Building Energy Management Systems (BEMS) - Engineering Specifications

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1.0 Introduction

This document indicates the University's generic Building Energy Management Systems (BEMS) specification.

These Specifications must be used by Mechanical & Electrical Consultants / Supervising Engineers, and by University staff when specifying controls on either new build or retrofit installations.

Users of this specification must also refer to any additional project specifications identified by a University Project team in furtherance of unique needs and regulatory compliance appertaining to the respective building.

Any new or retrofit design must have the capability to integrate with the University's existing BEMS systems (see 1.4).

Consultants and or designers must obtain approval in writing for any variation from these specifications.

Before incorporating these specifications in tender documentation etc, always check to ensure that the current approved Issue is used.

Please consult with ESS Sustainability Team to discuss any point for clarification or possible improvement - and to obtain further copies of this specification.

1.1 General

This document outlines Newcastle University's general Building Management Systems (BMS) Client Requirements. Design consultants should also refer to room data sheets, specific project client requirements, the project brief and any other information provided by the University.

Any new or significant system alterations must fully integrate with the University's new standard BMS systems (Schneider Struxureware and Siemens Desigo CC) and existing legacy systems i.e. Schneider Sigma and Siemens Insight CC.

Design Engineers shall consult with the university Estate Support Service (ESS) and project specific mechanical engineer on all schemes involving automatic controls. Scheme proposals shall be developed during the design development process and agreed prior to tender stage.

Reference is made throughout to the nominated Field Equipment List – see Appendix A.

The design consultant shall seek confirmation from the university Estate Support Service (ESS) and project specific mechanical engineer at the project inception stage that the BMS client requirements are the most current version.

Where particular guidance is not provided or the information provided is not considered explicit enough, further advice shall be sought from the university Estate Support Service (ESS) and project specific mechanical engineer.

Building Management Systems (BMS) controls packages shall only be installed by a controls specialist contractor.

The BMS software programming shall be written by the controls system specialist

Contractor to the requirements of the appointed engineering design consultant with reference to this document.

The BMS software configuration, programming and commissioning of the systems shall be carried out by the approved systems house, controls system specialist.

1.2 Contract Programme

Newcastle University requires timely opportunity to comment on BMS System proposals at each key stage of the Design Development process.

The Engineering Design Consultant will be responsible for submitting design proposals to the university Estate Support Service (ESS) and project specific mechanical engineer for comment allowing adequate time (10 days) to assess the design proposals, give feedback and for any suggested design and/or specification changes to be incorporated without impacting on the project programme.

RIBA Stage 2 – Concept

Line diagrams and layouts indicating basic proposals, location of main items of plant, routes of main pipes, air ducts and electrical distribution in such detail as to illustrate the incorporation of the engineering services within the project as a whole and with respect to any zoning.

Line diagrams indicating main items of plant and their interrelationships in such detail as to illustrate the incorporation of engineering services within the project as a whole.

RIBA stage 3 – Detailed Design

Draft Narrative on Mechanical Installation, description of operation and control philosophy.

Developed Mechanical Layout drawings & Equipment List.

Developed systems schematic layout drawings.

Draft BMS Points List and Control Equipment List.

RIBA stage 4 – Technical Design

Narrative on Mechanical Installation, description of operation and control philosophy.

Mechanical Layout drawings & Equipment List.

BMS Points List and Control Equipment List.

The Design Team Consultants shall provide copies of all documents to the University Estate Support Service (ESS) and project specific mechanical engineer 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 Estate Support Service (ESS) and project specific mechanical engineer.

The controls specialist contractor shall submit to the M&E Consultant and to the university Estate Support Service (ESS), (with a copy to the project specific

mechanical engineer) a components list of all equipment required for the project and a programme for the following:

Wiring Diagrams and Control Panel Internal and Fascia Layouts

Plant Schematic Layouts with Control Equipment Locations

The Specialist Controls Contractor and Design Consultant shall give the university Estate Support Service (ESS) and project specific mechanical engineer a minimum of ten working days' notice of the following key stages:

Pre Commissioning Review – at completion of mechanical system commissioning and prior to BMS commissioning provide the university Estate Support Service (ESS) and project specific mechanical engineer a commissioning cause and effect testing method statement for comment, also proposals for:

- Graphics Pages
- Software
- Alarm Priorities
- Alarm Routing
- Logging for the Supervisory PC

Commissioned System Check - A witnessed cause and effect functionality test of all points shall be carried out and documented. The system shall be presented to the university Estate Support Service (ESS) and project specific mechanical engineer only after seven days of logged performance which meets the design specification. This check shall include all software, completed Graphics Pages, Logging, Alarms, and control installation.

Commissioning report – The specialist controls contractor shall undertake a full system commissioning exercise with reference to BSRIA AG 9/2001. Any

commissioning anomalies, defects or deficiencies shall be corrected before a re-commissioning exercise is carried out. On completion of a satisfactory system commissioning exercise, the specialist controls contractor shall submit a fully detailed commissioning report to the principal/main contractor, mechanical sub-contractor and design consultant for validation/verification. Only when the system is considered to be commissioned and operating satisfactory shall it be offered to the University. A copy of the system's fully detailed commissioning report shall be submitted to the university Estate Support Service (ESS) and project specific mechanical engineer including and identifying any systems that have not been commissioned.

Official Handover of –

- 'As Fitted' O&M Manuals and installation of completed software
- System methodology
- Log configuration
- Alarm routing and graphics on to the server.
- As fitted Drawings indicating all field equipment.

1.3 Designers' and Contractors' Responsibilities

These Client Requirements have been prepared to outline the University's general requirements, further details should be provided as part of the project specific client requirements. Where particular guidance is not provided or the information provided is not considered explicit enough, further advice shall be sought from the university Estate Support Service (ESS) and project specific mechanical engineer.

It shall be the responsibility of the design team to identify any potential and/or actual conflict or discrepancy between the project scheme proposals, any existing plant arrangement and mode of operation. The design engineer shall ensure that the scheme proposals offers the University the most optimal integrated design solution which is robust, effective and energy efficient in operation.

The Engineering services design consultant shall arrange design review meetings as necessary with the university Estate Support Service (ESS) and project specific mechanical engineer to ensure that the design development is consistent with the

design brief, client requirements and the proposed design solutions are in-line with the University's overarching building engineering services and BMS strategies.

The BMS/automatic controls element of the design shall not be developed beyond each RIBA stage until it has been issued to the university Estate Support Service (ESS) and project specific mechanical engineer for review/comment and received sign-off.

