant zoning e.g. AHUs, underfloor heating, VT heating etc. Sensor, valve, control panel positions shall be indicated on the plan.

Several Floor Plans may be displayed on one slide where appropriate. The 'North' point shall be clearly displayed on each slide.

Slides shall also be provided which display the active components of each item of HVAC Plant. Again more than one item of related equipment should be placed on one graphic slide to reduce overall number of slides. The outside air temperature must be displayed on slides where appropriate.

Only live data shall be displayed on the slides. "Previous Values" shall not be displayed on the graphic slide i.e. during the process of the slide being called up, or if the communication link has dropped, then this shall be reflected to the user in place of the dynamic data.

All Digital and Analogue Alarm values and text shall be displayed inside a text box that changes colour to red when in an alarm condition.

Analogue values shall be displayed with no decimal places with the exception of temperatures which should display one decimal place and absolute humidity which should display the appropriate number of decimal places. Temperature values shall be displayed in value°C.

Pump and fan graphic symbols shall change colour according to their condition - grey for an 'Off' condition, green for a 'Run' condition and red for a 'Fault/Trip' condition. Where differential airflow switches are installed, then the status signal from these shall be used to initiate the Green Run condition.

Graphic slide backgrounds shall be white to prevent excessive colour printing.

User buttons shall allow users direct access from the graphic slide to all BEMS functionality taking into account user access levels e.g. Occupancy Times, Set Points, Logged Data Graphs, Alarm History etc.

11.0 O&M Manuals

11.1 General Requirements

Controls Operation & Maintenance (O&M) Manuals shall be submitted in a consistent format to the University Controls Systems Team as an indexed suite of separate .pdf files on practical completion of works. In addition, a separate copy consisting of editable documents shall be included. In addition, control panels drawings must be placed within the control panel document holder. These requirements are in addition to the provisions made for the O&Ms for the principal contractor. Revision dates shall be clearly indicated on all documents.

Two sets of Manuals shall be hardback ring-bound copies. The third copy shall be soft backed, suitable for insertion in the control panel document holder described in the Control Panel section.

Manuals shall be titled with project name, Building Number and date on front cover. Manuals shall be indexed with page numbers and sections clearly identified to assist navigation.

All retrofit and additions O&M documentation shall be integrated into the existing O&M manuals for any given project.

11.2 Manual Sections

- Section 1 - Description of Operation:
  This section shall contain an introductory scope of the project, including the name of the contractors that the Controls Specialist is working to and a description of the project – including any details of interfaces with existing plant (e.g. CHP) or other related buildings which may be affected by the project. It should also include floor plans and a plant summary followed by a general controls narrative with a detailed description of the operation of each item of plant controlled by the BEMS system.

- Section 2 - Controller Data Tables / Controller Connection Drawings:
  Manuals shall contain input/output usage charts for all controller hardware points

- Section 3 - Controller Strategy Drawings / Flow Charts:
  Manuals shall contain all relevant software strategy diagrams for each item of plant controlled. In respect of the Trend systems installation, a software copy of the SET project must be provided and installed onto the University BEMS Server.
- Section 4 - Control Panel Drawings / Wiring Diagrams:
  This section shall contain all wiring diagrams and panel fascia layout drawings associated with the project including details of any revision changes that have taken place. Wiring diagrams shall be presented in a standard, consistent, structured format. They shall contain all wiring core numbers and panel termination numbers. A relay cross-reference chart shall be included in this section to enable relay contacts to be traced. Controller LAN communication wiring diagrams shall be included in this section clearly showing the “break in” connections to existing communications buses and end of line controllers where appropriate.

- Section 5 - Commissioning Details and Controls Settings:
  This section shall contain all commissioning test and record sheets for control panels, fans, pumps, inverters, valve actuators etc. It shall also include settings for all control loops including set points, proportional bands, integral action times, differentials etc. (See appendix No.2 for examples)

- Section 6 - Maintenance Instructions:
  This section shall contain the relevant service schedule and instructions for maintaining all controls equipment to the standard that is required by the equipment supplier.

- Section 7 - Technical Literature:
  This section shall contain only relevant data sheets and instructions for control equipment on the project. Where data sheets have multiple model options, pertinent part numbers shall be identified.

