ESTATES & FACILITIES

Document Title

Briefing Notes for B E M S HVAC Systems

Please note that this specification remains in DRAFT and proposed therefore, whilst the recommendations contained within it should be used as a starting point for design, proposals must always be discussed with the Liaison Engineer before proceeding.

Document Number

ES/ 008-D

Revision Index.

Revision	Date of Revision	Revised by	Revision made
A	25/11/05	David Andrews	For review
B	31/01/06	David Andrews	Issued for use
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C	12/11/18	John Matthews	Revision Completed – DRAFT for Review
D	10/10/19	Mark turner	Issued for use in draft form

BUILDING MANAGEMENT SYSTEM (BEMS)

HVAC CONTROL SYSTEMS DESIGN NOTE

FOR M&E DESIGN CONSULTANTS & BEMS CONTRACTORS

INDEX

SECTION A

A 1 General – Approved Contractors

All control systems are to be designed around current TREND intelligent outstations.

The complete Building Energy Management System (BEMS), are to be designed, supplied, installed, tested, programmed, documented, commissioned and handed over by Trend Control Systems Ltd (TREND advance) or an accredited Trend System house partner either a Trend Technology Centre (TTC) or Systems Integrator (SI).

An up to date list of approved Trend System House partners is available using the link below

https://www.trendcontrols.com/en-GB/partners/Pages/default.aspx

A 2 General – Contractors Responsibility

The University of Southampton has a large-scale Trend Controls System installed. The installation has spanned a large number of years and developments across the University of Southampton Campus and also at the Winchester School of Art. It controls and connects to all buildings at both sites. The Trend Control systems at both sites are fully networked and reports centrally back to the HVAC Building management supervisor at the Highfield campus.

The Trend Control system has been installed over a number of decades and spans the full product back catalogue. This includes, IQ1, IQ2, IQ3 and IQ4 series of controllers.

The University has over these years invested in the Trend Controls infrastructure and controls system. The University has invested in training and support of the controls infrastructure. The Trend Controls hardware and software installation is fully backward compatible and has allowed the university to support its buildings infrastructure throughout the life of the building. This sustainability policy allows for long term support of the infrastructure and the low life time cost of support for our university

The University of Southampton wants to continue the development in infrastructure of its existing controls architecture, and as such only control systems manufactured and supplied by Trend Control Systems Ltd will be supplied to site.

The BEMS shall be of standard TREND Control Systems Ltd manufacture, freely maintainable by any approved TREND Partner.

Software configuration, programming and commissioning of the intelligent outstations shall be carried out by the BEMS Specialist Sub-Contractor.

In completing the works, the BEMS shall comply in all aspects with the Trend SI and TTC criteria as defined by Trend Control Systems Ltd relating to the skills of the engineers employed, methods, standards of workmanship and quality.

The BEMS Specialist Sub-Contractor is to tender for the works as itemised in the Particular Specification, which generally comprise:

- The complete design, supply, configuration, documentation and commissioning of the BEMS including all hardware, software and supply of all connected sensors and actuators.
- Manufacture of the Motor Control Panels.
- Controls wiring including the provision of conduit and trunking.
- Power wiring between the motor control panels and pumps motors etc.
- Commissioning

The system shall comply in all respects with this equipment specification and with the particular controls specifications appended as drawings and schedules and all current legislation and standards.

The programming is to be written by the BEMS Sub-Contractor in conjunction with the requirements of the appointed Consultant Engineer (Engineer) and the University BEMS Engineer.

NOTES

1. After the BEMS Sub-Contractor has been nominated, they are to arrange a meeting with the appointed consultant engineer, the University BEMS Engineer and Trend site maintenance partner early in the contract period, to formulate specific software & hardware requirement, based on the University Standard requirements and application macros.

2. Software documentation will then be prepared in provisional form by the BEMS Sub-Contractor, for submission to the University BEMS Engineer for approval and comment.
   Early provision of this documentation is vital, to ensure that all requirements are met, prior to any outstation being programmed on site.

3. Control panel drawings must be issued prior to construction to allow the University BEMS engineer an opportunity to comment. - RIBA Plan of Work stage 4 "Technical Design"

4. **All** University software programming notes, as detailed under Section 'B' of this document, will apply and will form the basis of the preliminary software meeting.

A 3 H&V Control Panels

The control panels are to be two compartment, power & control.

The preferred solution is for all HVAC Plant with an electrical rating of >6KW, or if 3 phase, to be directly supplied from the building 's electrical distribution system. These power supplies will normally be installed by the electrical services contractor or sub-contractor (unless the appointed Main Contractor determines otherwise).

H&V Control Panels shall be manufactured from sheet steel with a minimum thickness of 2.5mm, rigid construction with stove enamel finish and a minimum degree of protection to IP54 as detailed in BS5490.
Control Panels located externally shall be IP66.

Paint colour shall be light-grey gloss or other approved BS or RAL standard colour.

Panels shall be constructed for floor or wall mounting with suitable plinths and/or fixing brackets and removable lifting eye-bolts. Removable grand-plates shall be provided at top and bottom for cable, trunking or conduit entry.

Terminals shall be located to suit the outgoing wiring.

A main earth terminal or bar shall be provided within the panel for connection of all incoming earth conductors. All non-current carrying metalwork in the panel shall be connected to earth.

The control panel shall house control relays, contactors, indicator lamps, manual control switches, electronic controllers and intelligent outstations required to meet the operational functions.

All control circuits are to be 24V ac. Transformer/s for this will be of suitable size to ensure proper operation in the event of power off/power on.

The control panel will have an asset tag installed upon it. The identification will be via the PlanOn asset management system.
In addition to this each outstation will also require an asset tag, the details recorded to include the outstation model, identifier [LAN/OS number] & type and number of IO modules fitted.
The panel equipment to be suitably identified with labelling and clearly described in panel drawings.
The front door of the control panel is to be fitted with a label detailing where the control panel is supplied from.

Panels shall typically be Form 2, unless specified otherwise, constructed with separate compartments for power & control.

Compartment 1: Power

The power compartment shall contain the following equipment.
An electrical distribution board c/w integral isolator.
The distribution board's integral main isolator and all MCB's are to be lockable in the OFF position.
This distribution board will provide power to all single-phase HVAC plant with an electrical rating of below 6KW (Note: a all single phase supplies above this rating and all three phase supplies will be fed directly from the electrical distribuition boards in the building) and also provide power to the following equipment.

- 230V/24V transformer – control circuit
- 230V/24V transformer – control valves power
- 230V supply for outstation(s) - located within the control compartment.
- 230V supply for 13A socket - located within the control compartment.

All field power wiring shall terminate directly into the distribution board, this will negate the need for a panel power termination rail and potential exposure to live terminals.

All motor controllers, speed inverters, etc. are to be located in the field, adjacent to the plant they control.
Their IP rating must be suitable to the environment that they are installed in.

NOTE - A door interlocked isolator is NOT required.

The control panel electrical power supply, provided by the electrical services contractor, will terminate into an electrical isolator sited adjacent to the control panel.

The mechanical services contractor's scope of works will include installing the power wiring from this isolator to the control panel and for all electrically wiring emanating from the control panel.

The Main external door shall be able to be opened without the need to isolate the supply. The door shall be fitted with appropriate warning labels. **"Caution 230V** " (note: because all three phase plant will be fed directly from the electrical distribution board, the 230V will be the maximum power in the Power compartment) and "**Authorised Personnel only**".

Doors to be fitted with door locks of approved type.

Compartment 2: Control

To have an independently openable hinged door.

Generally, only the ELV control voltage (i.e. 24V) shall be present within this section, except where absolutely necessary.
(e.g. Power supplies for Intelligent Outstations.)

All wiring and terminals within both compartments with an applied voltage in excess of 55V to earth, shall be fully shrouded, so as to prevent any direct contact during normal routine maintenance. Caution notices shall be fitted to all shrouds and the LV wiring to be kept within separate, labelled cableways.

Interface relays of different coil voltages will be segregated and clearly marked to help prevent interchanging of incorrect relays.

All terminals carrying voltages from 3rd party equipment which may remain live when the incoming power supply to the control panel is isolated must be shrouded and clearly marked to indicate live voltages may be present and where the power is derived from. These voltages should not exceed 24V.

All panel wiring to be clearly identified with slip on cable markers. Numbers must read away from the termination and must comply with the numbering on the approved panel drawing.

The panel equipment to be suitably identified with labelling and clearly described in panel drawings.

The control section will allow enough space / terminal rail length for two additional Trend IO modules, or 15% capacity per controller installed whichever is greater.

BEMS Control Panel Components and switches

Switches and indicators are to be fitted to the fascia of the controls compartment.

For the "Trend BEMS controller system" within the MCCs Control Panels, only standard TREND controller components shall be supplied and installed.

The Switches/Pushbuttons/LED Lamps shall be standard type and not "intelligent membrane" type Switches/LED indicators utilising a "PLC type controller" or any interfaced solution.

With the exception of safety critical systems, e.g. Fireman's Control, The MCP fascia mounted switches are to connect direct to the outstations as DI's (Off-Auto) & (Test Off-Test On).

For safety critical systems these switches are to have a double set of contacts, one set connected direct to the outstation and the other set for hard wired control logic.

Safety interlocks are also to be hard wired and are to be fail safe.

In both cases, and to prevent nuisance alarms, the BEMS software is to be configured to match the hard wire logic.

For typical requirements please refer to Appendix 1.

Adequate clearance should be provided when installing equipment to allow for removal and replacement.

BEMS Control Panel Touch Screen Display

Supply and install touch screen display panels (facia mounted) for use with the BEMS controllers within each MCC where indicated in the specification or Equipment. In general, each plant room to incorporate a single networked display, currently IQView8 or Trend controls current equivalent.

This allows the maintenance staff to access the Trend system from each plant room for essential interaction with the BEMS.

Display and Directory modules are to be set up within the controllers to allow easy viewing of the plant.

Standard Control Panel Equipment

In addition to the required BEMS controllers, IO Modules, network hubs, wiring, relays, terminals etc. each control panel shall contain the following items as standard:

- A 13A socket outlet with integral RCD and shall be sub-protected by a 6 Amp MCB.
  It shall be clearly labelled "6 Amp circuit. For BEMS Laptop Use Only".
- An internal light, preferable white LED strip, equivalent to standard 40W bulb, to be controlled by a door mounted micro-switch that enables the light door is opened.
- A pocket for drawings. This shall be riveted in place, not stuck using double sided tape/foam.