The Engineering Design Consultant shall arrange for review meetings at each relevant stage of RIBA plan of work.

The Engineering Design Consultant will be responsible for arranging these meetings at the appropriate stage, allowing adequate time for the university Estate Support Service (ESS) and project specific mechanical engineer to assess the design proposals, and give feedback for any suggested design and/or specification changes to be incorporated without impacting on the project programme.

It is the responsibility of the principal contractor in conjunction with design team to ensure that adequate time is allowed in the overall project programme for full and concise commissioning of the BMS controls system. In the event of project time pressure/constraints the necessary commissioning period for the BMS/automatic controls should not be compromised.

The handover of the system will not be accepted without the full and detailed commissioning report from the specialist controls contractor which is accepted by the university Estate Support Service (ESS) and project specific mechanical engineer.

The handover of the system will not be accepted without the upload of the project programme files, software and graphics onto all BMS servers and front ends.

1.4 Approved Controls Systems and Specialist Contractors

The university will require the following BMS systems in new developments, which do not have significant integration issues to legacy systems, to be of the following types and manufacturers.

- Siemens Desigo CC (PX range of controllers and IO modules)

All new controllers from the above manufacturer are to be fully Ethernet, BACnet, BACnet IP and Modbus communication enabled to allow integrated communications between all systems and other integrated devices/systems.

These BMS Client Requirements are generic and advice should be sought from the university Estate Support Service (ESS) and project specific mechanical engineer on the most appropriate system.

The Automatic Controls system shall be designed, installed and commissioned by a Siemens Expert Partner.

Where there is an existing control system to be modified, the new installation shall be designed around the Desigo CC or Desigo Insight PX systems, a Siemens Expert Partner shall carry out the design, programming, installation and commissioning of the control system.

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

2.0 Controls Philosophy

2.1 General

The BMS control philosophy shall provide good control of the building engineering services it is connected to in order to maintain the desired levels of service, comfort and safety in an energy efficient manner.

The design consultant shall provide detailed system design information, system methodology and integration as part of the design development process which will provide sufficient information for the specialist controls contractor to develop a detailed work specification and description of operation. The Description of Operation shall be submitted to the University Estate Support Service (ESS) and project specific mechanical engineer for review/comment.

The diversity of the University buildings and the different/specific requirements of end users, make it impossible to generalise on the required approach for controlling specific items of plant, systems and environment. Reference should be made to the

project brief, client requirements and room data sheets. The BSRIA library of controls strategies provides the overarching system control methodologies – consult with the university Estate Support Service (ESS) and project specific mechanical engineer as necessary. If in doubt Ask!

2.2 Offices and Standard Teaching Areas with Natural Ventilation

Standard occupancy time for these areas is 08:00 to 17:00 hours Monday to Friday.

Plant shall be initiated to give a desired room temperature of 19-21°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 19-21°C. "Optimum Off" temperature shall be the same as occupancy temperature.

Where multiple offices are serviced via a VT wet system then one temperature sensor per 4 offices should be fitted, where large offices are serviced with more than 20 people then 2 sensors should be fitted and an averaging reading must be used for the actual temperature

2.3 Lecture Theatres and Seminar Rooms with Mechanical Vent & Radiators

Occupancy times for these areas are normally 08:00 to 17:00 hours Monday to Friday.

Plant start up:

The lecture theatre plant will start via an optimised time clock which will be configured with maximum search period of 2 hours. The plant will start up in

‘background mode’ and remain in this condition until further occupancy status is achieved.

Holiday (summer / winter switch) override:

Should the holiday override be activated then the lecture theatre plant will be shut down but remain under frost protection control. Summer winter switches should be available for all appropriate graphics.

Frost protection:

The frost protection will be activated permanently.

At any time should the room temperature fall below the internal frost protection set point then the plant will start in the background condition.

At any time should the outside air temperature fall below the outside frost protection set point then the plant will start in the background condition.

Operating / background condition selection:

Lecture theatre plant will run in background condition unless one of the PIR detectors within the lecture theatre is activated. Once a PIR is activated the lecture theatre will run in the operating condition for a minimum time of 30 minutes. All Lecture Theatres / Teaching Rooms should be PIR controlled.

The BMS graphics will show the current live state of the PIR and also the ‘latched’ state as used by the control programme. Where there are multiple PIR’s within a lecture theatre the common ‘latched’ state will be displayed on the graphic.

PIR override:

PIR override facility will be available via the BMS graphics to allow the plant to be set in occupancy mode should the PIR control fail.

Background condition parameters:

In background conditions the following plant control will be active:

- Fan speed background
- Background temperature set point control

Temperature will be achieved by modulating the AHU heating control valve and enabling any supplementary heating (convector, trench, radiant panel or radiator).

Occupancy condition parameters:

In operating conditions the following plant control will be active:

- Fan speed occupied
- Occupancy temperature set point control

Temperature will be achieved by modulating the AHU heating control valve and enabling any supplementary heating (convector, trench, radiant panel or radiator). Should the room temperature set point be exceeded then the cooling valve or DX cooling will be enabled. Heating and cooling functions will be controlled via 'cascade control' and will not be active together.

Heat demand:

Heat demand from the lecture theatre AHU to the boiler plant will be activated when the heating software PID control exceeds 5% demand.

Pre heat valve control:

The pre heat or 'frost' valve will be controller via the preheat set point and will work independently of the lecture theatre temperature set point.

Supply air low limit control:

Supply air low limit set point will be the minimum allowable air temperature which can be supplied to the lecture theatre whilst in the occupied condition. Supply air low limit control can only be implemented if a supply air sensor is fitted to the lecture theatre AHU.

Outside temperature high limit:

Should the outside air temperature exceed the outside air high limit set point then the AHU heating valve and supplementary heating will be disabled.

Air quality control:

Plant shall be initiated to give a desired room air quality set point of 1200ppm/CO2 during occupancy time.

Where lecture theatres are fitted with air quality sensors the fan speed will be increased to a speed set point in excess of the occupied set point.

Fans will remain at this speed for a further 30 minutes after the air quality set point has been achieved.

In some applications where there is air quality control and no installed PIR's then the air quality set point will facilitate the change from background to operating mode.

Pressure control:

Where lecture theatres are fitted with pressure sensors the background / occupancy fan speed set points will be matched to a pressure set point.