- Section 8 – Handover Documentation:
  This section shall contain copies of all completion/acceptance/handover documentation, duly signed by the Controls Systems Contractor and the University Controls Systems Team, together with a Snagging List of items of works outstanding at time of handover, together with proposal dates for completion.

12.0 APPENDICES

12.1 Appendix No. 1 - Field Equipment List

Item	Range/Spec No	Manufacturer
Screened Cable LSZH 2-Core Twisted Pair - Blue outer sheath	A7DG2-P002L (2 x 0.75mm²)	Anixter UK Ltd. Uxbridge, Middlesex, UB8 2AD or BATT Cables equivalent
Screened Cable LSZH 4-Core 2x Twisted Pair - Blue outer sheath	A7DG2-P005L (5 x 0.75mm²)	Anixter UK Ltd. Uxbridge, Middlesex, UB8 2AD or BATT Cables equivalent
Indoor/Outdoor 600V Control Cable 22AWG Single Pair	7/0.25mm Stranded Tinned Annealed Copper Conductor Extruded PE Insulation (Polyethylene) 2 Cores Paired Up and Taped with Aluminium/Polyester Screen in contact with Tinned Copper Drain Wire Core Identification Black/White Matt PU (Polyurethane) Outer Sheath Colour: Grey/Matt	Leigh Cables, Unit 5, Brook Mill, High Street, Leigh, Lancashire, United Kingdom, WN7 2AD T +44 (0) 1942 605505 | E sales@leighcables.com | W www.leighcables.com
Motor Inverter Controllers	VLT FC 102 Range	Danfoss Limited Capswood, Bucks, UB9 4LH
Microwave Presence Detectors	Lightspot Mid & Long Range	Ex-Or Ltd. Haydock, Merseyside, WA11 9UJ
CO^2 Sensors - Duct & Room	GMD/GMW Range	Vaisala UK Ltd. Fluidic Ltd., Motherwell, ML1 1YE (Local Supplier)
Air Pressure/Flow Transmitters	Micaflex MF-P/MF-FD Range	Micatrone Fluidic Ltd., Motherwell, ML1 1YE (Local Supplier)
Panel Document Holder	RS 500-308 (or equivalent)	RS Components
Panel Fascia LED Lamps	~~TMU with LED7 cluster (4.5V)~~?? ND16-22DS or RADT22XX	~~Tranilamp Ltd.~~ Chint or Europa Components

Alternatives to the above list of preferred equipment may be acceptable if approved by the University Controls Systems Team *prior* to commencement of the contract.

12.2 Appendix No. 2 - BEMS Points Schedule Example

To be completed for specific projects as applicable

THE UNIVERSITY of EDINBURGH

Project Title:	**Client:**
Panel Reference:	**Client panel location:**
Engineer:	**Quotation Reference:**
System:	Air Handling Unit

Field Equipment Description	AI	AO	DI	DO	Lamp	Switch	kW	Phases	Power	Comments
AHU Supply fan enable										
AHU Supply fan status										
AHU Electric frost battery stage 1 enable										
AHU Electric frost battery stage 2 enable										
AHU frost stat										

12.3 Appendix No. 3 - BEMS Commissioning Schedule Example

To be completed for specific projects as applicable

THE UNIVERSITY of EDINBURGH

Project:	**Project Reference:**	**Date:**
Project Location:	**Control Panel Ref:**	**Engineer:**

Plant Equipment Items

	Description	MCB Rating & Type	Rated F.L.C	Overload/Device Settings	Comments	Checked By/Date
1.	AHU 1 Supply Fan	32A	30A	30A	Inverter	John Smith, 8/3/18
2.	AHU 1 Frost Thermostat			3°C		John Smith, 8/3/18
3.	AHU 1 Supply Fan DP switch			50 Pa		John Smith, 8/3/18
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						

12.						
13.						
14.						