As fitted control panel drawings

Control panel "as fitted" drawings are to be supplied in two formats

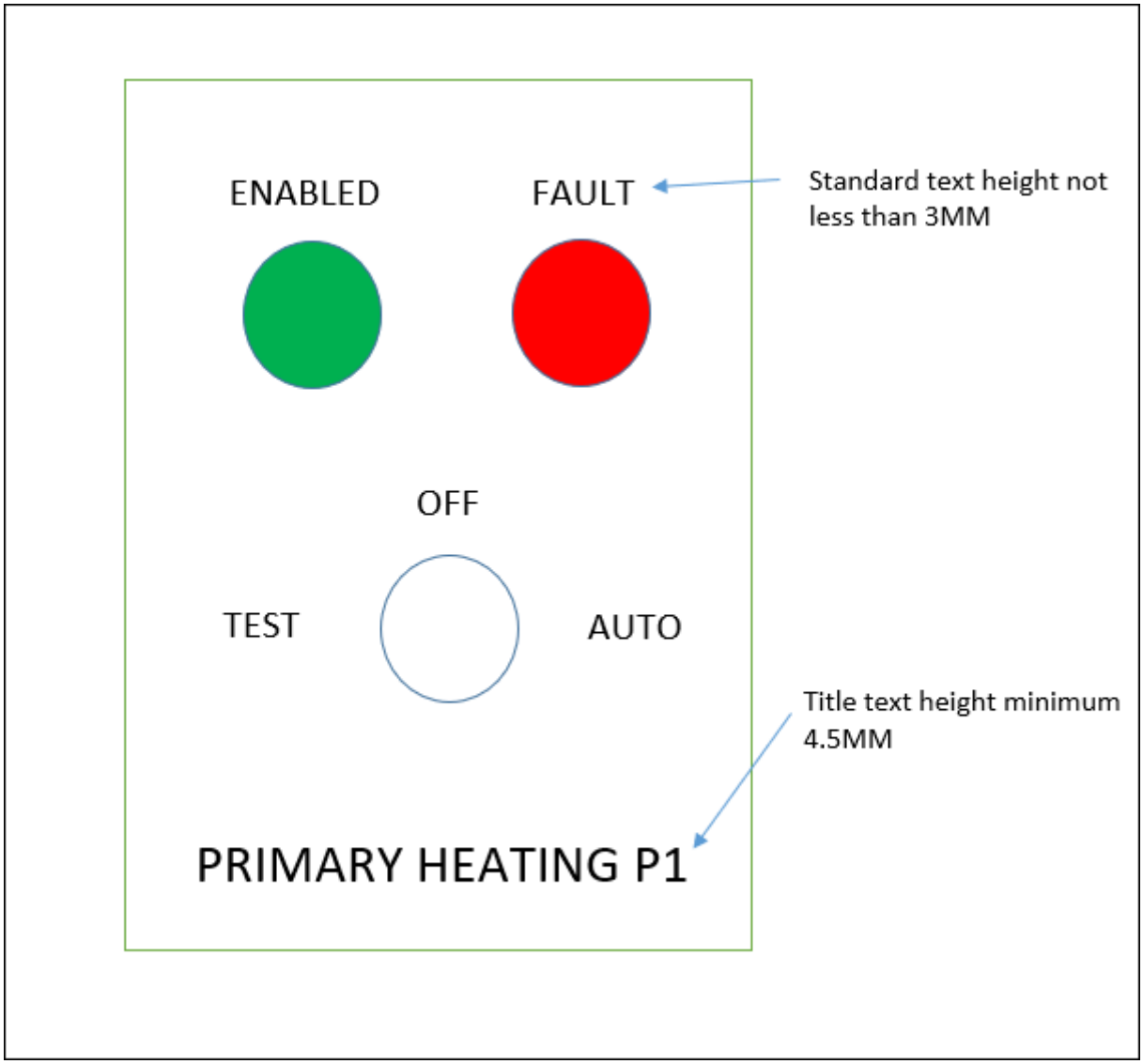
In PDF format for record purposes and the other set in .DWG format.
(This will allow any future modifications to be documented).

A hard copy of the control panel drawings together with any special operational instructions, e.g. startup sequences etc. are to left within the control panel.

A 4 Motor Control Panels - equipment standardisation

Component	Manufacturer	Comment
Distribution Boards	Schneider,	All MCB'S to be lockable in the OFF position
Fuses	Eaton, Busman, Moeller or Cutler Hammer	MCB's are the preferred device
MCB's	Eaton, Moeller, Schneider, Siemens, Cutler ABB	
Panel Indicators & Switches	To be LED, either Eaton or Titan range	The correct LED must be used for the lens colour
Relays	Finder, Carlo, Omron, or Weidmuller	Must incorporate LED indication
Terminals	Klippon, Weiland, Weidmuller or ABB	
Ethernet switches	Moxa or Weidmuller	To be unmanaged; one spare port for BEMS engineer's laptop.

Indication & Labelling



Lens Colours

Panel indicator lights shall be high output LED. All indicator lamps shall be coloured for their mode according to BS EN 60073:1991

Green-Running
Red – Tripped/Fault
White – Healthy
Orange/Amber – Software Override Active, Warning
Blue – Not to be used unless agreed by the BEMS Assistant Engineer

A 5 Trend Controls Intelligent Outstations

Controllers will be selected from the Trend IQ4xx series controllers with IQ4E included in main panels and sized in accordance with the particular specification BEMS points schedules.

The BEMS Specialist Sub-Contractor shall detail the spare Input/Output capacity of each controller.

I/O Channels: All IO connection will utilise standard Trend Control IQ4E expansion modules, supplied and manufactured by Trend Controls. No form of interfaced IO or non-Trend standard IQ4E IO will be accepted.

Each controller shall have universal inputs for analogue voltage (V), analogue current (I), thermistor (T) or digital (D).

Digital Input multiplex modules (DIX) should not be utilized, Trend I/O expansion modules only should be used.

All IQ controllers shall have Analogue Voltage outputs (0-10V),
(Note: IQ4E Digital Output modules should not be used).

The only acceptable output interface modules are SRM's and 2RM's and these must be manufactured by Trend Controls.

Future expansion shall be by the addition of expansion modules connected to the IQ4xx controller via a CAN bus. The Trend IQ4E controller installed should be sized to allow a 15% expansion in its capability to be able to be unlocked if required.

Note - The CAN bus must not extend outside of the control panel.

The BMS contractor must request the PIN, user name and password to be used on the project.
No other users to be configured.

Trend Controller Programming

The BEMS Sub-Contractor shall ensure that the Intelligent outstations have sufficient internal logic/software modules to meet the programming requirements and additional outstations shall be provided if required.

The BEMS Sub-Contractor will be required to make all the appropriate changes to all existing BEMS Supervisors, to allow interrogation, diary operation and alarm reporting from all new outstations/LANs installed. This is to be done in conjunction with the University BEMS Engineer, and the onsite Trend Controls maintenance provider.
All outstation module labelling to follow the standard as provided under Appendix 2.

The BEMS Sub-Contractor shall provide full documentation, produced using the Trend 'SET' package, of the installed systems, in duplicate, which must consist of at least the following elements: -

i) Basic control strategy descriptions.

ii) Schematic of any local networks.
iii) Wiring schedules - Trend standard, completed in **FULL.**
iv) Configuration schematics.
v) Sequence tables.
vi) Time zone details.
vii) OSS details.
viii) Sensor types.
ix) Knobs list.
x) Switches list.
xi) Sensor alarm settings.
xii) Inter-controller comms. list.
xiii) Module availability table.
xiv) Analogue and digital node availability tables.
xv) Spreadsheet record all IC comms, detailing local & remote setting's + description.
xvi) Plant schematics in A4 format, complete with all input/output locations.
xvii) Manufacturers Specification Sheets on all equipment fitted (In panel and remote).

Terminal Unit Controllers

All terminal controllers shall be IQ41x or IQ42x.
Trend BACnet MS/TP IQEco controllers must not be used.

A 6 BEMS Standard Analogue Inputs

To facilitate enhanced energy monitoring & control the following sensors shall be provided as standard.

General

Outside air temperature

Heating & Cooling Plant

Individual boiler flow temperature sensors.
Individual chiller flow temperature sensors.
Primary circuits flow & return temperature sensors.
Secondary circuits flow & return temperature sensors.
LTHW, & CHWS static pressure sensors
Room temperature sensors for all heating and cooling zones

Air Handling Units

Air off temperature for all coils
Air temperature onto and off from all heat recovery systems
For mixing dampers-fresh air, return air, and mixed air temperatures.
Frost coil LTHW outlet [return] temperature
Filters – differential air pressure sensors.
Extract / return air temperature.
Room temperature sensor(s) where AHUs are providing space heating or cooling.
Where AHU's incorporate humidity controls the following sensors shall be provided.
Fresh air temp & humidity, Supply air temperature & humidity, Return [or Space] air temperature & humidity.

Performance:

Logging shall be of no less than 1000 plots capacity per item logged without compromising memory capacity available for strategy. All AI, DI, AO.DO, IC Comms and calculated values, i.e. min, max, setpoints must have a plotting channel assigned to them. The standard plotting interval to be 5 mins.

A 7 Remote Peripheral Equipment

The BEMS Sub-Contractor shall be responsible for the supply, installation and commissioning of all standard remote equipment for the control system.

It is the University of Southampton's wish to standardize on peripheral parts supplied and installed in its buildings. This allows the easy replacement of spares, and identification of parts by the site maintenance teams.

The preference is for the control system peripherals to be supplied via the Trend Controls standard peripheral range. This can be branded Trend or Honeywell.

Dependent upon the building primary use, ether standard sensor types or high-quality sensor types will be utilized.

In standard office, lecture teaching spaces, standard grade sensors technology can be utilized.
For laboratory, high specification spaces high quality sensors are required to be utilized.

The University BEMS engineer or consultant can confirm the specification for the building.

Trend Standard Peripheral Equipment

Sensors

Description	Standard Part No (xx indicates scale or value variant)	High Quality Part No (xx indicates scale or value variant)
Outside Air Temperature Sensor	TB/TO.	T/PO/-40
Outside Air Temperature and Humidity	HT/O	HT/O
Room Temperature Sensors	TB/TS	TP/S
Immersion sensors	TB/TI-S	T/PI-S/xx
Duct Temperature sensor long	TB/TI-L	T/PI-L40
Clamp on Temperature sensor	TB/TC	T/PC/xx
Flying lead sensor	T/TFR-4/10	T/TFR-4/10
Space temperature / Humidity Sensor	HT/S	HT/S/2%
Duct Temperature / Humidity Sensor	HT/D	HT/D/2%
Air Differential pressure switch	DPSxxx	DPSxxx
Air Differential pressure transmitter	DPTExxx	DPTExxx
Liquid DP Sensor	DPIL/xxx	DPIL/xxx
Liquid static pressure sensor	PIL4/xx	PIL4/xx
Air Velocity Sensor	AV/D/10	AV/D/10
Duct CO2 and Temperature	CO2/T/D	CO2/T/D
Space CO2 and Temperature	CO2/T/S	CO2/T/S
Space CO2, temperature and humidity	CO2/T/H/S	CO2/T/H/S
Frost protection thermostat Auto Reset	FT6961-xx	FT6961-xx
Brass pocket	WBxxx	WBxxx
Stainless pocket	WSxxx	WSxxx

Valve and Actuators

All plant valves to be from the Trend Honeywell or Belimo range.
All actuators to incorporate position feedback signals (either potentiometer or 0-10Vdc), to give true indication of valve position to the BEMS, to aid in fault finding and maintenance.

Damper Actuators

All damper actuators to be from the Trend Honeywell or Belimo range.
All modulating damper actuators to incorporate position feedback signals to give true indication of damper position to the BEMS, to aid in fault finding and maintenance.