Temperature sensor selection:

Temperature control will be measured via the available temperature detectors that are connected to the BMS outstation. The most appropriate sensor for temperature control will be selected in the following priority based on the methods of heating available –

- Where non-mechanical supplementary heating is available (i.e. radiators) - Extract air temperature sensor
- Where mechanical heating is the only available method Room temperature sensor (average if more than one installed)

Recommended set points:

Where software re programming is carried out the set points will be retained. Should set points be considered incorrectly set then the following settings will be entered:

- Pre heat control valve – 12'C
- Supply air low limit – 18'C
- Occupied temperature - 21'C
- Background temperature – 18'C
- Internal frost – 12'C
- Outside frost - 5'C
- Outside high limit – 18'C
- Air quality limit -1200ppm

- Fan speed air quality exceeded – 45/50Hz
- Fan speed occupied – 40Hz
- Fan speed background – 20Hz

2.4 Research Facilities

Some of these areas are 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 specifications change.

Individual temperature and humidity specifications will vary depending on the type of establishment and should therefore be set only after consultation with the University Project Leader. Generally speaking, room temperatures are normally controlled at 21°C +/- 2°C. Humidity control (if required) 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 made within the control system for a common alarm signal to be generated to a remote monitoring facility. This shall be either a volt free pair of contacts at the control panel terminal rail or a dial out facility via SMS calls to mobile phones. The exact method of remote alarm monitoring used may differ for each project and so guidance should be sought from the ESS Sustainability and Maintenance Teams before engineering this facility.

Stock Holding Room temperature alarm conditions are normally set to – High Temp Alarm 25°C, Low Temp Alarm 16°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 BMS 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 specifications 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 server BEMS PC and be accessible to end users through Client PCs or local servers.

Introduction:

This specification is applicable to the installation of new and retrofitted controls systems to laboratory supply and extract air systems including where fume Cupboards are installed.

General Laboratory ventilation systems shall be designed to operate on variable volume control. Actual design will vary where systems incorporate a dilution bar however the following principles shall be followed:

Where possible consideration shall be given to full system shutdown outside normal working hours. Generally this is not achievable due to storage of chemical within the fume cupboards. Where full system shutdown is not possible the system extract volume shall be reduced as low as possible, however consideration shall be given to maintaining safe operation of the system and its component parts.

System Control:

The system shall utilise inverter technology on all supply and extract fan motors. Generally this shall be via pressure transducers installed in the ductwork controlling fan speed to a fixed static pressure. Supply air to each lab shall be controlled via a modulating supply damper. Where room / lab construction allows, the supply air damper shall be controlled via differential room pressure between lab / corridor to maintain a – VE pressure. Where differential pressure cannot be successfully implemented due to air leakage between both lab and corridor the supply air to each lab shall be controlled via measurement of the extract air volume, to also ensure desired replacement of air. Measurement and supply damper modulation shall be either BMS integration / software or individual room controllers such as provided by CMR Controls. If the latter is utilised the controller shall connect to the BMS via a

compatible network protocol interface. Consideration shall be given to maintaining the lab at a – VE pressure via a % adjustment of supply / extract air volumes with BMS / room controller software.

Extract:

Each fume cupboard / extract hood shall, unless significantly non-feasible, be independently controlled. This shall be achieved by either fume cupboard standard incorporated control panel or via external mounted ancillary panel either controlling the extract fan direct or a shut off damper. Where user interaction is required to turn off each fume cupboard, subject to assessment of end user cooperation, the external mounted ancillary panel shall be utilised.

The External mounted ancillary panel should have a rotating lockable selector switch for the following functions; Auto, Override and Off, with corresponding Green, Amber & Red lights respectively. The panel shall be controlled via the relevant BMS system for the building.

Auto function should control the relevant fume cupboard, fan or damper etc. by a single press of an illuminated green button. Within the BMS software an agreed time schedule shall be programmed (default 08:00 – 18:00 hrs) to `enable` the push button within the designated time schedule. The green push button should immediately illuminate indicating to the user the system is on. A second press of the button shall turn off the green button illumination and relevant fume cupboard, fan or damper etc. Where slow response controls are utilised the red `off` lamp shall remain illuminated until the system / air flow is in full operation.

The override function shall allow full permanent operation of the relevant fume cupboard, fan or damper etc. and ignore the time schedule. During override function an automated notification shall be generated and sent via email to the `responsible person/s` for the department / Lab at the end of each time schedule.

The off function shall turn the relevant fume cupboard, fan or damper etc. off permanently.

Note: Where an external mounted ancillary panel is incorporated to control the extract from an existing fume cupboard, consideration shall be given to the safe operation / notification of users that the fume cupboard is of non-permanent

operation. Each fume cupboard shall have fitted in a prominent visible position an illuminated indication panel with green, amber and red lights indicating current operational status. A prominent sign also indicating that the fume cupboard is of non-permanent operation should be displayed.

Following shutdown of extract air the cupboard shall be allowed to enter into alarm mode and the audible alarm shall be allow to sound for 30 seconds to warn users the air supply is off. Following this elapsed period of time the fume cupboard power shall be turned off via the control system.

Time Control:

All boilers should work on demand only, not timeclocks

Timeclocks should be on associated VT zones, AHU's, or other plant red from the boiler (see 2.8 Demand Control)

Full day shall be selectable from the graphics panel and this would normally be set at 8.00 to 17.00, typically during the winter period

Half day shall be selectable from the graphics panel and this would normally be set at 8.00 to 12.00, this would be applied typically to VT circuits where heat was required early in the morning until the building was occupied and operational, i.e. spring and autumn periods

2.5 Offices and Standard Teaching Areas with Natural Ventilation

Standard occupancy time for these areas is 08:00 to 17:00 hours Monday to Friday.

Plant shall be initiated to give a desired room temperature of 19-21°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 19-21°C. “Optimum Off” temperature shall be the same as occupancy temperature. Where multiple offices are serviced via a VT wet system then one temperature sensor per 4 offices should be fitted, where large offices are serviced with more than 20 people then 2 sensors should be fitted and an averaging reading must be used for the actual temperature

2.6 Winter-Summer- Holiday Control

Winter setting allows all heating and ventilation systems to operate as normal. Both VT and CT demands active. Internal / external frost protection active.

Summer setting shuts down the VT pumps. Demand from AHU's active and acting on boilers. CT pump / boilers on if there is demand from one or more AHU, Boilers & CT pump(s) off if no demands.

Holiday setting shuts down all H&V and A/C systems. Internal / external frost protection active.