Comments :

Time Schedules and Set Points

	Description	Time Schedule Settings	Set Points	Checked By/Date
1.	AHU 1	Mon-Fri 0700-1800	Supply air temp SPA – 18°C	John Smith, 8/3/18
2.	AHU 1	Mon-Fri 0700-1800	Supply air pressure SPA – 200 Pa	John Smith, 8/3/18
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
Comments :				

BEMS Controls (Sensors, Control Valves and Actuators)							
Description & Location		**BEMS Point Reference**	**Equipment Functioning and Installed as per Manufacturers Guidelines**	**Sensor Calibration Checked**	**Actuator Stroke Checked**	**Comments**	**Checked By/Date**
1.	AHU 1 Supply Air temp sensor	OSN 1/A1	Yes	Yes	N/A		John Smith, 8/3/18
2.	AHU 1 Fresh Air Damper	OSN1/DO1	Yes		Yes	End switch OK	John Smith, 8/3/18
3.	AHU 1 Heating valve	OSN1/AO1	Yes		Yes	Access to the valve is restricted	John Smith, 8/3/18
4.							
5.							
6.							
7.							
8.							
9.							
10.							
Comments :							

12.4 Appendix No. 4 - BEMS Handover Check List

The issue of the Practical Completion Certificate will be in accordance with the Conditions of Contract and the decision of the Project Manager.

	Check List	Yes	No
1.	Have the Control Panel(s) been factory tested and commissioned by the Controls Specialist for the Project and have the Test Certificate(s) been issued?		
2.	Has the BEMS Installation Completion Certificate been signed off by the Controls Specialist?		
3.	Has the BEMS system Commissioning Certificate been signed off by the BEMS Commissioning Engineer– Controls Specialist?		
4.	Has the BEMS system been demonstrated to the satisfaction of the designer/ consultant?		
5.	Has the BEMS system been demonstrated to the satisfaction of the University Controls Systems Team?		
6.	Have all the snagging list items been addressed, completed and signed off ready for inspection by University Controls Systems Team?		
7.	Has the Controls Specialist BEMS Acceptance Certificate, been signed off by the Controls Systems Team (on behalf UoE) and notified to the University Project Manager?		
8.	Have the BEMS Strategy drawings/ SET project and system description been provided to the University Controls Systems Team?		
9.	Have BEMS commissioning certificates been provided to the University Controls Systems Team, specifically for specialist BEMS equipment with separate or extended warranties?		
10.	Have the BEMS Operation and Maintenance Manuals as detailed in section 11 been provided as per client requirements and do they contain all required information and are arrangements in place to revise “as built” drawings/ documents?		
11.	Has the final connection and integration to the University BEMS system been completed and demonstrated to the University Controls Systems Team?		
12.	At Practical Completion, has the outstanding works list been fully recorded with timescales for remediation and actions for completion?		
Signed: University Controls Systems Team:			
Signed: University Project Manager:			

12.5 Appendix No. 5 - Compulsory Standard Risk Assessment for Live Testing & Diagnostics on University Premises

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STANDARD RISK ASSESSMENT FOR LIVE TESTING & DIAGNOSTICS – January 2019 –V1

Risk Assessment Serial Number :

(Complete precisely and legibly in BLOCK CAPITALS)

PART 1 –To be completed by the Project Manager or Contract Supervisor / Engineer

Hazards
Every effort must be made to identify electrical faults with the **supply isolated**. However, it is acknowledged in certain circumstances it will be necessary to carry out fault finding and diagnostics on low voltage circuits up to 415 Volts with the supply" live". This may require using the defeatable function of a panel isolator or switching the panel isolator to "on" when the panel is open. In this event the following hazard has been identified :- **Electric Shock** (from control circuit or from adjacent live circuits up to 415 volts) With consequential risks : • Death • Cardiac arrest • Eye injury (from an electric arc) • Burn injury • Injury to third parties • Trauma injury Note: Under no circumstances will the manipulation of a "live" conductor be allowed, such work, if found necessary, will need to be carried out by competent electrical persons and an additional risk assessment will be required.

Control Measures for work on or near live conductors (including fault finding and diagnostics)	
Control	**Details**
PPE:	1. Close fitting clothing (not containing man-made fibres)as appropriate to the work. 2. Rubber soled shoes or boots as appropriate to the work. 3. Non-conductive gloves as appropriate to the work. 4. Conductive floors, rubber mats are mandatory (to BS 921: 1976). 5. Safety glasses for eye protection as appropriate to the work. 6. Jewellery should not be exposed.
Equipment:	1. General hand tools (insulated). 2. Padlock (for lock-off of isolator). 3. Electrical test equipment - insulated, fused and within date for calibration (to SG.011 requirements) suitable for live testing and tested regularly with results available. 4. Warning notices as appropriate to the work area. 5. A suitable means of cordoning-off the work area, as appropriate to the work area.