For two position (open /close dampers) this will be achieved via end of travel micro-switches.
For modulating dampers, the feedback signals will be either via a potentiometer or 0-10Vdc

Variable Speed Drives

All Variable speed drives to be from the Trend Honeywell, Vacon or ABB range as detailed.

The speed shall be smoothly adjustable, and controlled by any one of the following: -

- Inverter's keypad - Local /Remote (manual/auto) operation
- Potentiometer - Local/Remote (manual/auto) operation
- 0-10V dc signal – Remote (Auto) operation
- 4-20mA signal - Remote (Auto) operation

It shall be possible to select manual/automatic speed control on the frequency Inverter's keypad or via a remote volt-free contact. It shall be possible to change the control place from Local (manual) to remote (auto) and vice a versa by digital input.

Where there is a requirement in the Particular Specification for a communication interface with the BEMS, the frequency Inverter shall communicate via, BACnet IP to the local Trend IQ4E outstation. The type and amount of data interface to be determined via the specification.

Note – The BACnet interface is to be used for data collection /view only; it must not be used for control

A 8 Remote Equipment not supplied by BEMS Sub-Contractor

The BEMS Sub-Contractor will be responsible for the wiring, interfacing and operational checking of various other remote equipment supplied by the Main contractor. The commissioning of the actual equipment itself will be the responsibility of the Main Contractor via his nominated BEMS Specialist Sub-Contractor (e.g. The Manufacturer).

Typical Equipment under this category: -

,
Gas Safety Valves
Gas monitoring (Leak detection)
Gas meters
Water meters
Heat meters
Motor Speed Controllers

A 9 Boiler House Safety Equipment

Every boiler house shall be furnished with the following safety components: -

1. Emergency lock/stop buttons adjacent to each entry/exit point.

2. Suitable Sieger gas-leakage detection system.

3. Fixed temperature heat detectors, mounted directly over the boilers. Number required will depend on number and layout of the boilers.

4. 2-pole changeover, fire alarm relay, - activated from the auxiliary of the local fire alarm panel.

5. Main gas safety shut-off valve (Maintained open type).

6. Any additional fire alarm components, compatible with installed/proposed building fire alarm system, as detailed

at time of tender.

A 10 H&V Controls Electrical Installation

The complete electrical installation shall be supplied, installed, tested and commissioned by the BEMS Sub-Contractor. The electrical installation shall comply with all requirements detailed by the Engineer on behalf of the University of Southampton and shall be tested and certified as required by the CURRENT EDITION of the Institution of Electrical Engineers Regulations complete with all amendments to date.

Generally, the installation will comprise the following elements: -

i) All H&V Controls.
ii) Lighting and power requirements within boiler-houses and plant chambers.
N.B. Mains incoming supply by others, unless specified.
iii) Local fire interlocks within plant chambers and boiler houses.
iv) Gas leakage detection equipment within boiler houses.
v) Metering.

A 11 Plant Wiring

Within the boiler houses/plant chambers all 415/240Vac wiring shall be carried out in single hi-temp. PVC cable enclosed within galvanised screwed conduit and/or galvanised trunking.

All signal cabling is to be segregated when sharing the same trunking with 415/240Vac lines or is to be installed in a completely separate conduit/trunking system. Alternatively, signal cables may be run on light gauge galvanised cable tray and affixed with cable ties.

Multi-core Signal cables will generally be individually screed types for all analogue inputs and overall screed types for digital inputs, their respective type will be indicated on the drawings.

Where a single multi-pair is used for a mix of both analogue and digital inputs, the higher spec for the individually screened type must be used.

All conduits trunking and trays installed must be suitably bonded to earth. Copper bonding links will be used on all tray and trunking joints.

All pipework shall be bonded as it enters or leaves the boiler house or plant chamber using a suitably sized, PVC insulated copper conductors enclosed within a conduit/trunking network and shall be taken back to the main earth terminal on the H&V Control Panel, or where applicable, the local distribution board.

All extra-low voltage BEMS I/O cables shall be run in screened twisted pair cables to the Trend standard specification. They shall be affixed to tray, drawn into conduit or trunking and protected as agreed with the engineer to suit the various environmental, social and mechanical locations. No joints will be allowed in cables, where these are unavoidable, the cables shall be joined using an approved housing, securely fixed and having cable securing clamps. Any such connecting boxes shall be shown on the record drawings. No trays, conduits or cables are to be affixed horizontally at floor or pedestal level. Where cables are connected to sensors measuring extreme heat, the necessary thermal breaks, local connecting cables are to be supplied. No BEMS data cable shall be installed in the same conduit as any power cable nor affixed within 25mm if surface/tray mounted. Where cables are run in trunking or with others clipped to tray of a similar type they shall be identified either by colour or labels every 2m.

Special care shall be taken to ensure that the manufacturer's recommendations with respect to earthing data cables and outstations are obeyed.

Each BEMS field device shall be identified (internally on space temperature and humidity sensors) with a common code used on points and wiring schedules, parts lists, control strategy, MCP and installation diagrams/drawings.

All BEMS cables shall be suitably identified with sleeves at the terminations. These shall be recorded on the installation diagrams and wiring schedules.

Sensors, actuators, switches and all field devices shall be mounted according to the manufacturer’s instructions. All will be installed with clearance to allow for servicing, and the conduit connected by methods to allow easy replacement.

Where outstations switch circuits having potentially different mains voltage supply feeds, extra low voltage relay circuits shall be employed. A notice shall be fixed inside the outstation detailing how all mains feeds into it can be isolated. Consideration shall be given to employing an extra low voltage control circuit for motor starter and contactor coils and shall be mandatory where MCP with separate cubicles for motor starters are employed.

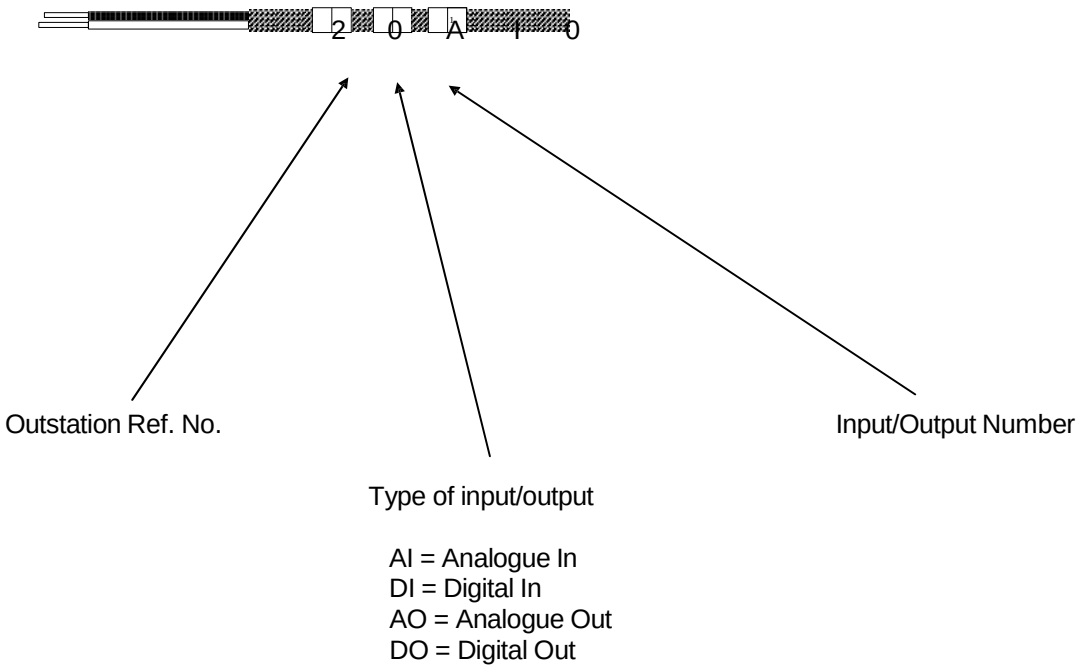
Each outstation shall be provided with a schedule identifying the points connected to the I/O terminals inside the panel door.

Wiring within the outstations shall be completed in a neat and professional manner with lacing/cable ties. No wired connector shall be in tension by wires cut too short, earthing braids/wires shall be neatly terminated. Prior to commissioning each outstation enclosure shall be cleaned of all cable waste.

A 12 Cable Identification Outstation (Input/Output)

All input/output cables are to be identified at each end using R.S. Components heat shrinkable cable markers of the appropriate size.

Coding will be to the following pattern:



N.B. Multi-pair cables will require an overall identification Ref: on the outer sheath, using appropriate size heat shrink markers. Reference to be as per tender drawings.

A 13 Connections to campus network

The University BEMS Engineer will assign the following.

TCP/IP addresses
LAN numbers
Outstation numbers
Existing networks – Site GUID's

For new projects the BMS contractor will allocate the site GUID.

Outstations & networks must not be added to the campus network until the 963 supervisor(s) have been fully engineered.

TCP/IP Networks

The controllers shall have automatic IP addressing as a default setting, on power up the controller will attempt to contact a network Dynamic Host Configuration Protocol Server (DHCP server). If found the DCHP Server will allocate the IP Settings. If no DHCP server is available or one is not connected to the network, then the Controller will adopt an internal privately negotiated addressing scheme (sometimes referred to as LINK-LOCAL addressing)

The university's own IT BEMS will provide a TCP/IP outlet adjacent to each MCC panel.
The BEMS contractor is to install a patch cable from this outlet to the control panel.
The control panel is to contain all necessary Hubs, routers, switches to network all BEMS equipment.

Inter Controller Communications [ICC]

The controllers shall communicate in a true peer to peer relationship and must be capable of operating on a 'stand-alone' basis. Should a failure of the communication network occur, the controllers must still be capable of full control of plant items based on most recent information available or by a default strategy programmed in the controller.

ICC FROM comms should be used where ever possible.
Should an ICC fail, after a grace period [15 mins] an alarm should be sent to the BMS supervisor.

A 14 Front End Supervisor [IQ Vision]

The IQVision supervisor connects to HVAC plant-controlled outstations in buildings on the main campus and also to buildings at satellite sites in Southampton and Winchester.

Each building or in some cases groups of buildings are set up as trend sites having their own unique TCP/IP connection.

Two sets of schematics are required for each building.