2.7 Alarms

Critical alarms are to be set up to typically signal the following criteria, Boiler Lock out, VT and CT Pump Start Failure, Gas Valve Tripped, AHU Start Failure, Fire Circuit Tripped,

Advisory alarms are typically, AHU Filter dirty, Change of state etc.

2.8 Demand Control

Relevant demands which act on boilers should be shown on the boiler/cooling plant graphic (e.g. VT Zone 1. Htg. Demand On/Off, 1st Floor AHU Demand On/Off etc.).

In some instances these demands will be from a number of buildings - all demands should be shown.

The ability to manually enable demand should be available through a tick box.

Winter Demand Hierarchy is as follows:

1. Frost (See 5.2.5)

2. AHU Demand

Outside Air Temperature High Limit

Room Temperature set point

Timeclock

3. V.T Demand

Outside Air Temperature High Limit

Compensated temperature set point

Temperature set point

Timeclock

(Look at Annex A for a graphic explanation of the Control Demand)

2.9 Trending

Trending capability for inputs and outputs must be available as this will enhance the commissioning, tuning and fault detection of the control strategy

2.10 Time Clock Exceptions

Access to setting new time exceptions must be provided to cater for out of hours operation, i.e. weekends

Hourly time extensions to existing operational times must be provided

3.0 Control Panels

3.1 Panel Body

The control panel shall be constructed of sheet metal of 2mm minimum thickness, 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 shall be vertically hinged.

Panel construction shall have separate power and control sections linked together. The power section shall be defeat-able door isolator interlocked. 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, keypads, all 24 volt control relays, switching modules with manual overrides, etc. shall all be located outside the power section. Motor Speed Inverters shall be fitted external to the control panel to keep panel size to a minimum.

Removable gland plates with gaskets shall be provided on control panels as either top or bottom entry. 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 in situ by protecting all internal controls equipment. The installation electricians, to maintain the IP Rating of the panel, must plug any unused holes left in the control panel gland plates. All doors, mounting and gland plates 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 lock design for every panel.

Each panel shall have a minimum of 10% surplus space on the back-plate 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 and a set of as fitted control panel drawings.

If floor mounted panels are to be used a suitable raised plinth will be installed.

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

3.2 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.

NO DOUBLE BANKED CONNECTORS TO BE USED.

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.

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. 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 BMS 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.

"Permanently Live" circuits should not be engineered 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 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: 3 Phase: Brown, Black, and Grey Neutral: Blue Control Wiring: 24V AC White, OV AC Grey ELV DC: Purple

3.2.9 24-volt control circuits shall be wired in PVC 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.

All internal cables shall be crimped at both ends and any screened cable insulated with

Neoprene type sheaving to prevent accidental earth-ing.

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

All panels - Critchley type markers shall identify the "Controller Point Number" 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.

All 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 failsafe.

These interlocks shall be duplicated on the BMS 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.

Each panel shall have an internal UPS unit installed, supplied from the live side of the isolator, via a suitable protection device. This UPS unit will in turn supply the BMS Controller/controllers, gas solenoid valve, laptop socket and any communications device.

(Ethernet switch, modem or media converter.)

The gas solenoid circuit is to be off the automatic resetting type unless otherwise specified, due to constraints of the connected equipment.

Each control panel shall have a 13Amp dual switched socket outlet, supplied from the panel mounted UPS in turn supplied from live side of the main panel isolator, fitted inside the control section to power a laptop computer for commissioning and service engineers.

3.3 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.

MCB’s 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 the control section door of the panel inside separate a plastic wallet.

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

A hard wired 10 second delay timer shall be fitted in the control panel to prevent all the

Enable signals 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 indication to show they are energised, e.g. flag or LED, and have a “manual override lever” for test purposes.

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

3.4 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 Identification, the Project Number and the Controller/controller number/id shall be engraved on a fascia plate located at the top centre of the power section door. These names will be provided by the University.

Fascia switches to override automatic functions of plant shall have “ON/OFF/AUTO” engraved on their fascia plates. The hand position shall operate plant even in the

event of failure of the BMS Controllers. Pumps/fans where duty/standby is used shall have “1 / 2 /OFF/AUTO”.

Inverter drives/speed drives/variable speed pumps shall have an output, separate from BMS control, of 75% when facia switch is in manual position.

A common ‘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 BMS 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, VSD pumps etc. shall have a “true run” signal provided. 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 Run/Enable indication for fans, pump motors etc.
- Red Trip/fault indication for fans, pump motors, filters, fire alarms etc.
- White Control circuit “live” indication
- Amber Power supplies “on” to boilers, humidifiers, chillers, pumps, fans etc.

3.5 BEMS Systems Hardware

All systems will utilise the university IT data network as a communications medium.

Controllers/controllers shall be complete with all necessary input/output cards, modules etc. are required to provide a fully operational controls package. Care shall be taken during the design stage to incorporate sufficient resilience in the controls hardware/software design solution, avoiding single point(s) of failure (i.e. critical plant controlled within a single controller) and global traffic is kept to a minimum.

All Controllers shall have 10.0% spare capacity for each point type.

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

All 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 Newcastle University standards and shall be the responsibility of the Control Systems Contractor, in the event of any query contact Engineer.

All Controllers shall provide automatic time change from BST/GMT.

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

Control Panels shall be fitted with a touch screen display 1500 mm above floor level, to enable local, password protected, and operator interrogation of the system. A full controller list of points, including Point Labels or Point Titles & Point Numbers shall be supplied and fitted in the controls section document holder to enable this function to be carried out.

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

Each controller shall have a local communication port for a laptop computer.

Each Controller shall be clearly identified with a permanent label stating the controller IP address and MAC address on the front to assist in fault finding and servicing.

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

Where Controllers are supplied and mounted within other Original Equipment

Manufacturers' supplied package plant (A/C Units, AHU's, and 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 and the University.

It will be incumbent of the OEM to provide all the necessary software registers to enable the controls specialist to perform the necessary BMS integration.

All Controller(s) should be fitted to enable stand-alone recovery of all files.

4.0 Field Wiring and Equipment

4.1 External Wiring

All wiring between Controllers, control panels and field equipment shall be installed by the controls contractor or an approved appointed electrical installer to carry out the installation.

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

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.

Communication cables between Controllers shall be clearly identified at both ends with Critchley type ferrule numbers and Dyno-tape label stating cable destination. All LAN and WAN drawings shall be updated with this information after each project and provided to the University Project Engineer.