STANDARD RISK ASSESSMENT FOR LIVE TESTING & DIAGNOSTICS – January 2019 –V1

Risk Assessment Serial Number:

(Complete precisely and legibly in BLOCK CAPITALS)

PART 1 –To be completed by the Project Manager or Contract Supervisor / Engineer

Control Measures – Continued	
Control	**Details**
Information, Instruction and Training:	1. Competency must be authorised by your line manager and Authorising Engineer. 2. Post safety hazard signs adjacent to isolators and fit "lock off" device to warn other personnel that electrical circuits are being worked on. 3. Visual inspection within a control panel before fault finding for potential hazards. 4. When “live” testing ensure that an up to date wiring diagram is used if available and followed. 5. Test for "live" with a suitable and **proven test instrument**. 6. Be familiar with all safety and operating controls. 7. Work by a process of elimination during testing, whether “live” or “dead”. 8. Faults Identified within a live control circuit will be **repaired with the supply isolated** and **tested for dead**. 9. Isolate or discharge power- factor correction capacitors / inverters etc. before primary circuit work. 10. Follow the UoE "live fault finding/testing" or "electrical isolation" method statements (attached) as appropriate.
Fault finding and diagnostic and resources:	1. For “live” working (manipulation of live insulated conductors), this work is required to be carried out by competent person with a Risk Assessment. 2. Accompaniment is required during live testing; if the person carrying out the work is unable without assistance, keep other persons from the work area.
Environment:	1. Do not work with or carry out electrical repairs in wet or very damp conditions. 2. Ensure that adequate task lighting is provided. 3. Ensure that there is adequate clear space for access into control panels. (1m is the minimum) and that the floor is kept clear of trip hazards.
Procedures, documents, etc.:	1. Adhere to any site instructions and permit-to-work procedures. 2. The Electricity at Work Regulations 1989 apply. 3. A method statement may be required for non-routine operations. 4. Beware when isolating electrical circuits that circuits providing a safety function are not isolated e.g. controllers, gas safety systems etc.
Communications:	1. Inform site management and others in the area of work that electrical work is being undertaken, as required. 2. Inform the responsible person or work colleague when isolating panels as this may mean that safety circuits are being isolated e.g. Alternative means of monitoring and raising an alarm must be agreed. 3. When lone working - ensure that someone knows where you are and how long you will be there preferably carry mobile phone, agree call back and set call back time alarm.

STANDARD RISK ASSESSMENT FOR LIVE TESTING & DIAGNOSTICS – January 2019 –V1

Risk Assessment Serial Number :

(Complete precisely and legibly in BLOCK CAPITALS)

PART 1 –To be completed by the Project Manager or Contract Supervisor / Engineer

Emergency action/procedures:	1. Switch off and isolate supply, it is important that points of isolation must be identified prior to commencement of work. 2. Remove injured person(s) from danger area (if without risk). 3. Render first aid (if able). 4. Call emergency services.
Access:	1. Access to the work area will be controlled by signage, or barriers or a second person. 2. Emergency exits to be identified and checked free from obstruction prior to commencement of work.

General Safety Notes - Before undertaking "Live" Testing, the following should be considered:

- Can the outcome be achieved by another test method?
- Can the test be done with the circuits "dead"?
- Can the voltage be reduced for the test activity?

Never work on live equipment other than for testing and diagnostics
If in doubt, stop and ask!

Risk Evaluation of Identified Hazards			
Likelihood	Highly unlikely = 1	Unlikely = 2	Likely = 3
Severity	Slightly harmful = 1	Harmful = 2	Extremely harmful = 3

Risk level: Example below
(Likelihood x Severity = Risk level)
1 = Trivial, 2 = Tolerable, 3 – 4 = Moderate, 6 = Substantial, 9 = Intolerable

Identified Hazards (base scores on existing or planned control measures)		Trivial	Tolerable	Moderate	Substantial	Intolerable
1. Electric shock (from the control circuit or from adjacent live circuits)	1x3			3		
2. Eye injury (from an electric arc)	1x2		2			
3. Burn Injury	1x2		2			

4. Cardiac Arrest	1x3			3		
5. Injury to a third party	1x2		2			

Tolerable	Standard methods of work undertaken by competent person, supplemented by this standard risk assessment.
Moderate	Thought must be given to reducing risk by control measures.
Substantial	Work **must** not be started until the risk has been reduced, for work in progress, urgent action is required. Considerable resources may have to be requested and allocated