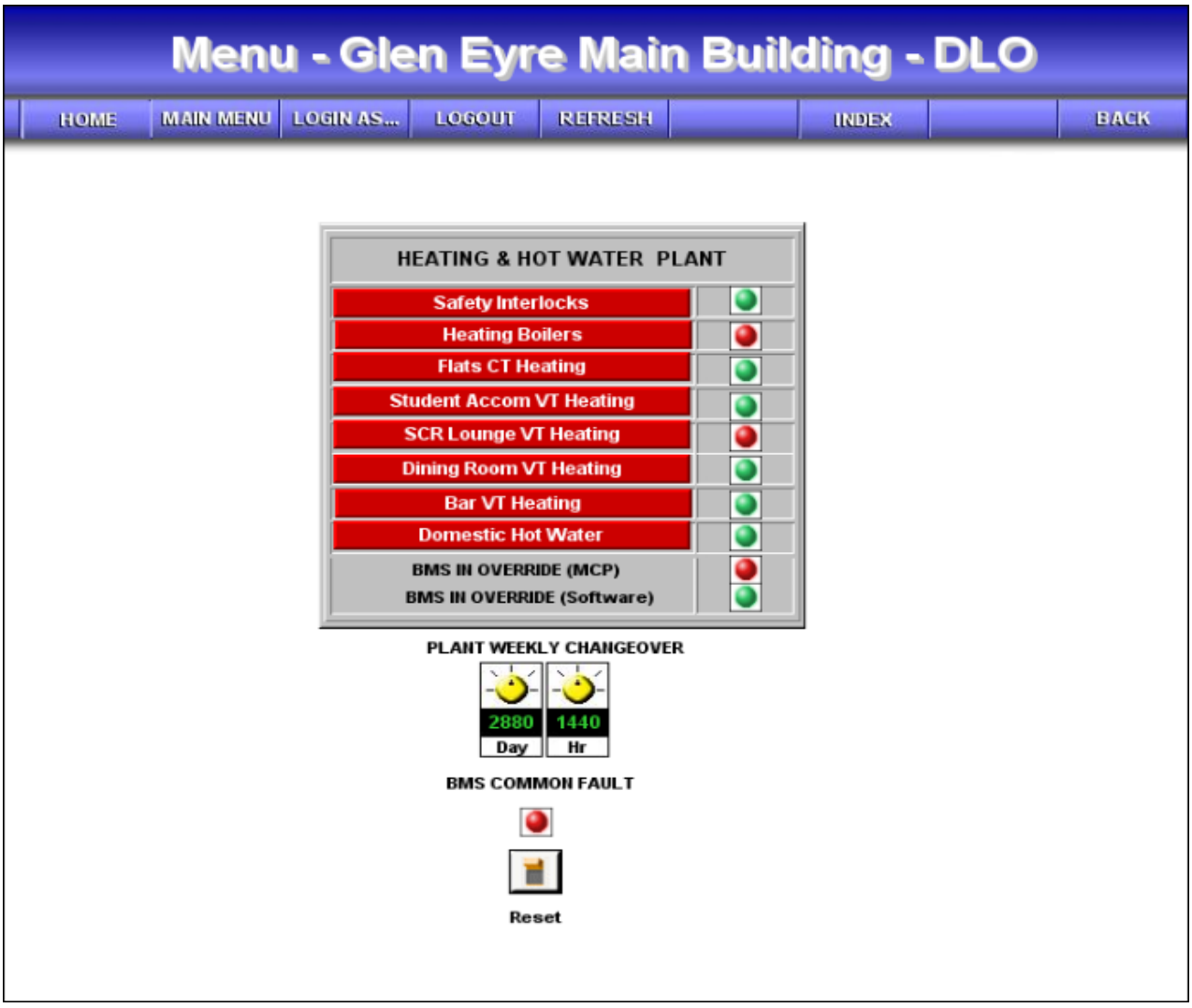
The 1st set will be plant traditional schematic pages which will allow department and other end users to view plant operation and, in some cases, make minor adjustments.

The 2nd set, called "DLO User Pages" and are intended to be used by maintenance engineers.
These pages will allow engineers to quickly identify current plant alarms as well the ability to easily reset software latched alarms and override BMS outputs for test purposes

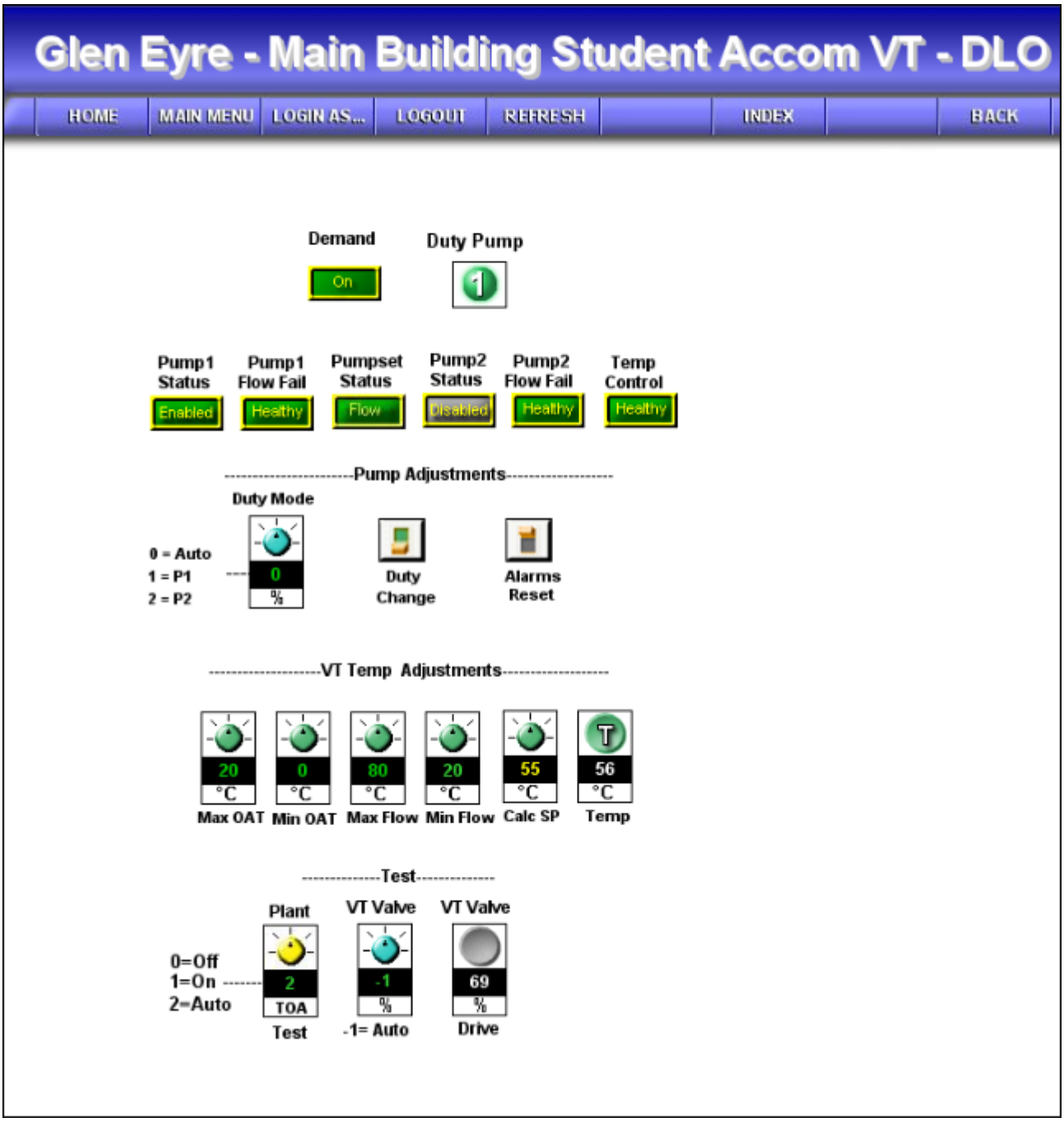
The top level DLO page will list items of plant on a zonal basis, e.g. Boilers, Chillers, VT Heating Z1, VT Heating Z2, AHU1 etc. and for each one there will be a common fault indicator "Healthy / Fault".

Clicking on a zone label will jump the user to a sub menu page which will provide more information about that zone. From this sub menu page, the maintenance engineer will be able to view individual alarm states and thus identify which points are in alarm. This page will also have all maintenance engineer's adjustments e.g. fault reset, duty change, plant test, valve manual test etc, please see sample pages below.

DLO Page

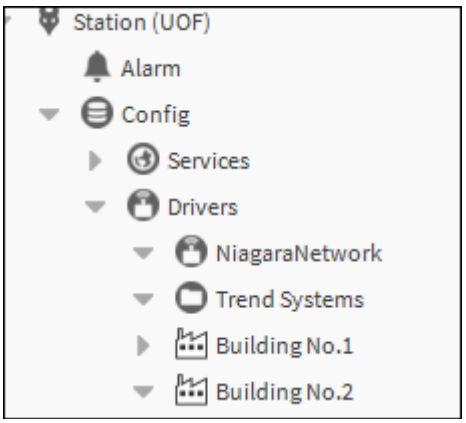

Menu - Glen Eyre Main Building - DLO
HOME
MAIN MENU
LOGIN AS...
LOGOUT
REFRESH
INDEX
BACK
HEATING & HOT WATER PLANT
Safety Interlocks
Heating Boilers
Flats CT Heating
Student Accom VT Heating
SCR Lounge VT Heating
Dining Room VT Heating
Bar VT Heating
Domestic Hot Water
BMS IN OVERRIDE (MCP)
BMS IN OVERRIDE (Software)
PLANT WEEKLY CHANGEOVER
2880
Day
1440
Hr
BMS COMMON FAULT
Reset

Sub Menu Page



File structure

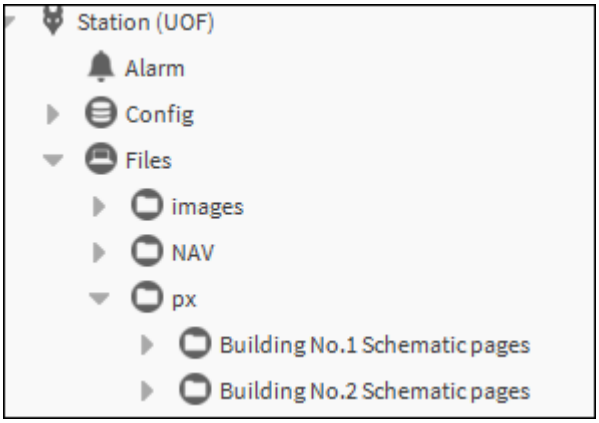
Each Trend site is to be learnt (discovered) as shown below. (This is the equivalent of device viewer on the 963)



To ensure that alarms get routed correctly the Site GUID in outstations must be set the same and this same Sire GUID must be set when configuring the alarms for that site in IQ Vision.

Schematic Pages

Schematic pages should be stored in location shown below



Sketches/diagrams showing the layouts and menu forms shall be supplied prior to data entry for approval by the University BEMS Engineer.

Generally, colour displays shall be supplied on the basis of one per plant, with sequential and cross indexing/paths to allow movement between the displays in a logical manner. An exit to the head/index page will be available from each display. The correct performance of the displays will form part of the plant commissioning procedures.

No supplier's advertisements shall be incorporated into the display pages. Each page shall identify the name of the site, building and the location.

In general, but not exclusively, the following supervisor features are to be configured:

Colour schematics for the Supervisor shall be supplied displaying the following features:

Each and every connected point, status conditions (Running/Stopped etc.), analogue values with engineering parameters ('C, %RH, l/s etc.), Output positions (% open, rpm etc.).

Animations shall be used where appropriate to make the graphical user interface more intuitive.

All calculated parameters as dictated by the controls specification, (highest, lowest, total, rate etc.)

Selected optimiser switching times, (start, stop,)

Adjustable set points and overrides. (overrides to appear on DLO user pages only).

Current sequences in operation

Energy/efficiency calculations.

Alarm conditions, shown highlighted.

Push buttons or icons to gain text panels, pre-configured graphs and other displays.