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, UV-STABLE insulation to 300v, cable (see Appendix A for exact specification) with the screen grounded to earth at the Controller end only. The field end of the cable shall have the screen removed and the cable end insulated with Neoprene type sheaving to protect against inadvertent connection to earth.

Controller communication cable (see Appendix A for exact specification) shall be installed in screened four core cables 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., then, these must be left intact and joint boxes used for final terminations.

4.2 Field Equipment General

Field equipment shall be fully accessible for inspection and maintenance and due consideration should be given to this when locating and installing equipment.

All field equipment shall be installed to the manufacturer's recommendations. It shall be the Control Specialist Contractor's responsibility to identify the optimum position of all field equipment at the appropriate time in the contract.

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

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 etc. shall be clearly identified with a securely fixed traffolyte engraved label. These should be engraved as per the control drawing description and reflect mechanical plant references.

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 critical systems and all AHU's, pumps and fans shall be monitored by Differential Pressure switches or seek approval for other appropriate equipment. Where Variable Speed Inverter controlled pumps are installed, differential pressure switches shall be fitted to monitor positive flow condition. These switch signals shall be duplicated in the software on the BMS system graphics with indicating lamps on the control panel fascia.

Automatic gas valves should be of the 240-volt solenoid type with provision of an auxiliary contact for individual BMS and control panel fascia lamp indication. All automatic gas valves will be supplied via the panel internally mounted ups unit.

See Appendix A for a list of preferred suppliers.

4.3 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. Positive feedback of actuator position should be wired on all actuators. All actuators shall be capable of manual override.

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 BMS system.

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.

All actuators shall provide visual indication of position.

All High Limit Actuators shall be of the spring return type.

On all Domestic Hot water calorifiers separate control and spring return high limit actuators and valves shall be fitted.

See appendix A for a list of preferred suppliers.

4.4 Sensors

All sensors must be capable of being removed from ductwork and pipework for inspection and maintenance purposes without removal of ductwork, pipework or thermal insulation.

All sensors shall be installed to operate within the design range of the medium and as close to the middle range as practicable.

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 manual reset type.

Space temperature sensors shall be located within a building to provide a realistic representation of the overall building's internal temperature.

External temperature sensors shall be located out of direct sunlight on a north facing elevation and away from any influences of plant operation. (Boiler flues, extraction systems, grilles or vents from boiler rooms).

All sensors must be labelled with controller, Point/ input reference.

All sensors locations must be indicated on as fitted layout drawings provided by the control specialist contractor/ Mechanical Contractor.

See appendix A for a list of preferred suppliers.

4.5 Utility Metering

The University shall employ the services of a dedicated metering partner to monitor utility metering values across a common platform.

There is no normal requirement for meter values to be displayed upon the BMS systems.

Advice should be sought from the university Estate Support Service (ESS) and project engineer.

5.0 Programming

5.1 General

Programming of the Controllers shall be carried out in a consistent, structured manner using standard programs for: e.g. pump changeovers, compensated slopes, plant rotations, sequencing etc. All Programmable points shall be kept as simple and uniform as possible. Logic Strategies shall also be kept as simple and uniform as possible.

Global points and references should be kept to a minimum for communications purposes. In particular global references should not be repeated throughout Controller programs when one common global reference will do.

Each Controller shall incorporate a software hold-off timer circuit to prevent all commands 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, wherever building design permits, to allow economical running of plant whilst still maintaining temperature and humidity control within the desired limits for a given project.

All control loops requiring set-points/knobs shall be fully adjustable at the Server PC, in graphical and text format, using standard set-points/knobs. E.g. all compensated/reset slopes should be fully adjustable without accessing engineering programming levels.

Where control sensors exceed their design ranges, e.g. static pressure surges, temperature overshoots etc., and 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 set-points 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.

All systems must provide the necessary software to view and facilitate changes to the control logic programs of all controllers.

Integration of new BMS project installations

The University has significant capital and refurbishment programmes, projects carried out under these programmes will on occasion lead to new BMS installations. Such project work will be procured in line with University purchasing procedures – and the 'BMS Project Contractor' appointed for such BMS installations may not be the incumbent BMS Maintenance Contractor.

Where this is the case, the incumbent BMS Maintenance Contractor will perform the following duties in relation to project work carried out by others and must be contacted:

SSE Energy Solutions (Gateshead)

B5 Marquis Court,

Team Valley,

Gateshead,

Tyne & Wear

NE11 0RU

Contact: Paul McKay

Gateshead.admin@SSE.com

The current incumbent BMS Maintenance Contractor, SSE Energy Solutions (Gateshead) will provide a cost for the following works:

The BMS Project Contractor will supply the BMS Maintenance Contractor with the number and type of controllers required for the new project.

The University will supply the naming convention for the new site to the incumbent BMS Maintenance Contractor.

The University will supply IP addresses for the new site to the BMS Maintenance Contractor.

Issue to the BMS Project Contractor an Xworks project from the main site backup with blank controllers defined.

Provide a backup of the site graphics for use by the BMS Project Contractor, in order that only the University standard graphics are used.

On completion of the project and satisfactory demonstration to University Staff - on a local laptop only (by the BMS Project Contractor), the Xworks project should then be issued back to the incumbent BMS Maintenance Contractor.

The BMS Maintenance Contractor will change the Bacnet number on the Xworks project to the correct Bacnet number as issued by the University.

The corrected Xworks project will then be re issued to the BMS Project Contractor.

Once all controllers have been re loaded and the new site has been accepted by the University, with no Alarms. The Xworks and graphics project should be re issued to the BMS Maintenance Contractor for inclusion in the main site project file.

Notes and items which are excluded are:

Any additional BMS points are to be purchased by the BMS Project Contractor and not the incumbent BMS Maintenance Contractor;

The rectification of any faults;

End User system demonstration and training.

It is the responsibility of the BMS Project Contractor to ensure all versions of BMS software, firmware and graphics are fully compatible with the University's current systems.

5.2 Time Schedules

All Control Systems: Time Schedules should be kept to a minimum for each building. 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 Engineer for each individual project.

Time schedules should be provided for all individual AHUs and / or individual zones. No schedules should be provided for central heating plant, these should respond to demand on the associated circuit.

Calendar 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.

Holiday Schedules shall be incorporated for each building or site.

5.3 Frost Protection:

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.

Air Handling Units Supplied from Boilers and CT circuits:

AHU Heating batteries will be protected from frost damage by a hard-wired 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.

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.

5.4 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.

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 specifications of specific accommodation.

5.5 Naming of Points

All point names should indicate the area/room number monitored or controlled.

