

Design Guide Part 5: BMS systems

RIBA Stages 5 - 7

2018 V1.0 Grey Cover

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1 Introduction

1.0 Prior Reading

It is imperative for readers of this document to first refer to the introductory Part entitled:

'Design Guide Part 1 – Principles and overview'.

Part 1 gives vital information and context that apply to all projects.

1.1 Purpose of the UEA Design Guide

The Design Guide (as a whole) is written for employees of the UEA, architects and external consultants and contractors. The purpose of the Guide is to act as a briefing document to give designers an overview of the design requirements, constraints and challenges presented by the UEA's specialist needs. It applies to all new-build and refurbishment projects controlling quality in the production of designs, specifications and the subsequent performance of buildings.

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

1.2 Purpose of this Part of the Design Guide

This Part of the design guide is written for designers, specifiers, installers and commissioning and maintenance engineers of Building Management Systems (BMS) from the Developed Design Stage (RIBA Stage 3) to when the building is in use (RIBA Stage 7).

1.3 Interpretation

Any part of the Design Guide may be referenced in project contractual documentation in order for the UEA to control quality. The following interpretations apply:

Enforced requirements; the use of the word(s) 'shall', 'are required', 'is required' 'must' or 'will be' denotes a requirement that is non-negotiable and shall be used as the basis for designs, technical submissions and/or activities. If such a statement conflicts with a statutory obligation then a report to the Head of Engineering and Infrastructure shall be produced highlighting the conflict, for his or her final decision regarding compliance.

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

Quality; the Design Guide aims to arrive at the UEA's highest design aspirations and standards. It may be that, at the UEA's sole discretion, solutions are value engineered during

subsequent design iterations. Designers are encouraged to consider where value engineering may result in an improved financial performance should funding constraints occur.

Currency of third party documents; where superseded standards and regulatory documents are referred to in the text, the reader shall apply current versions and disregard superseded versions.

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

Approval and proof; all designs shall be approved by the UEA. Approval shall be interpreted as meaning written approval from either the UEA's appointed approving authority or by the Head of Engineering and Infrastructure where no other approving authority is appointed. Approvals shall be sought prior to design decision points or installation activities (depending on context) and shall be made in writing. Where approvals are sought, a written technical submission shall accompany the request setting out, with proof (e.g. calculations, drawings), the case for the approval. The purpose of the approval process is to ensure designs meet the strategic requirements of the UEA.

The obligations owed by external architects, consultants and contractors to UEA and their liabilities to UEA is not in any way diminished or otherwise reduced by the approval process. UEA is not taking over the roles and duties of the external architects; consultants and contractors who will remain fully and totally responsible for the design and/or works carried out by them or on their behalf by their staff; agents; sub-consultants or sub-contractors.

1.4 Version control and updates

Any new or amended content is highlighted in red so readers can easily identify changes from previous versions. Where no red highlights exist the document either remains unchanged or it is the first version to be published.

Please note that this document is has been completely re-written since the 2016 Version. This is the only reference to this change in preference to highlighting the entire document in red.

2 General

- 2.1 Trend Control Systems have been identified by UEA as the standard for the Building Management System (BMS) in all buildings serviced by Estates.
 - 2.1.1 The UEA Project team and external M&E consultants when specifying controls on either new build or retrofit installations must use this policy document and the design shall be reviewed by the BMS team.
 - 2.1.2 The appointed controls specialist shall be responsible for the disconnection of all relevant controllers from the UEA network prior to commencement of works.
- 2.2 The UEA BMS shall be designed around the Trend product range and fully integrated into the UEA Trend network.
 - 2.2.1 Trend IQ4 series controllers are to be utilised. Pre-programmed software strategies are not to be used. Programmable IQ Eco terminal unit controllers may be used where appropriate.
 - 2.2.2 Where there is a requirement for ITCS data sockets to be installed this work is to be undertaken by the UEA approved ITCS Data installer.
 - 2.2.3 It is the responsibility of the controls specialist to advise the PM (in good time, not less than 4 weeks) of the quantity and location of the data sockets for each project. Unique outstation address's, LAN numbers and device Hostnames must be applied for (in good time) by the controls specialist via the PM. Please note that the MAC addresses of each associated device will be required at this time.
 - 2.2.4 Packaged plant controls will also utilise Trend controllers for their final control. Where Trend controllers cannot be fitted as standard a full read / write interface shall be provided. Should there be a need to deviate from this a full discussion must take place with the UEA BMS Development Manager.
 - 2.2.5 Schematic graphic pages shall be provided for each item of plant. These pages will follow the format detailed later in this policy document and will operate from the existing 963 client server. No other stand-alone supervisors or remote IQ Views will be allowed to be connected to the network.
 - 2.2.6 When engineering the system consideration should be given to keep communications traffic to a minimum. In general all common items of plant shall be controlled from a single outstation and not from two smaller ones. The use of multiplexed input and output modules will not be permitted.
 - 2.2.7 20% spare input and 20% spare output capacity must be allowed for at design stage to accommodate additions to the system. This may be achieved by selecting an expandable controller and allowing space for further expansion modules and terminal rails.
 - 2.2.8 An approved Trend Technology Centre company must be used to design, install and commission the control system and control panels. Trend Technology Centre status signifies that they are regularly audited by Trend to ensure they are maintaining defined high standards of workmanship and quality control.