Push buttons or icons to select pre-configured control actions.

Plant 'out of auto' indication

Hyperlinks should appear on the building MENU schematic page to access the following documentation.

- 'Description of Operation' for the relevant plant
- Strategy diagrams.

These documents are to be stored on the station in a folder named OandMs. This folder will be located under the building schematic pages folder.

Both documents must be in be in pdf format.

The 'Description of Operation' pdf must have hyperlinks added to allow the user easy access to any section without the need to scroll through pages. Each sub section title must also have a hyperlink added to navigate the user back to the beginning of the document.

Tooltips shall be used to further aide users to identify the function of each button/hotspot on the schematics.

The graphics shall be set up to allow different access levels as per the University standard access levels.
This will typically be, view only, user, engineer, and programmer.

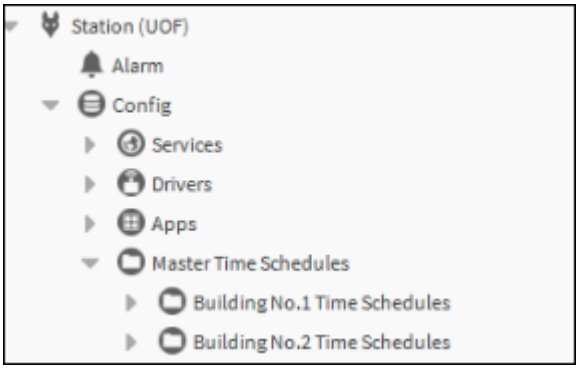
Dashboard displays Graphic

The University is promoting the user engagement of systems onsite and requires for each building a dashboard is created. The standard dashboard is to display typical building information, weather, temperatures, set point, metering, target conditions and any information required. This is designed to be utilised by each building manager or in each building's foyer as a global indication of the operation of the building. The full requirements of each dashboard to be confirmed with the University BEMS engineer.

Alarms shall be grouped by general location and type. A display page(s) shall be set up showing the condition of all critical alarms. Critical alarms and any other alarm specified shall automatically load the schematic or text page to ensure accurate identification of the event. Where appropriate the two stage schematics shall be used to ensure easy identification of the alarm event. Alarm information need also be grouped by workgroups, such that an alarm panel can be sent to the appropriate person/s should they be logged into the system at the time of the alarm occurring.

Diary Functions [Calendars]

The Calendar files should be stored in a folder named 'Master Time Schedules' as shown below.



Each building will have its own folder.
This folder will have a wiresheet which contain all the IQVision Boolean Time schedules for a building plus one common calendar schedule.

When setting up a site in IQVision boolean time schedules are to be created for each Trend time program and then linked on a one to one basis.
E.g. if a building has 10 Trend time programs then 10 boolean time schedules are to be created and then linked as shown below

Trend Z1 – IQVision Boolean schedule 1
Trend Z2 – IQVision Boolean schedule 2
Trend Z3 – IQVision Boolean schedule 3 ……
Trend Z10 – IQVision Boolean schedule 10

The IQVision is to be set to update the Trend time zones every 4 hours.
The Calendar schedule is to be used for bank holidays.

The bank holiday dates are set in the Calendar schedule.

The link to the calendar schedule is made in the individual boolean time schedule by setting up a special event and event type select reference and then choose the calendar schedule.

Note the actual time profile for the bank holiday is set in the boolean time schedule so it is possible to have different bank holiday times for each boolean time schedule.

Also, when setting the bank holiday times, you must set all periods so for example so you wanted the plant to run from 08:00 to 16:00 you would need to set the following.

00:01 to 08:00 – Unoccupied.
08:00 to 16:00 – Occupied
16:00 to 24:00 – Unoccupied.

N.B. It shall be the BEMS Sub-Contractor's responsibility to ensure that the complete operational requirements are achieved to the satisfaction of the University BEMS Engineer.

A 15 Smart buildings & Integration

Smart Buildings

With the advancements in integration, sharing of data between systems has become more common.
However, this can cause operational difficulties for the university's R & M team.
The preference is therefore to avoid this if at all possible.

If it is going utilised the following ground rules must be adhered to.

- The BEMS contractor to be given overall responsibility for managing the delivery of all integrated systems.
- The BEMS contractor must be able to provide in house post O & M support for all systems.
- Off the shelf solutions are to be adopted, bespoke software solutions are to be avoided.
- Bacnet to be used as the common protocol
- The BEMS is to be the initiator of all data requests either via ICC FROM or ICC TO comms.
- Default control strategy to be configured in the event of ICC comm failure.
- All integration software to be fully documented.

HVAC Plant Integration & Metering

This integration is to be used to view and capture data, it must not be used for control.
Control to be via conventional Trend controller I/O.

The integration should be achieved at controller level.

As with smart buildings the integration must be fully documented; this will include data look up tables etc., and the provision of user logins.

Trend & 3rd party OEM Controls [Packaged Plant]

Some HVAC plant manufacturer's (Air Handling Units / Chillers/ Fan Coil Units etc.) offer packaged equipment either with either their own proprietary control systems or Trend OEM controllers fitted to them.

However, it is the University of Southampton's preference for all intelligent controls to be provided by the Trend Controls sub-contractor. This minimizes the University's requirement to interface these devices to the main trend BEMS saving time and money and duplication of hardware.

The issues with Trend OEM controlled equipment is the manufacturers often write one control strategy to cover many applications. This makes the software over complicated and confusing and it ends up not being engineered to the university's standards.

Therefore, packaged plant fitted with 3rd party or Trend OEM controls should be avoided.

Any proposed Trend OEM or 3rd party control solution must be submitted to the university's assistant BEMS engineer for approval.

Where packaged plant is deemed acceptable it will be supplied with its own complete control system.

The controllers must be networked and connect with to the Trend BEMS network.

Any control interfacing should be by conventional I/O.

In the case of 3rd party controls they must support Bacnet protocols to allow integration with the Trend BEMS.

963 schematic pages should be provided.

The Trend BEMS sub-contractor will be responsible for providing all hardware to allow integration, installing the network cabling and 963 engineering.

In case of terminal equipment such as fan coils the Trend BEMS sub-contractor's package should include for the supply of pre-engineered IQ4xx controllers to the fan coil manufacturer to allow these controllers to be factory fitted to the terminal units.

A 16 Commissioning

The BEMS specialist contractor shall be responsible for the full commissioning of his system and any other controls equipment supplied under the contract.

Off-site pre-commissioning

The outstations and front-end software are to be fully checked / proven by the project BEMS design team.
Ideally this should not be carried out by the engineer who designed the software.

The approved draft description of operation should be used as the terms of reference.

Outstation software

Functional testing should be carried out using simulation mode in SET.

By overriding appropriate I /O and IC comms all control routines should be checked.
This will include all interlocks (safety or otherwise), occupation plant enables, heating & cooling demands, non-occupation protection routines, boilers & chillers sequencing and duplex plant control strategies.

An itemised record of this testing should be provided within the O & M documentation.

All IC comms should be double checked for accuracy.

An itemised list of all IC Comms shall be provided in spreadsheet format detailing all parameters as well as a functional description of what each IC Comm does.

Commissioning

All safety interlocks, overrides and fail-safe conditions are to be operational prior to starting the plant. Demonstrate as agreed with the engineer and University BEMS Engineer prior to starting plant in BEMS auto mode.

Fault conditions for all critical alarms, safety devices and control interlocks shall be simulated and proved effective as soon as practical once BEMS control mode is selected.

Sensors shall be checked to ascertain accuracy within limits, pressure switches checked for switch points and hysteresis. Humidity sensors shall be checked for accuracy using a wet/dry bulb thermometer.

All the necessary test equipment and materials used in commissioning shall be supplied by the BEMS Specialist Sub-Contractor. All test equipment shall have valid test certificates.

Trend graphs will be provided to demonstrate the stable control of the plant. Simulated inputs will be employed to check stability over the design environmental range.

The BEMS Specialist Sub-Contractor shall allow suitable additional time for the commissioning engineer to revisit the system at a later date (after hand-over). He shall check and adjust operational parameters, and re-tune any control as maybe required by change in the control system load conditions or bedding-in of the plant. Allowance should also be made for the commissioning engineer to revisit the system for seasonal commissioning ensuring the correct operation of the system in full heating and cooling demands.

Commissioning documentation and schedules shall be submitted for approval during the design phase showing each plant, point, interlock and control algorithms, and the stages of checks and commissioning required. Each cleared item to have date and engineer reference. Completed copies shall be available to the engineer prior to acceptance testing. A complete set of the commissioning documentation is to form part of the system documentation.

Once any item of plant is commissioned and left running to the dictates of the BEMS, documentation showing the overrides, control and software configuration shall be available on site at all times. All system documentation shall be in accordance with Trend standard templates.

A 17 Demonstration/ Hand-over and Documentation

Acceptance Demonstrations

The BEMS Specialist Sub-Contractor shall give seven days' notice to the engineer, University BEMS Engineer, and Trend site maintenance provider of his intention to provide the acceptance demonstrations once the commissioning is complete. The operation of all safety interlocks shall be tested and ten per cent of all points shall be selected by the engineer and demonstrated for operation/accuracy. Should more than 10% fail performance test, a further ten per cent may be selected. If above 10% fail he may at his discretion demand 100% demonstration. The BEMS Specialist Sub-Contractor shall supply sufficient man-power/test equipment, consumable items and portable telephones to conduct the demonstration efficiently. Testing shall also incorporate an audit of the wiring and hardware installation, demonstration of safety interlocks, start of system from power-down and review of time schedules and alarm levels, grouping and selected control parameters.

System Hand-Over

The BEMS Specialist Sub-Contractor shall ensure the following are completed at hand-over:

- Any snagging to be documented and agreed date determined for clearance.
- All passwords/PIN numbers, levels and operators recorded.
- Copies of all system and data files supplied. Including all Trend SET files and IQVision back up. [IQVision paraphrase, platform username/password & station admin username/ password must be provided.]
- Proprietary software manuals & disks.
- All equipment access keys handed over.
- Complete sets of O&M manuals left with system, any agreed amendments/additions required to be documented and a target date for completion agreed.
- Training of engineers and operators to be checked complete or program for completion agreed.

Documentation

Compile a guide for occupants
A simple well-illustrated and annotated guide for occupants to be supplied. This will help users to understand the design intention and to use the building effectively

Compile a technical guide
A technical guide should be provided to the facilities team with a succinct introduction to the building and its systems. It should have been developed during the design and construction phases as information becomes available

If will include two 'hard' copies of all final operating and maintenance manuals will be supplied within two weeks of hand-over in A4 binders. Two 'soft' copies shall also be provided in the form of CD for storage / reference. Preliminary copies shall be available to the client during this time. All Trend system documentation shall be in accordance with Trend standard templates.

'As Installed' Back up data files (strategy and graphics) shall be issued as part of the O&M documentation. The backup data shall not be stored on the same PC containing the supervisor software.

Operating Manuals shall comprise instructions on equipment safety checks, start-up and closedown procedures, daily operation and full descriptions of operating features. These shall match and comply fully with the software supplied, provide examples of operation with supporting flow/strategy diagrams. Diagrams shall show the full diagrammatical (network structures, outstations and peripherals) and physical layout of the system and components. Operating manuals should be readily available via hyperlink from the relevant IQVision graphic pages.