All Control Systems: Naming of the point titles for programming and graphic page shall be as consistent as possible with each point type identified as in the following chart:

- Point Type Examples of Point Title Description
- Enable Pump No 1 Enable Boiler No 1 Enable
- Status Pump No 1 On/Off Supply Air Proved
- Analogue Input Boiler Flow Temp Out-side Air Temp/Room xxx Temp
- Analogy Output Htg Valve 0/P AHU Electric Thyristors 0/P
- Control Point Compensated Control AHU Control
- Set-point Compensated Set-point Reset Air Set-point
- Rotation Pump Rotation Boiler Rotation
- Optimiser 3rd Floor Optimiser
- Time Schedule AHU Time schedule
- Holiday / normal mode (summer / winter mode)
- Holiday Schedule Htg Holiday Schedule DHW Holiday Schedule

5.6 Compensation Slope

Compensation slopes shall normally be established with the following Outside Air and Variable Flow Temperature settings:

- Outside Air ~ Temperature -1°C: 20°C
- Flow Temperature 20°C: 82°C

5.7 Heating Hold-Off on Warm Days

Heating circuits shall be disabled if outside air temperature rises above a set value, normally 15°C, for a period of one hour and the average internal temperature is

above the internal space temperature set-point within the “on” period of a heating time schedule.

They shall be enabled again if the outside air temperature drops 1 °C below set point, for a period of Two hours.

The set points must be fully adjustable to the user and, as each building has different thermal insulation characteristics, the initial programmed set point should be discussed with the university Estate Support Service (ESS) and project specific mechanical engineer.

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.

5.8 Alarms and Logging

All alarms deemed Critical will be fully configured to present at the Newcastle University 24hour Security Office Alarm Server with full description and required actions and contacts. These will be presented in clear text.

All alarms and the acknowledgements are to be logged in a fully auditable database.

All Systems: Logging shall be set up at the “Handover” stage on every analogue sensor value at an interval of fifteen minutes. Historical Logging should be set up on the Server PC.

Siemens Controller shall have its own ‘Controller Monitor’ Index Level containing Door Monitor, Mains Monitor and Controller time.

A schedule of alarm priorities/routing and optimiser event reports shall be submitted for comment to the university Estate Support Service (ESS) and project specific mechanical engineer, ten working days prior to final commissioning of the project.

Controls Contractors must fully check their systems for any spurious alarms at time of commissioning. They must demonstrate to the university Estate Support Service (ESS) and project specific mechanical engineer that there are no unnecessary alarms transmitted to the BEMS front-end servers at the handover stage.

The university BMS SMS/Email alarm transmission systems. This is to be configured to transmit alarms deemed Critical by the university on each specific project. Controls Contractors should therefore discuss Alarm Monitoring with the University Controls Engineer for each project prior to engineering to establish which alarms require to be added to this system. These alarms are to be fully operational at “handover”

Alarm priorities shall be programmed in line with the university’s Alarm Priorities Schedule. See section 9.0 Appendix B of this document.

6.0 Systems Security

All server, systems and controllers will have full user specific password protection.

General controller access passwords will be set to a standard provided by the university Estate Support Service (ESS) and project specific mechanical engineer. These passwords will be required to prevent network/web access by unauthorised persons to any controller.

All servers will be fully backed up and copies provided to Newcastle University after each system change by the control specialist contractors.

7.0 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 specifications:

7.1 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. Holes left in trunking or ductwork shall be plugged.

Controllers, thermostats, and sensors remain the property of the University. Before disposal permission must be sought from the BMS Operation Group.

The Controls Specialist Contractor shall decommission all redundant software and graphic pages from the BEMS network.

7.2 Integration

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 fixed 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 IO modules for the additional controls, then it shall be of similar construction to the existing control panel i.e. metal construction, colour RAL 7035.

Revised wiring diagrams, flow charts, strategy diagrams, graphic pages, controls descriptions and O&M manuals shall be presented, in triplicate, to the university Estate Support Service (ESS) and project specific mechanical engineer, no later than two weeks after the practical completion of works. A copy of the revised wiring diagrams shall be placed in each panel. Revision dates shall be clearly indicated on all documents. (See O&M Manual Section)

Revision dates shall be clearly indicated on all documents.

New graphic pages 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 plant and plant graphics. All new and modified graphics drawings shall require approval by the ESS project engineer.

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
- All redundant graphics, slides and links are to be removed.

8.0 Graphics

Graphic pages shall be supplied for each project in a consistent structured format. Page contents and structure shall be provided for comment to the university Estate Support Service (ESS) and project specific mechanical engineer as detailed in the Preamble Section.

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

The University "Home" Page 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 "Main" page listing each main floor plan page on left side of screen and each HVAC Plant page on right.

Each Floor Plan page shall display location of room sensors, outside air sensors and control panels / Controllers, with a display of calculated or actual set-point, together with the actual temperature sensed.

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

Specific heating and ventilation 'zones' must be colour-coded and identifiable within each floor plan, with a key noting the associated AHU, VT circuit, heat pump, etc.

Pages 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 page to reduce overall number of pages.

The outside air temperature should be displayed on pages where appropriate.

Only live data shall be displayed on the pages. "Previous Values" shall not be displayed on the graphic page i.e. during the process of the page being called up,

or if the communication link has dropped, then this shall be reflected to the user as asterisks on the page 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.

Pump and fan graphic symbols shall change colour when running - Grey for an ‘Off’ condition and Green for a ‘Run’ condition or suitable animation provided. Where differential airflow switches are installed, then the status signal from these shall be used to initiate the green run condition.

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

All Control Systems: User menus shall allow users with allowed access rights direct access from the graphic page to:

- Point Editor (all point types)
- Alarm History
- Data view Logging
- Dynamic Data Graphs
- Occupancy Times
- Set Points
- Graphs
- Engineering Mode

All set-point are to be indicated on a graphical page and be adjustable to a user with the relevant access rights.

All valves, dampers and actuators shall be able to be manually overridden by a simple button on the graphics page to a user with the relevant access rights.

9.0 Active Graphics

Graphic Pages shall be supplied for each project in a consistent, structured format. Page contents and structure shall be provided for comment to the university Estate Support Service (ESS) and project specific mechanical engineer as detailed in the Preamble Section.

Pages shall be structured in such a way that University Works Division staff can be guided through to the chosen building and its individual room temperatures or plant status, using ‘Hot Key Buttons’ on every page. Buttons should enable the operator to work forwards and backwards through the pages without having any prior knowledge of the building or its HVAC plant.