- 2.2.9 Information regarding the BEMS should be requested (via the Project Manager in the case of a project), from the UEA by the completion of a RFI.
- 2.3 Final commissioning of the control system shall only commence when all associated air and water systems are fully balanced. Details of the requirements for commissioning the control system are detailed later in this policy document.

3 Control Panels

- 3.1 Control panels shall be supplied and manufactured by the controls specialist selected for the project.
- 3.2 Control panels shall be divided into two sections, one for power and one for controls. The controls section shall be lockable. The power section shall be door isolator interlocked. The power section shall not contain any items of equipment likely to be accessed during normal plant operation and maintenance. Any deviation from the above will require prior approval by the UEA BMS development manager.
- 3.3 Each section of the control panel will incorporate a light arranged to extinguish on door closure.
- 3.4 The controls section shall incorporate a 13A. RCD protected socket outlet supplied from the live side of the isolator to supply power for a laptop computer.
- 3.5 All control circuits shall be low voltage 24Vac. and supplied from a transformer with a minimum rating of 200 VA.
- 3.6 Field wiring shall be wired individually from the control panel, the use of multi-core cables with joint boxes will not normally be permitted, however where packaged plant is utilised an exception can be raised. Controls related equipment shall be wired via isolation terminals.
- 3.7 An MCB identification chart shall be supplied and permanently fixed in the section of the control panel housing the MCB's.
- 3.8 A copy of the as fitted panel wiring diagram shall be located within the controls section of the control panel in a mounted document wallet.
- 3.9 Motor starters shall be of the non-enclosed type with coils rated at 24Vac.
- 3.10 Fascia switches and indicators shall be identified with engraved Traffolyte labels. Switches to override automatic operation shall have the inscription 'Hand/Off/Auto'. The control panel shall have its designated asset number engraved on a Traffolyte label.
- 3.11 MCB's shall provide protection for all fans, pumps and control circuits. Fuses shall not normally be used.
- 3.12 Panel fascia indication shall be by means of multi cluster LED's with a minimum intensity of 240cd/m². Colour configuration shall be as follows:
 - Green Run indication (positive feedback)
 - Amber Enabled indication (no positive feedback)
 - Red Fault indication
 - Blue Frost indication
 - White Control circuit live indication

A lamp test facility must be provided.

- 3.13 Cable termination ferrules shall be utilised and markers shall be used to identify all control panel and field terminations in line with the control specialists wiring diagram.
- 3.14 Where a combination of different coil voltages for plug in relays within a control panel exist, bases with a different pin configuration shall be used for each voltage present.
- 3.15 All exposed live electrical terminations and equipment within both power and control sections shall be shrouded against accidental contact.
- 3.16 The status of all plant switches on the control panel facia shall be monitored by a single digital input. This input will be used to indicate on the plant schematics when any piece of plant is NOT in auto.
- 3.17 A master plant reset button shall be incorporated on the control panel facia. The function of this push button is to reset all plant that requires a software reset. The operation of this button shall have no effect on plant that does not require a reset. The reset button may be omitted providing there is no plant within the control panel that requires a reset via prior approval by the UEA BMS development manager.
- 3.18 Where there is a requirement for the Trend equipment to be connected to the UEA IT network, connections must be within the control panel via individual data outlets or a managed switch installed via the UEA ITCS. The contractor is not to install a switch/hub (except for his own commissioning purposes)
- 3.19 Every MCC panel with Trend controllers connected to the UEA Ethernet network must have a free data point available for an engineer's laptop.