Maintenance Manuals shall comprise full descriptive and maintenance details on each and every item of equipment supplied. Suppliers and spare parts references, contacts, telephone numbers, and addresses shall be supplied where relevant. Wiring schedules shall show the connection of each item of equipment to the field equipment. Data sheets and maintenance instructions shall be provided for each item of equipment. Diagrams showing the configuration of all control and monitoring schemes, identifying the modules used, their interconnections and setting parameters, copy printouts showing the individual outstation module configurations and sequences.

Record drawings of the installation will be supplied on marked up architectural velographs, which will be free-issued to the BEMS Specialist Sub-Contractor.

All drawings relating to the BEMS will be supplied A3/A4 sizes bound into A4 ring binders. These shall include system, outstation and user terminal configuration diagrams, listings and flow charts.

A 18 Training, Warranty & Maintenance

Site/User Training

The BEMS Specialist Sub-Contractor shall supply the following training for the clients engineering staff.

General engineering staff:
Off-site prior to hand-over at manufacturers works; non-specific system structure, components and applications. Operation of user terminals, keyboards, use of displays, overrides, passwords.
On-site; specific system structure, outstations locations, control strategy overviews. Operation of user terminals, adjustments, trend graphs and alarm handling. Other networked components.
Ensure building operators are familiar with the BEMS and allied controls. Staff will need to know how to adjust and fine-tune settings and have the appropriate level of access

Engineer & selected staff:
Off-site prior to hand-over complete training courses at the manufacturers works, instruction in the following; all as above but also including, configuration of outstation and user terminals software, Windows file structures, password and engineering utilities, fault-finding, tuning and maintenance.

On-site;
The clients engineer University BEMS Engineer and Trend BEMS maintenance provider will attend the acceptance demonstrations, the BEMS Specialist Sub-Contractor shall instruct him in the specific application of the system, the structure and the control strategies adopted to meet the specification.

Warranty, Support Period, Soft Landings & Maintenance Contract

The warranty period for the new equipment shall be twenty-four months from the date of Trend manufacture or a minimum or one-year form practical completion and hand over of the site.
‘Statement on Product Reliability’ can be made available on request.

At handover the following post contract 'fault' call out on site support shall be provided free of charge for a period of twelve months.

Seasonal review / commissioning, future visits to site to review BEMS performance. A site visit in conjunction with the University BEMS engineer and Trend maintenance provider to review BEMS performance.
A written review of overall energy and systems performance at six-month intervals, 6months and 12 months after project practical completion to be provided after site meeting and review.
Seasonal changes and results of project performance review monitoring may require fine-tuning of systems and setpoints. Site based engineering time to be factored into the program for post project seasonal review work.

SECTION B SOFTWARE CONFIGURATION

B.1 General

These notes are to be used in conjunction with the University **MACRO** library, by the BEMS Sub-Contractor for the design of Caradon-Trend Outstation software for H&V Control in University buildings.

The Macro Library documents are too large to include on the Standard Specifications web site or to send by email and so you should make a request to the Liaison Engineer to have them sent via the University's SafeSend system.

When a BEMS Sub-Contractor is appointed he must request the up to date Macro Library SET project from the university's BEMS engineer. They can then copy and paste the relevant macros into their particular project.

These macros will form the basis for the preliminary software briefing, which is to be held between the University BEMS Engineer, the Consultant Engineer and the BEMS Sub-Contractor, shortly after his appointment.

The BEMS Sub-Contractor will retain **FULL** responsibility for the safe and proper operation of all equipment covered by the software, based on these notes and the macro files.

The control macros must be fully commissioned by the BEMS Sub-Contractor and the university's BEMS engineer advised of any "bugs" so that the master files can be updated.

For applications where macros do not exist the BEMS Sub-Contractor is to design & submit a control strategy to the university's BEMS engineer for approval.

Once accepted it will be added to the macro library.

B.2 Master Switches

Where a single outstation provides control for a whole building, it shall have the following 'soft' master switches set-up.

Switch 1	(W1) Holiday/Normal	ON = normal
Switch 2	(W2) Summer/Winter [Manual Select]	ON = winter
Switch 3	(W3) Fireman's Smoke Vent	ON = ON (normally OFF)

Where more than one outstation provides control for a building, the lowest Ref: outstation shall be assigned to the main Boilerhouse or plantroom and be provided with the above switches.
The master-switch logic will then be sent via Inter-controller Comms. to act on all other outstations within the building as required.
On the large complexes, consisting of a number of individual buildings, each building's lowest outstation will carry the three master switches. Switches 1 and 2 will then be over-written from one block (usually the lowest assigned e.g. Block 'A'), using global text comms. with an Attribute 2 set-up to represent the complex name. (E.g. Montefiore Hall = MONTY).

This set-up will allow easy mastering of the whole complex, but still allow individual blocks, required to be operational, to be locally over-written.

Switch 1 (W1) Holiday/Normal
When switch 1 is in the 'ON' mode all plant is to run normally under the dictates of the local time-zones.

When switch 1 is in the 'OFF' (Holiday) mode all plant operation is halted, but **FULL** frost protection is still available.

Switch 2 (W2) Summer/Winter [Manual Select]

When switch 2 is in the 'ON' mode all plant is to run normally under the dictates of local time-zones.

When switch 2 is in the 'OFF' (Summer) mode all heating plant, unless of a special nature, shall be blocked from operation.

Note – The Summer/Winter manual select can be overridden by the Summer / Winter auto select, please refer to macro G001.

In Summer mode supply and extract ventilation fans are to be left fully operational, but their interlocks with LTHW supplies etc. will require blocking.

HWS calorifiers with immersion-heater facilities will be automatically engaged and controlled, with any unnecessary primary pumps and controls blocked from operation.

All high- and low-level space temperature alarms are to be blocked where cooling is not provided.

Switch 3 (W3) Fireman's Smoke Vent

Switch 3 is only to be placed in the 'ON' mode at the dictate of a Fire Officer's request after a genuine fire. All extract fans are to run, clearing the building of smoke.

N.B. A Fire alarm signal will cease **ALL** fan operation.

On larger buildings where, definitive fire zones are present, more than one Smoke-Vent switch may be required, where this is required all additional switches are to be configured.

N.B. When called for operation, the fire signal will possibly still be present and operating logic must allow for this contingency.

B.3 CONTROL MACROS

G001 – Summer – Winter Auto Select – requirement one per site

This strategy incorporates the Summer-Winter manual select.

Summer months are calculated by F10, F11, F135 & F136 (May – Sept Inclusive)
In May the heating is terminated early, this is set by K27, current value 10.30.

In Jun/July/Aug & Sept the heating is disabled.

The system can be manually selected to go into summer via the Summer select switch, W2.
The system can be put back into winter prematurely via the winter override switch, W14.

G002 – Summer – 1st Stage Frost – requirement one per site

This strategy is used outside normal operation.

The threshold is set via knob K1 V=2°C.

If the OAT falls below this level then the circulating pumps will be enabled.
They will remain enabled until the start of normal operation or until the OAT has risen 2°C. above the threshold setpoint.

1st Stage Frost – heat still available (LTHW return temperature > 30°C).

VT heating valves

Please refer to macros G018A

AHU valves

Frost Coil – please refer to Macros G078 & 48.

Other heating valves – Open to 50%

Cooling valves – Open to 100%

1st Stage Frost – no heat available

VT heating valves - please refer to macros G018A

AHU valves

Frost Coil – please refer to Macros G078 & 48.

Other heating valves – Open to 100%

Cooling valves – Open to 100%

G003 - Alarm Handling – requirement one per outstation

There are to be 3 x alarm destinations configured and 2 x alarm groups.

All alarms are to be transmitted to the local IQView display panel and the IQVision HVAC supervisor.

Only Critical Alarms are to be transmitted to the IQVision Security supervisor.

Nb software enable switches have been configured so that alarm transmissions can be disabled whilst commissioning the plant.

All alarm transmissions are to be tested at the end of the commissioning process.

G004 – Power Up Safety Interlocks – requirement one per outstation.

This strategy is used to sequence the plant back in stages following a power interruption or safety circuit activation.

Plant should be sequenced in the following order.

Circulating pumps first, followed by boilers, then AHU's and finally chillers.

G005 – 2nd Stage Frost (LTHW Protection) – one per boiler / heat generation system

This strategy is used outside normal operation and can only be active when the OAT is low. (please refer to macro G002).

The threshold is set via knob K3 V=10°C.

If the LTHW / Boiler return temperature falls below this level then the boilers and circulating pumps will be enabled. They will remain enabled until the start of normal operation or until the LTHW return temperature has risen 20°C. above the threshold setpoint.

G006 – 3rd Stage Frost (Building Protection) – one heating zone system

This strategy is used outside normal operation.

The threshold is set via knob K4 V=12°C.

If the space temperature falls below this level the heating zone will be enabled in BOOST and the boilers and circulating pumps will be enabled.

They will remain enabled until the start of normal operation or until the space temperature has risen 2°C. above the threshold setpoint.

G007 – Weather season calculation – requirement one per site

This strategy is used to determine the season of the year so that adjustments can automatically be made to some of the heating setpoints.

G008 – Optimiser maximum warm up – requirement one per optimised heating zone

This strategy calculates a maximum warm up time based upon how cold it was at midnight on the previous day.

The purpose is to provide a “safety net” such that if a room sensor goes faulty or the optimiser over a period of time winds out due to a continual lack of heat, the maximum warm up is automatically clamped.

Function F132 goes high in the between the months of May to September and during this period the optimiser warm period is overridden to 0 minutes.

Logics G25/26 detect when the heating has been off for more than 24 hours, i.e. at weekends.

When this occurs the maximum warm up possible is increased via F25.

G009 – Heating Optimiser – requirement one per heating zone

In Winter, as detected by Function F30, the minimum space temperature is to be used as the internal control reference.
At other times the average space temperature will be used.

In Winter, again as detected by Function F30, Knob K5, V =21°C will be the target room temperature setpoint.
At other times the target room temperature will be 20°C [Fixed by function F31]

The maximum warm up available is calculated by macro G008
The optimiser looking at the external and internal temperatures will calculate when the heating needs to start to get up to temperature for the start of occupancy.

Time zones Z1 and Z3 are the standard occupation times for Accommodation & Teaching blocks.

G010 – Plant Override Timer – requirement one per plant system and then as required.

This timer is intended to be used by maintenance engineers to test systems out of season.
It can also be used to provide an override facility for department users.

Knob K6 is set override time in minutes (normal value = 0) [Range 0-60 mins]

When the knob value is set to a value >0.5 function F32 goes high and G29 goes low causing the counter logic G28 to start counting.

Digital input No.1 which is connected to F32 is the override bit.

The output (totalised) of counter G28 is subtracted from the original knob value by F33 and the resultant value is then written into knob K6, so the value displayed in the knob is the remaining override time.

When the knob reads < 0.5 function F32 goes low causing the timer to reset to zero and then cease counting.

An override session can be aborted prematurely by setting the knob value to zero.

G011 – Valve Override – requirement one per valve.