The University “Home” graphics page shall offer a list of each principal building, grouped in maintenance areas. In addition, other buttons for direct access to key summary pages shall be allowed space too, such as:

- OAT Overview
- Meters Overview etc.

Once a building name is clicked on, an initial building “Home” page listing each main Floor/Level or showing a floor map of each floor (preferred) should appear. In case of the latter, the floor maps will show the position where boiler and AHUs plant rooms sit. The floor maps will also show the positions of all utility meters i.e. electricity, gas, heat, water, etc.

By clicking in a floor, 2 floor plans should be shown: one for heating and other for ventilation. Floorplans shall be obtained from the university Estate Support Service (ESS) and project specific mechanical engineer and they shall be NU final plain floorplans with NU room numbers on it.

Each Floor Plan page shall clearly display the room number, location of room sensors, outside air sensors, zone valves and control panels / outstations, with a display of calculated or actual set-point, together with the actual temperature sensed. If all these items cannot be displayed clearly, Hot Key Buttons for heating and ventilation shall allow access to individual pages for each. Floor plans shall map and colour-code the areas covered by each heating circuit and / or AHU. These areas will be labelled and, where possible, will provide direct access to the heating circuit and / or AHU by clicking on the area.

A legend on one of the sides of the page shall indicate the labels names. If direct access from the map was not possible, legend’s buttons will provide direct access to the heating circuit or AHU by clicking on them.

A ‘North’ arrow shall be clearly displayed on such pages.

Pages 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 page to reduce overall number of pages. The outside air temperature should be displayed on pages where appropriate.

Only live data shall be displayed on the pages. “Previous Values” shall not be displayed on the graphic page i.e. during the process of the page 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.

Pump and fan graphic symbols shall change colour when running - Grey for an ‘Off’ condition and Green for a ‘Run’ condition. Where differential airflow switches are installed, then the status signal from these shall be used to initiate the Green Run condition.

Feedback faults in pumps and fans shall be shown in red for “Stopped” and “No Flow” conditions (when equipment should actually be running).

Graphic page backgrounds shall be plain to prevent excessive colour printing.

For a visual description of a template, please refer to appendix C at the end of this document.

10.0 O&M Manual

10.1 General Specifications

Two copies of the Controls Operation & Maintenance (O&M) Manuals shall be submitted in a CD / Electronic format to the University Controls Engineer within two weeks of completion of each project.

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

10.2 O&M Sections

Section 1 - Description of Operation.

This section shall contain 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 - Outstation Data Tables / Outstation Connection Drawings.

Manuals shall contain the input and output slot usage charts for the outstation hardware points and software points.

Section 3 - Outstation Strategy Drawings / Flow Charts and Points Display List.

As Flow Charts can be obtained live from the server, then paper copies are not required within the Controls O&M Manuals.

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. Outstation LAN communication wiring diagrams shall be included in this section clearly showing the “break in” connections to existing communications buses.

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 setpoints, proportional bands, integral action times, differentials etc.

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 all relevant data sheets and instructions for control equipment on the project.

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 Engineer, together with a Snagging List of items of works outstanding at time of handover, together with proposal dates for completion.

11.0 Appendix A – BMS Field Equipment List

Preferred Manufacturer

Motor Inverter Controllers

ABB - ABB Limited, 3100 Daresbury Park, Daresbury, WARRINGTON, Cheshire, WA4 4BT

Room Controls

Siemens Building Automation – SSE B5 Marquis Court, Team Valley, GATESHEAD, Tyne & Wear, NE11 0RU

Immersion Sensors

Siemens Building Automation – SSE B5 Marquis Court, Team Valley, GATESHEAD, Tyne & Wear, NE11 0RU

Duct Sensors

Siemens Building Automation – SSE B5 Marquis Court, Team Valley, GATESHEAD, Tyne & Wear, NE11 0RU

Thermostats

Siemens Building Automation – SSE B5 Marquis Court, Team Valley, GATESHEAD, Tyne & Wear, NE11 0RU

Liquid DP Switches

Siemens Building Automation – SSE B5 Marquis Court, Team Valley, GATESHEAD, Tyne & Wear, NE11 0RU

Air DP Switches

Siemens Building Automation – SSE B5 Marquis Court, Team Valley, GATESHEAD, Tyne & Wear, NE11 0RU

Control Valves & Actuators

Siemens Building Automation – SSE B5 Marquis Court, Team Valley, GATESHEAD, Tyne & Wear, NE11 0RU

Dampers & Actuators

Siemens Building Automation – SSE B5 Marquis Court, Team Valley, GATESHEAD, Tyne & Wear, NE11 0RU

Alternatives to the above list of preferred equipment may be acceptable if approved by the university Estate Support Service (ESS) and project specific mechanical engineer prior to commencement of the project.

12.0 Appendix B - Alarm Priorities List

BMS Alarm Priorities List (Priority 1-10)

1 Critical Alarms/Fire Alarms

2 Intruder Alarms

3 Gas valve Closed / Boiler Safety Circuit

4 Mains Failure

5 Generators Run / Fuel Level

6 Science alarms

7 Critical Systems/ Flow failures

8 Flue fan Failure/fault/airflow

9 Boiler Pressurisation Unit Fault

10 DHWS Hi limit

General Alarms (Priority 10-20)

Boiler Lockouts

General Airflow/ water flow failures

DHWS Hi limit (normal areas)

Pumps/fans tripped

Air con + Condenser / Chiller Faults

Frost Stat active

Filters dirty

Future

Future

All Alarm Points are to be confirmed with the university Estate Support Service (ESS) and project specific mechanical engineer on a project specific basis.