STANDARD RISK ASSESSMENT FOR LIVE TESTING & DIAGNOSTICS – January 2019 –V1

Risk Assessment Serial Number :

(Complete precisely and legibly in BLOCK CAPITALS)

PART 1 –To be completed by the Project Manager or Contract Supervisor / Engineer

Risk Evaluation of Identified Hazards - Continued		
Intolerable	If unlimited resources cannot reduce risk, work will need to be prohibited or shall not proceed.	
Is the risk adequately controlled using the above control measures? (delete as appropriate)	YES/ NO	If "NO" State further action required
State further action required:		

Note: This risk assessment is only valid when all control measures are in place before the work or activity commences and will be reviewed January 2019 or earlier if the nature of the work changes or there is a dangerous occurrence.

Assessor:	Heather Fleming (SAP)	(Sign)	Date: Jan 2019
	Martin Crawford	(Sign)	

STANDARD RISK ASSESSMENT FOR LIVE TESTING & DIAGNOSTICS – January 2019 –V1

Risk Assessment Serial Number :

(Complete precisely and legibly in BLOCK CAPITALS)

PART 1 –To be completed by the Project Manager or Contract Supervisor / Engineer

Method Statement
For Live Fault Finding/Testing / Diagnostics of
Circuits up to 415 volts

1. Before starting work ensure that the appropriate PPE is available and used.

2. Before starting work ensure that the following equipment is available:

    - Electrical test equipment which is insulated, fused and within date of calibration
    - Warning notices
    - Suitable means of cordoning off the area as appropriate to the work
    - Suitable hand tools in good condition and insulated
    - Electrically insulating rubber matting as appropriate to the work

3. Inform the responsible person or colleague that electrical testing/fault finding will be taking place.

4. Comply with any site rules and permits to work.

5. Check that isolation of supply will not initiate an alarm and undertake inhibit action as required.

6. Check that isolation does not interfere with safety circuits or cause "danger" to others.

7. Place rubber mat on the floor in front of the equipment to be worked on, as appropriate to the work.

8. Ensure that adequate lighting and emergency lighting is available.

9. Ensure that you have a clear area to work in (a minimum of 1m is required).

10. Place warning notices and barriers as appropriate to the work.

11. Report back to responsible person or work colleague when work has been completed.

STANDARD RISK ASSESSMENT FOR LIVE TESTING & DIAGNOSTICS – January 2019 –V1

Risk Assessment Serial Number :

(Complete precisely and legibly in BLOCK CAPITALS)

PART 1 –To be completed by the Project Manager or Contract Supervisor / Engineer

Method Statement
For Electrical Isolation up to 415 volts

1. Before starting work ensure that the appropriate PPE is available and used.

2. Before starting work ensure that you have the following equipment:
    - Electrical test equipment which is insulated, fused and within date of calibration.
    - Padlock
    - Warning notices,
    - Suitable hand tools in good condition

3. Inform the responsible person or colleague that an electrical isolation will be taking place.

4. Comply with any site rules and permits to work.

5. Check that isolation of supply will not initiate an alarm and undertake inhibit action as required.

6. Check that isolation does not interfere with safety circuits or cause "danger" to others.

For mechanical work, follow steps 6 and 10 to 14.

7. Isolate the supply by switching off the isolator and "lock off" with the padlock. Suitably label the isolator complete with name and mobile telephone number. If the removal of fuse links is the only available safe method of isolation, then you must ensure that the fuse links stay in your possession until the work is complete.

For electrical work, e.g. replacement of electrical control components follow steps 7 to 14.

8. Isolate the supply by switching off the isolator or removing fuse links (MCB's).

9. Check using a single-purpose mains tester that the equipment has been disconnected properly by testing for "dead". (Proof test your test instrument on a known "live" immediately before and after testing for "dead").

10. "Lock off" if possible and suitably label.

11. When work is complete, ensure that any shields, protection guards or fuse links removed are replaced. Close and lock panel doors.

12. When work is complete, check all items isolated are operating. Remove padlock, warning notices and barriers.

13. Ensure work area is clear of any obsolete equipment, fuses, etc.

14. Complete permit to work if required.

15. Report back to responsible person or work colleague when work has been completed.

THE UNIVERSITY of EDINBURGH
Estates Department

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