This override is intended to be used by maintenance engineers to test motorised control valves are operating correctly.

Knob K7 is the override value. (normal value, when not in override V = -1) [Range -1 to 100%]

When the knob value is set to any value between 0-100% function F35 goes high and the value going to the valve driver is switched from the normal control value to the value of the knob.

Logic delay ON timer G30 [3600 seconds] starts counting and after the delay 3600s [1 hour] automatically resets the knob value to -1 putting the valve back into auto control.

The valve can manually be put back into auto control at any time by changing the knob value to -1.

G012 – OAT Heating Hold Off – requirement one per site.

Knob K32 is the OAT heating hold off setpoint.

When the OAT rises above the setpoint the heating is held off.

It will remain in that state until the OAT falls more than 1°C below the setpoint.

The setpoint is automatically reset to 14°C on the 1st of May and back to 16°C on the 1st October.

G013 – Zone IAT Heating Hold Off – requirement one per heating zone.

Knob K9 is the IAT heating hold off setpoint.

If the IAT is > 0.5°C above setpoint and providing the OAT is > 12°C the heating will be held off.
It will remain held off until either the IAT falls > 0.5°C below the OAT setpoint or the OAT falls below 10°C.

G014 – VT circuit enable – requirement one per heating zone.

Normal Timed control

The heating circuit is enabled providing.

- The BMS is in Normal Mode (W1=ON)
- The BMS is in Winter Mode (G11D – Macro G001)
- The optimiser is in warm up or occupation
- The T/O/A knob is in auto mode
- VT heating is required
- LTHW flushing is not active
- All safety interlocks are satisfied.

Other Control – Test Mode or Building Protection

The heating is enabled when either the VT system is in either in Test Mode , please refer to macro G044 ,or Building protection providing

- LTHW flushing is not active
- All safety interlocks are satisfied

In Test mode the VT calculated setpoint is set at @ minimum of 60°C
In building protection, the system operates in BOOST, VT calculated setpoint fixed @ 80°C

For flushing / valve exercise mode please refer to macro G020.

Note – The VT pumps only are enabled under 1st stage frost.

G015 – VT Room BOOST – requirement one per heating zone.

The room BOOST threshold is set by function F44. (ON when IAT<18.5°C, OFF when IAT> 19.5°C)

In BOOST the VT calculated flow setpoint is fixed @ 80°C by function F60.

G016 – VT Room Influence – requirement one per heating zone.

Room influence is used to adjust down the VT calculated flow setpoint when the zone space temperature overshoots the room setpoint by > 1°C.

For every degree above it reduces the VT weather compensated flow setpoint by 5°C up to a maximum reduction

of -15°C.

G017 – VT Heating Early OFF– requirement one per heating zone.

The early off is activated when

- the OAT has risen to above 12°C at some time during the day and is still > 10°C.
- and the zone room temperature is > 2°C above setpoint
- and the actual time is < 2 hours before the end of occupancy.

When activated the VT valve is driven to 0% and the pumps continue to operate until the VT flow temperature has decayed to 25°C.

G018 – VT Heating calculated flow setpoint – requirement one per heating zone.

Weather Compensation

Knob 8 is the required flow temperature @ 0°C OAT and also sets the maximum VT low temperature.
Knob 10 is the VT Slope (Default value -3)

The table below illustrates the weather compensation calculation with these settings.

OAT	Calc SP
0	80
1	77
2	74
3	71
4	68
5	65
6	62
7	59
8	56
9	53
10	50
11	47
12	44
13	41
14	38
15	35

Actual VT Flow calculated setpoint

The actual calculated flow setpoint in normal operation is the weather compensated value less the room influence.
In BOOST it will be 80°C and in Test mode it will be a minimum of 60°C.

G018A – VT Heating valve control – requirement one per heating zone.

Normal Operation

The VT valve is modulated to achieve the calculated VT flow setpoint (see macro G018).
The normal VT valve control is overridden by

- Heating early off. (See macro G017)
- Valve Test (See macro G011)
- Pump & Valve exercise (see macro G020)

Non-Occupation.

Under 1st stage frost if the VT flow temperature falls below 10°C the unoccupied flow setpoint is set to 80°C and a heat demand signal is sent to the start the heat generation plant.

The VT system will continue to operate in this mode until the VT flow temperature has risen above 30°C.

G019 – VT Flow over temperature alarm – one per heating zone

In normal operation if the VT flow temperature exceeds the VT calculated flow setpoint by more than 5°C for more than 15 minutes an alarm will be generated.

G020 – Heating Pump / Valve Exercise and flushing routine. – one per site

Pump & valve exercise

This routine is only operational in summer mode. (See macro G001)
Knob K28 sets the exercise day of week and knob K29 sets the time.

When the actual week day and time match the setpoints a 5-minute pulse is generated.
This will via logic G49 run the heating pumps for a total time of 600 secs.

For the 1st 300 seconds the valve(s) drive signal will be 100% and for the last 300 seconds the valve(s) drive signal will be 0%.

Flushing Routine

This is selected manually by switch W5.
When selected the valve(s) will be driven 100% open and the circulation pump(s) will be enabled.

G021 – CHWS Pump / Valve Exercise and flushing routine. – one per site

This routine works in a similar way to G020 however the valve(s) and pump(s) exercise are only available in winter.

G022 – Plant Weekly Changeover – one per plant set, i.e. duplex pumps , boilers, and duplex fan sets.

Knob K30 sets the day of week when the duty changes and Knob K31 sets the time.
When the actual week day and time match the setpoints a 2 second pulse is generated via logic G121 output.

G023 – Duplex plant duty select – one per plant set, i.e. duplex pumps, boilers, and duplex fan sets.

This strategy has an extra feature which allows a maintenance engineer the facility to override the pump auto duty select , this is often needed if one item plant has been removed for repair.

Knob K11 provides this facility.

The normal value for auto changeover is when V=0.
If V=1 then No.1 item of plant would always be selected or be duty.
Similarly, if V=2 then plant item No.2 would always be selected or be duty.

In normal operation the pumps would automatically change duty each week (see macro G022).
In addition, the duty can be changed manually by changing the state of switch W10.

G024 – Global Alarm Reset (Software only)– one per outstation(s) / or MCP.

This strategy provides a global reset of latched alarms.
This is achieved manually by changing the state of switch W7 and happens automatically on outstation power up.

G025 – Global Alarm Reset (Software & Hardwired) Local – one per outstation(s) / or MCP.

This strategy operates in a similar way to macro G024.

However, in addition there is a fascia mounted reset button input which resets any electrically latched alarms as well as software latched alarms,

G026 – Global Alarm Reset (Software & Hardwired) Local & Remote – one per outstation(s) / or MCP.

This strategy operates in a similar way to macro G025.
However, in addition there is BMS pulsed output relay which resets any electrically latched alarms on power up or remotely from the IQVision supervisor.

G027 – Duplex plant control – one per plant set, i.e. duplex pumps or duplex fan sets.

Sheet 1

The common flow status is monitored by digital input No.25.
When a pump is enabled if a flow status is not registered within 30 seconds a pump flow failure alarm is generated.
These flow failure alarms are latched requiring an alarm reset.

Sheet 2

If the lead pump registers a flow failure it will be disabled and the lag pump will be enabled.
If the lag pump registers a flow failure it will remain enabled.

Alarms can be reset via the global reset switch , see macros G024-G026

G028 – Boilers Calculated flow setpoint – one per boiler installation.

When the OAT is below 5°C the boiler flow setpoint is the boiler maximum setpoint, set by knob K15
Once the OAT is above 5°C the boiler flow setpoint will be the maximum of.

- The maximum VT calculated flow setpoint + 5°C
- The boilers compensated flow setpoint

G029 – Boilers temperature control – one per boiler installation.

The boilers temperature control loop is enabled when there is a heat demand providing all safety interlocks are satisfied.

To prevent rapid cycling a minimum ON timer has been configured to the heat demand signal.
(logic G110 set @ 300s)

G030 – Boilers Sequencing 4No.

Sheet 1 – Boilers Duty select

The strategy on this page works in an identical as macro G023.

Sheet 2 – Boilers Staging Lead & 1st Lag

The strategy on this page generates the demand for the lead and 1st lag boilers.

Sheet 3 – Boilers Staging 2nd & 3rd Lag

The strategy on this page generates the demand for the 2nd and 3rd lag boilers.

Sheet 4 – Boilers enable signals.

Driver No.7 is a “dummy” driver configured for control purposes.
In conjunction with the number of boilers required and boiler duty it determines which boilers should run.
The signal output [state] is in analogue format so is decoded by function F105 to provide the boiler enable signals.

G031 – Boiler & shunt pump control via 2RM

When the boiler is required to run and providing all interlocks are satisfied the output of driver D6 will go to 50%.

This will energise the LO relay and bring on the shunt pump.

When the shunt pump run is proven (digital input No.36) and providing all interlocks are satisfied the output of driver D6 will go to 100%.

This will keep the LO relay energised and also energise the HI relay which will enable the boiler.

When the boiler is no longer required the output of D6 will go to 50% for 120 seconds (Logic G104), this will allow the shunt pump to run on to dissipate any residual heat.

G032 - BMS Common Alarm Output – requirement one per control panel

This strategy is used to drive a fascia mounted BMS Common fault lamp mounted the control panel fascia.

G033 - Digital Input COS Data Plot – as required

This strategy is used to generate a data plot when a digital point changes state.

G034 – Alarm Latch – as required

This strategy provides an alarm latch which will need resetting by the BMS operator.

A typical use would be for a filter dirty alarm.

If the filter dirty real input was used, with a filter is in a blocked condition, an alarm would be generated every day on plant start up.

This alarm would then clear when the plant shuts down.

Using the alarm latch this prevents nuisance alarm.

G035 - Boiler Sequencing 2No Boilers HI/LO.

This strategy works in a similar way as G030.

G036 - Boiler Hi - LO with Shunt Pump.

This strategy works in a similar way as G031 but with the addition of 2 boiler stages.

G037 – Minimum Off and minimum ON timers – as needed

Unfortunately, the Trend BMS does not have a logic minimum OFF timer so this strategy creates one.

When there is an initial demand Logic G139 goes high as comb K is satisfied.

As the long as the demand exists G139 remains high via comb J.

When the demand is removed Logic G139 goes low.

If a demand re-appears Logic G139 cannot go high until G140 has timed out.

G142 is used as to keep the signal high for a minimum ON period.

G038 - Humidity Control - Space Temp Reset

This strategy is used to vary the space temperature to achieve either passive dehumidification or humidification. The rule of thumb is that increasing the air temperature by 1°C results in an approximate reduction of 4% in relative humidity.

Sheet 1 is the traditional humidification / dehumidification control strategy.

Sheet 2 sets the acceptable range of space temperature.

The 1st 20% of humification demand is used to drive the space temperature setpoint down towards the minimum threshold. If more humidification is enabled then the steam humidifier is enabled.

Similarly, the 1st 20% of dehumidification demand is used to drive the space temperature setpoint up towards the maximum threshold. If more dehumidification is enabled needed then this is provided by mechanical cooling.

G039 – Setpoint Auto Reset to default @ midnight.

This strategy is used to reset a setpoint back to a default value @ midnight each day.