4 Outstations

- 4.1 All outstations shall be of the 230Vac version. Outstations will be supplied complete with all necessary input / output cards or modules required to provide a fully operational controls package.
- FCU outstations can be 24Vac if fed from the FCU manufacturer's equipment.
- 4.2 Outstations located remotely (i.e. FCU's) shall be isolated adjacent to the outstation and not in a position where accidental isolation can occur.
- 4.3 Outstations mounted within a control panel must have all of its input / output terminals wired to terminal rail located at the top or bottom of the panel. This is to include the 20% spare capacity and network connections.
- 4.4 Where an existing Trend current loop is used, the network speed for outstations shall be set for 19k2.
- 4.5 All cables shall be numbered at each end using the same numbering topology used for the associated control panel terminal numbers.
- 4.6 Cable screens shall be grounded at the controller only. The cable should be made off with 'Helleman' type expanding sleeves with the screen sleeved in green / yellow.
- 4.7 Field equipment that requires specialised wiring or device set up must be clearly documented. Devices requiring to be set up using switches, jumpers or other methods, should in addition to the documentation have these details contained within the device.
- 4.8 Where outstations are supplied and fitted within other manufacturer's equipment it will be the responsibility of the appointed controls specialist to:
- a) Ensure the strategy complies with this document.
 - b) Commission the communications.
 - c) Connect to the UEA network.
 - d) Provide the graphic pages and overview required by this document.
- 4.9 Where there is a requirement for an interface between manufacturer's equipment and the Trend control system, it will be the manufacturer's responsibility to supply the required interface device. They should liaise with the Controls Specialist to determine the UEA requirements and provide relevant documentation.
- 4.10 Control panel and outstation locations are to be approved/agreed at design stage and are not to be located above false ceilings, behind fixed panels or floor voids.

5 IQ Engineering

- 5.1 Details of the controls philosophies together with standard strategies are continually being developed and a copy of the latest strategies should be requested from the UEA BMS team. The standard strategies should be used to build up an outstation configuration or be used in full in the case of fan coil units.
- 5.2 Strategy design should be carried out in a consistent, structured manner and be kept as simple as possible.
- 5.3 Each point in a controller shall be labelled in a unique and unambiguous manner. Any reference to room numbers should ensure the final UEA room number is used and not project numbers. Room numbering is obtained from the UEA Space Team. Room numbering must be used for all devices specifically serving a given area and these must be displayed on the Trend Schematic pages.
- 5.4 The identifier of a controller or INC should indicate the area and / or plant that is being controlled
- 5.5 The identifier in fan coil unit controllers should indicate the final UEA room number to allow for the use of generic graphic pages. Building and room numbering is obtained from the UEA Space Team.
- 5.6 It is the Controls Specialists responsibility to ensure that no conflicts occur with the existing UEA network when using IC communications.

6 Supervisor Engineering

- 6.1 The Campus Trend supervisors consist of 963 client servers with a further 963 engineering Pc's. Access to the servers will not be available to the controls specialist. New projects will be added to the engineering machine only, to allow the new pages to be fully tested and witnessed by the UEA Controls Engineer. Once this process is completed the BMS Team will confirm to the Head of Maintenance that the project is ready to transfer from the Engineering PC to the Trend 963 servers for all to access.
- 6.2 Access to Trend schematic pages shall be with a client PC via the Trend 963 Server, no other stand-alone supervisors will be connected to the UEA network.
- 6.3 The Controls Specialist shall obtain the latest file structure, analogue library, bitmap library, animation library and backdrops library before commencing schematic page construction. To ensure correct operation of the schematic pages on the server these details must be strictly adhered to. No additional files will be added to the libraries without authorisation.
- 6.4 Schematic pages shall be provided for each item of plant supplied on the project. Plant that is monitored only by the control system will also have a schematic page with a note on the page indicating that the plant is not controlled by Trend.
- 6.5 A standard schematic page format for an item of plant shall consist of two pages. The first page shall be a view only page indicating the true operation of the plant. BEMS enable points shall not generally be used, the read-back point shall be utilised, indicating that the plant is operating. The second page shall consist of an adjustments page showing all available plant settings and secured as detailed below.
- 6.6 Time zones should be accessed via a button on the adjustments page set at a PIN level of 90.
- 6.7 Buttons on the adjustments page should be provided to:
- a) Override control valve and damper actuators.
 - b) To enable the valve exercise routine.
 - c) To operate a 1 hour plant extension routine
 - d) These buttons are to be set with a PIN level of 10.
- 6.8 Knobs are to be provided on the adjustments page to:
- Position valve and damper actuators when in override. (Pin 90) When in override the value is to flash red to indicate an override has taken place.
 - Allow adjustment of set points.

These buttons are to be set with a PIN level of 10 for standard set points and overrides, 50 for engineering set points and 90 for critical set points that would have a detrimental effect on the system operation.

- 6.9 Floor plans shall be provided detailing locations of plant and actual UEA room numbers. They should be provided in bmp format and be inserted onto an 'UEA blank' backdrop.