13.0 Appendix C - Graphic Template Slides

Fig .1

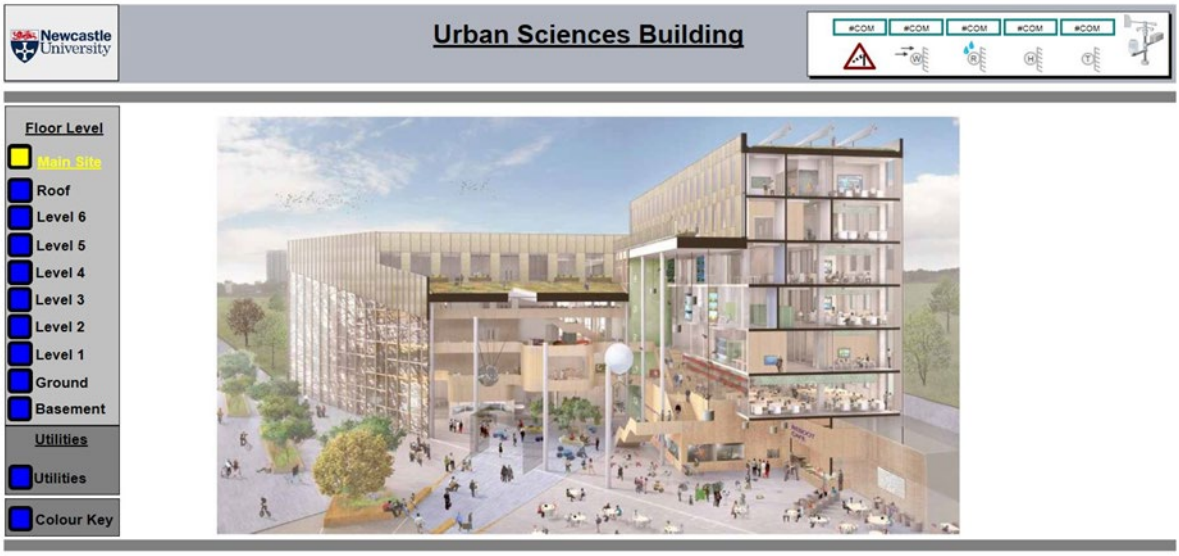


Fig.2

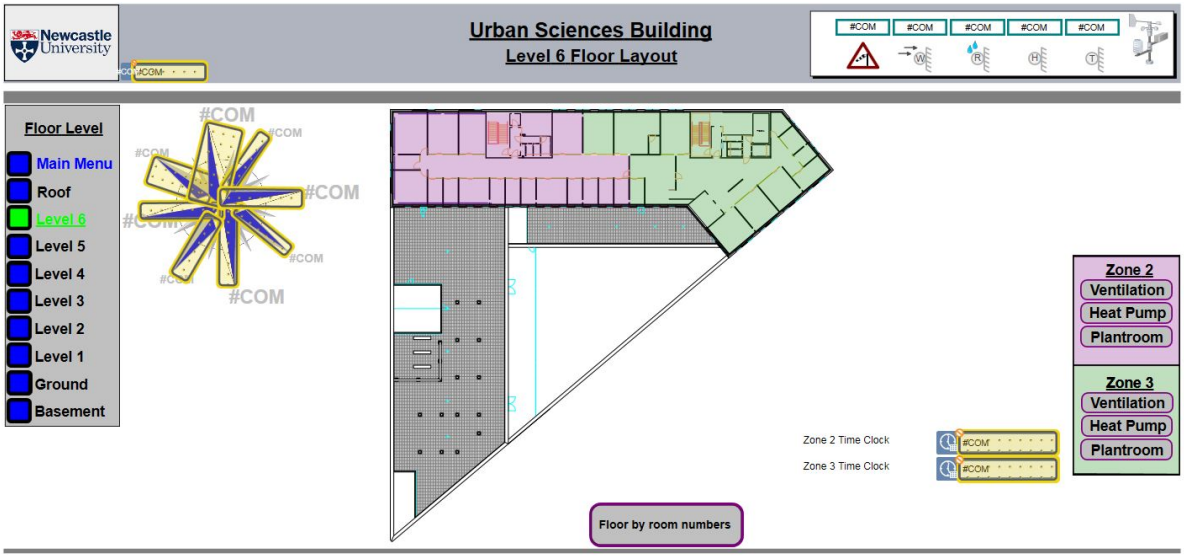
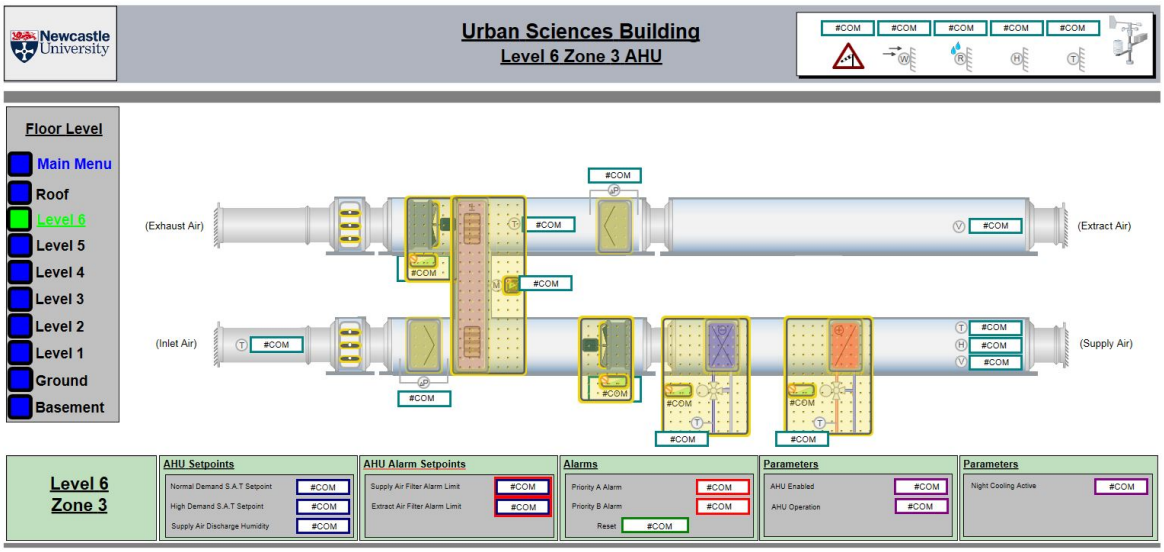


Fig.3


Newcastle University
Urban Sciences Building
Level 6 Zone 3 AHU
#COM
Floor Level
Main Menu
Roof
Level 6
Level 5
Level 4
Level 3
Level 2
Level 1
Ground
Basement
(Exhaust Air)
(Extract Air)
(Inlet Air)
(Supply Air)
Level 6 Zone 3
AHU Setpoints
Normal Demand S.A.T Setpoint
High Demand S.A.T Setpoint
Supply Air Discharge Humidity
AHU Alarm Setpoints
Supply Air Filter Alarm Limit
Extract Air Filter Alarm Limit
Alarms
Priority A Alarm
Priority B Alarm
Reset
Parameters
AHU Enabled
AHU Operation
Parameters
Night Cooling Active

End of Document