Function F134 i/p F holds the default value.

At midnight logic G149 goes high which via F134 writes the default value into the setpoint, knob K23.

G040 – Chillers Sequencing 3No.

The strategy on this page works in an identical as macro G030 except there are only 3 plant items.

The other differences are

- When there is a demand the lead chiller is always enabled.
- The delay time between stages is calculated based upon how far away the CHWS flow temperature is from setpoint.

G041 – IC Comms

All IC Comms should be TO rather than FROM comms and only analog comms should be used

Sheet 1

Shows the IC Comm settings in the originating outstation.

Where digital points need to be sent then they should be encoded into an analog value (see G171) and then decoded

back in the receiving outstation (see F162).

Sheet 2

This shows the IC comms in the receiving outstation.

G042 – Alarm Logic for IQVision

This strategy creates an alarm structure based on plant type.

It is used in IQVision to be able to identified current faults on a plant basis

G043 – MCP T/O/A switches

This strategy is used to configure the software work with these switches.

G044 – Software T/O/A knobs

Knob K33 is the T/O/A knob

V=0 Plant Off
V=1 Plant On [Test Mode]; note all safety interlocks remain active.
V=2 Auto

Test mode will automatically reset to Auto after 3600s [1 hour]

Automatic Personnel Detectors (APDs)

All reasonably sized areas identified as not being permanently occupied, such as Common Rooms and Lecture Theatres, etc. are to be mastered by APDs to save energy and provide fully-automatic 'out-of-hours' operation.

Operating sequence is given as for a Lecture Theatre with ventilation plant: -

Assume, out of time-zone requirement and non-occupied as start of sequence.

i)	Outside time-zone demand and no occupation	-	Plant off (but Frost protected).
ii)	Time-zone demand but, no occupation	-	Constant temperature pump starts to supply heater battery, if not already operating for other demands.
		-	Constant temperature circuit flow to heater battery monitored.
		-	Control valve for heater-battery to demand position.
		-	On sensing constant temp. supply >55^{o}C. both supply and extract start.
		-	Loop set-point select to occupied at set-back level 17^{o}C. **N.B.** Min. off-coil 16^{o}C.
iii)	Occupied during time zone demand	-	APD triggers internal timer of control unit set for 30 sec. Control unit output signals outstation input and a delay 'on' logic timer set @ 60 sec. after both times have time and assuming occupation still sensed, occupied set-point is rais normal 19^{o}C. level.
iv)	Non-occupancy sensed	-	APD timer drop out and signal during time zone demand is lost t outstation input delay 'on' logic timer set-up for also delay 'off' holds system on for 15 mins. To stop short-term pulsing.
		-	After 15 mins. system reverts to 17^{o}C. set-point.
v)	Occupancy sensed out of time zone demand	-	APD triggers internal timer of control unit which then triggers logic timer after which control as under (ii) but set-point 19^{o}C.
vi)	Outside time-zone demand	-	Plant off after 15 minutes. and no occupation

G045 – Automatic Personnel Detection

This strategy illustrates the operation of the APD along lines specified above.

G046 – AHUs Freeze Protection Shutdown.

There are 3 protection routines.

- Freeze protection capillary thermostat (thermostat o be auto reset type)
- Low off frost coil air temperature < 5°C.
- Low frost LTHW return temperature < 5°C.
-

All 3 when activated will require as manual reset.
The freeze protection thermostat will be hard & soft wired.

G047 – AHUs Frost Coil (fitted with a LTHW return temperature sensor) Control

Normal operation

Loop 7 is the normal temperature control (i.e. occupation)

Non-Occupation

In 1st stage frost (Low OAT + non-occupation) the frost coil will initially be driven to a fixed position [20%]
This will allow a minimum flow of water through the coil.

The LTHW return water temperature will be controlled by Loop 8 to achieve a minimum value as set by knob K36.

The off-coil air temperature will also be controlled by Loop 7, (non-occupation setpoint).

The valve will control to the maximum of these loops or 20%, whichever is the greater.

G048 – AHUs Frost Coil (fitted without a LTHW return temperature sensor) Control

Normal operation

Identical to macro G047

Non-Occupation

In 1st stage frost (Low OAT + non-occupation0.

If no heat is available LTHW minimum temp is < 30°C the frost coil will be driven to a fixed position [100%]

If heat is available LTHW minimum temp is > 40°C the frost coil will be driven to a fixed position [50%]

The off-coil air temperature will also be controlled by Loop 7, (non-occupation setpoint).

The valve will control to the maximum demand.

MPHW-LTHW Heating Calorifier - General

Where calorifiers are used from the existing CHP source the primary 2-port control valve/actuator shall be operated

under P+I control from a sensor within the secondary shell, (actuator to be 24V a.c. with 0-10V d.c. positioning signal).

N.B. Flow limitation and high-temperature limitation shall be provided by Samson direct-acting controls, which will also cover power-fail protection. Samson 2212 hi-limits shall be equipped with a dry-contact switch for indication of high-limit to the local outstation.

When any heating zone, taken from the calorifier secondary, is called into operation, the calorifier set-point will change from set-back (60^{O}C.) to normal operation (82^{O}C.). (Values quoted are general).

When the last heating time-zone requirement is removed, the set-point shall be automatically depressed to set-back level as defined by a soft knob. Logic timers with an off-delay, will be required for each zone to allow pump-down **after** calorifier set-point has been depressed.

N.B. During final pump-down, zones with 3-port valves must place them in the fully open position.

G049 - MPHW-LTHW Heating Calorifier

Safety Interlocks

- Temperature – Hi Limit, High Temperature, Temp Sensor failed [Read or Outside Limits (OUTL)]
- Pressure – Pressurisation Unit [PU] Hi or Low Pressure, Pressure Sensor Hi or Low Alarm, Pressure Sensor Fail [Read or OUTL].

If any of the above are in alarm the control valve will be driven fully closed [0%].

The occupational setpoint is set via knob K38 and the NOC is set via Knob K37.

The system will go into occupation when there is a demand providing the summer / winter switch is in Winter and the Holiday / Normal switch is in Normal.

A control loop has been configured to limit the LTHW / MPHW return temperature to 70°C when the OAT is > 10°C

G050 – LTHW – DHWS Calorifier

Safety Interlocks

- Temperature – Hi Limit, High Temperature, Temp Sensor failed [Read or Outside Limits (OUTL)]
- Pressure – Pressurisation Unit [PU] Hi or Low Pressure, Pressure Sensor Hi or Low Alarm, Pressure Sensor Fail [Read or OUTL].

If any of the above are in alarm the control valve will be driven fully closed [0%].

The occupational setpoint is set via knob K41.

The control system will go into occupation when there is a demand providing the Holiday / Normal switch is in Normal.

Once in occupation and providing the system is in Winter the calorifier control becomes active.

In summer the control is switched from the LTHW to electric Immersion heaters.

APPENDIX 1 - CONTROL PANEL INTERFACE REQUIREMENTS (SHEET 1 OF 2)

The table below gives examples of typical plant systems requirements, but it is by no means exhaustive so should to be used as a minimum requirement.
Should there be conflict between this document and particular specification this should be brought to the attention of the project team, who after consulting with the university's mechanical operations manager will advise accordingly.

PLANT	ITEM	PANEL FASCIA			BMS POINTS			*
		Switches	Buttons	Lamps	DI	Device / Function	DO	
GENERAL	LAMP TEST	0	1	0	0		0	
	BMS in OVERRIDE	0	0	Alarm	0		1	
	BMS COMMON FAULT	0	0	Alarm	0		1	2
	BMS RESET	0	1	0	1		1	3
	Fireman's OFF/AUTO/VENT	O/A/V	0	0	2	O/A and Vent	0	6
	FIRE ALARM	0	0	Healthy	1		0	1
	PANEL LIVE	0	0	Live	1		0	
	SAFETY CIRCUIT	0	0	Healthy	1	K/O Button	0	1
	GAS LEAK DETECTION	0	0	Healthy	1		0	1
HEATING	BOILERS	T/O/A	0	Run, Fault & Hi Temp	5	T, O/A, R, F, & HT	1	7
COOLING	CHILLER	T/O/A	0	Run & Fault	4	T, O/A, R, F	1	8
PRIMARY CIRCUIT	PRESSURISATION UNIT FAULT	0	0	Healthy	1		0	
	SYSTEM PRESSURE [HI or LO]	0	0	Healthy	1	LP/HP Switch	0	1
	PRIMARY PUMP P1	T/O/A	0	Run & Fault	4	T, O/A, R, F	1	4
	PRIMARY PUMP P2	T/O/A	0	Run & Fault	4	T, O/A, R, F	1	
	PRIMARY TEMP CIRCUIT MONITORING	0	0	Flow Proven	1	Water DPS	0	1

***NOTES**

1.Interlocks to be hard wired and also configured in software
2.Common BMS fault to be active whenever a plant fault or software generated alarm exists.
3.Reset button to be hardwired and matched in software. [The reset button will reset electrically latched alarms and software latched alarms]
4. Control wiring to provide interlock to prevent both pumps from being enabled at the same time.
5.Freeze protection thermostat to be auto reset type which when activated will electrically latch. This latch to be resettable via the control panel reset button or remotely via the 963 supervisors.
6.Control to be hard wired and matched in software.
7.Analogue Output [AO] required if BMS boiler modulation is specified.
8.Analogue Output [AO] required if BMS setpoint reset is specified.

Abbreviations

T- Test
O/A- Off/Auto
R- Run
F- Fault
HT- Hi Temp

CONTROL PANEL INTERFACE REQUIREMENTS **(SHEET 2 OF 2)**

PLANT	ITEM	PANEL FASCIA			BMS POINTS			*
		Switches	Buttons	Lamps	DI	Device / Function	DO	
CT CIRCUIT	CT PUMP P1	T/O/A	0	Run & Fault	4	T, O/A, R, F	1	4
	CTPUMP P2	T/O/A	0	Run & Fault	4	T, O/A, R, F	1	
	CT CIRCUIT STATUS	0	0	Flow Proven	1	Water DPS	0	
VT CIRCUIT	VT PUMP P1	T/O/A	0	Run & Fault	4	T, O/A, R, F	1	4
	VTPUMP P2	T/O/A	0	Run & Fault	4	T, O/A, R, F	1	
	CONTROL VALVE	0	0	0	0			
	VT CIRCUIT STATUS	0	0	Flow Proven	1	Water DPS	0	
EXT FAN SET	EXTRACT FAN EF1	T/O/A	0	Run & Fault	4	T, O/A, R, F	1	4
	EXTRACT FAN EF2	T/O/A	0	Run & Fault	4	T, O/A, R, F	1	
	EXTRACT AIR FLOW MONITORING	0	0	Flow Proven	1	Air DPS	0	
SUPPLY AHU	INLET DAMPER	0	0	Damper Open	1	T, O/A, R, F	1	4
	SUPPLY FAN	T/O/A	0	Run & Fault	4	T, O/A, R, F	1	
	FREEZE PROTECTION THERMOSTAT		0	Healthy	1	Alarm	0	1,5
	SUPPLY AIR FLOW PROVING	0	0	Flow Proven	1	Air DPS	0	

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