7 Additions to The Existing System

- 7.1 New works shall comply fully with this document. Requests for Host Names, LAN and outstation numbers shall be obtained by the completion of an RFI
- 7.2 Where retrofit works are carried out to existing items of plant and control panels the following shall be closely adhered to.
- 7.2.1 Existing documentation will be 'back engineered' and provided in SET format.
- 7.2.2 Outstation firmware shall be updated to the current version.
- 7.2.3 Redundant field and control panel equipment shall be removed. Any holes left in control panel doors shall be covered with permanent Traffolyte labels.
- 7.2.4 Where existing equipment is to be re-used it is the controls specialists' responsibility to ensure it is in good working order. The Project Manager and BMS manager should be advised if a replacement is required.
- 7.2.5 Wherever practically possible the requirements of this document shall be complied with in full. Any proposed deviations from this policy document must be agreed with the BMS Development Manager.
- 7.2.6 Additions to the existing system shall be engineered to fully integrate with existing plant. This shall include but is not limited to:
- a) Boiler interlocking for heat demands.
 - b) Chiller interlocking for cooling demands.
 - c) Frost protection requirements.
 - d) Interlocking of time zones and calendar scheduling.
- 7.3 Extensions to the UEA network both inter-network and local area network shall be carried out using Trend approved cabling. The cable will be marked every 20 meters or change of direction with an engraved Traffolyte label fixed to the cable using cable ties:
- 7.4 SWA Network cable will be used outside of plant room areas for distances exceeding 10m. (Excluding FCU's).
- Network cable specification: To manufacturer's recommendations.
- 7.5 Extensions to the inter-network or local area network will be carried out from an existing controller. Junction boxes will not be allowed.

- 7.6 Prior to the final connection to the UEA network two copies of the cable route details are to be provided to the UEA BMS Development Manager.

8 Field Wiring & Equipment

- 8.1 Control valves shall be of Danfoss, Siemens or Trend/Honeywell manufacturer and shall be installed to meet the requirements of their data sheets.
- 8.2 All main plant field devices to be identified with identification tags, with the tag being attached as close as possible to the device. The tags shall comprise Dyna Tape labels fixed to marker plates selected from the IMP range as manufactured by Hellermann Tyton (or equal and approved) Hand written labels will not be accepted.
- 8.3 All modulating control valve and damper actuators shall have a power supply voltage of 24V ac. And a control voltage of 0-10 V dc, with the exception of fan coil units.
- 8.4 All sensors, are to be manufactured by Trend Control Systems unless prior approval is obtained from the UEA BMS Team. Variable speed drives must be of Danfoss, ABB or Trend manufacture.

Packaged plant controls will utilise Trend controllers for their final control. Where Trend controllers cannot be fitted as standard a full read / write interface shall be provided. Should there be a need to deviate from this a full discussion should take place with the UEA BMS Developer and an Exceptions Report submitted. (See also clause 4.11)

- 8.5 Monitoring of filters shall utilise differential pressure sensors with dirty filter indication on the schematic pages originating from the alarm bit.
- 8.6 All cables shall be numbered at each end using the same numbering topology used for the associated control panel terminal numbers.
- 8.7 All field equipment shall be wired using manufacturers recommended cable
- 8.8 Due consideration to be given to the selection and location of all field devices to ensure that adequate protection is provided against water and dust ingress, UV degradation and the effects of temperature. Accessibility for maintenance is needed to be taken into consideration.
- 8.9 Strap on temperature sensors are not to be utilised. Should there be a need to deviate from this approval must take place with the UEA BMS Development Manager.

9 Alarm Reporting

- 9.1 Alarm reporting will be filtered using point labels and LAN addresses. Alarms shall be assigned to groups to allow flexibility.
- 9.2 No alarms shall be set in the controls strategy until commissioning has been completed.
- 9.3 The Project Manager shall co-ordinate with the appointed Controls Specialist and key stakeholders to create a list of the critical alarms required, their priority and destination addresses.
- 9.4 Alarms shall only be reported when the associated plant is intended to be operational. It is the Controls Specialist responsibility to ensure that alarm levels and time delays are set at realistic settings.

The Controls Specialist must inform the Project Manager should the requested settings not be achievable. The Project Manager must then co-ordinate the appropriate action to rectify any design issues.

10 Metering

- 10.1 The metering requirements for a project shall be fully compliant with current legislation and the UEA metering design guide.
- 10.2 The designer(s) responsible for the design of the electrical and/or mechanical systems shall develop a full metering strategy. This shall integrate with any existing strategies.
- 10.3 Power supplies for steam and heat meters shall be provided from the nearest motor control centre and not from local distribution boards. Battery powered meters shall not to be used.
- 10.4 Refer to UEA metering design guide for details of approved meters, including manufacturer and type.
- 10.5 The meter strategy should be configured to provide the rate and total at 15 minute intervals. These values are to be allocated to sensors between the range of 1 to 96 for monitoring and targeting (M&T) software to log, with plots attached to allow the UEA monitoring and targeting package to automatically collect data.

11 Lighting

- 11.1 Centralised may be controlled using the UEA BEMS Trend system. Lighting circuits shall be controlled via contactors/Lighting Control Modules (LCM's), connected to a BEMS outstation. This may be available on a fan coil unit if it is installed in the same area as the lighting, or a dedicated out station may be required.
- 11.2 The BEMS Trend system is capable of but not limited to:
- a) Providing volt free contacts
 - b) 0v-10v for dimming
 - c) On/off, scene settings (i.e. 10%, 50%, 100% etc)
 - d) Controls through day light sensing, PIR, occupancy detection, etc.
 - e) Time zone settings for different days of the week
 - f) Provision of override switching
- 11.3 Where complex lighting control arrangements are required which are outside normal Trend capabilities, the Ligo system (as manufactured by Open Technology. with a virtual IQ may be used with prior consent.
- 11.4 When utilising a FCU output with the control lighting in a modular space the heating and cooling dead band should be increased when the area is out of occupancy.

12 Commissioning / Witnessing

- 12.1 Connection to the UEA network shall not take place until the system is fully documented, commissioned, validated, witnessed and accepted by the UEA BMS Development Manager. The BMS specialist shall give seven days' notice to the engineer 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 1% fail performance test, a further ten per cent may be selected. If above 1% fail he may at his discretion demand 100% demonstration. The BMS specialist 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.

- 12.2 Prior to witnessing the Contractor/Project Manager shall ensure the following documentation is supplied to the UEA Controls Engineer:

- a) LAN wiring drawing for the project from point of connection. (Where applicable)
- b) Description of operation.
- c) Panel wiring diagrams.
- d) Strategy diagrams.
- e) Commissioning sheets
- f) Floor plans with controller and field devices locations

- 12.3 The format for witnessing by the UEA Controls Engineer shall be:

- a) Review of the documentation.
- b) Inspection of the field equipment.
- c) Compare with the software supplied at the design stage.
- d) Witnessing of approximately 10% of the input / output points.
- e) Functionality test of the software.
- f) Operational stability of the system.
- g) Connection to the UEA network.
- h) Security applied to the outstations.

- 12.4 Following the completion of 12.3 the schematic pages can be installed onto the 963 engineering machine. Projects not witnessed within 10 days will be removed from the Engineering Machine.

The format for witnessing of the schematic pages to the UEA Controls Engineer shall be:

- a) Confirm file structure and pages to be copied to the engineering machine.
- b) Copy files to project folders.
- c) Witness 100% operation of pages and points ensuring compliance with strategies.

13 Documentation and warranty

- 13.1 The documentation required by this policy document is over and above the UEA operation and maintenance manual requirements and must be supplied direct to the UEA BMS Team.
- 13.2 Connection to the UEA network will not take place until the documentation required by section 12.2 is in place.
- 13.3 On completion of the commissioning and witnessing a soft copy of the documentation on electronic media shall be supplied. The following documentation shall be supplied to the UEA Controls Engineer within 5 days:
 - a) Description of services governed by each controller (PDF format).
 - b) Control strategy drawings (PDF format).
 - c) Control strategy files (SET format).
 - d) Description of operation for each plant (PDF format).
 - e) Schedule of equipment and locations. (PDF format).
 - f) Control panel wiring diagrams (PDF format).

Provide 3 No. Copies of the information required under this clause, in electronic format.

The warranty period for the new equipment shall be twelve months as a minimum or the period aligned with the project contract, immediately following handover of the installation. Seasonal commissioning may be a requirement of the brief depending on the scale of the project.

At handover the following post contract 'fault' support shall be provided free of charge for a period of three months:

- a) 24 Hour Technical Helpline
- b) 24 Hour Emergency Remote Response within 2 hours of call logged
- c) 24 Hour On Site Response

14 Site/User Training

- 14.1 The BMS specialist shall supply the following training for the clients engineering staff.
- 14.2 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.
- 14.3 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/DOS file structures, password and engineering utilities, fault-finding, tuning and maintenance.
- 14.4 On-site; while the clients engineer will attend the acceptance demonstrations, the BMS specialist shall instruct him in the specific application of the system, the structure and the control strategies adopted to meet the specification.