MS02 Building Management Systems

UNIVERSITY OF LEICESTER

Document Control

Rev	Date	By	Comments
A	Jun'16	J. Hoare	Technical Review Update
B	Oct '17	J. Hoare	Technical Review Update
C	Dec 17	UoL	Sign off for release
D	Mar'20	J. Hoare	March 2020 Issue
E	April 2020	A.Singleton	General update to tracker and other minors.
F	June 20	A Singleton	Update with CPA and KRM
G	April 23	A Singleton	Reference to Uni Standard BMS Spec added
H	May 23	A Singleton	Framework suppliers schedule updated

Design Guidance

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

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e. All power to have local plant lockable isolation facility.
f. All rotating machinery to have local stop lock push buttons wired through auxiliary on the plant isolator.
g. BMS control of plant items to be by means of distribution board combined MCB/contactor or local field contactor unless the plant has packaged controls in which case the BMS is to interface with this.

7. So far as controls and power wiring is concerned.
   a. All containment and controls wiring from the controls panels onwards to field mounted devices shall be undertaken by the controls specialist.
   b. All containment, power and controls wiring from the combined controls/power panels onwards to field mounted devices shall be undertaken by the controls specialist.
   c. All containment and power wiring from the MCB distribution boards onwards to field mounted devices may be undertaken by the controls specialist or electrical contractor.
8. So far as weatherproofing is concerned
   a. Under exceptional circumstances it may be necessary to install control devices and panels externally in open weather conditions. This is to be avoided wherever possible but if unavoidable the fllowing must be adhered to.
   b. All external controls hardware (including, but not limited to detectors, valve actuators and damper actuators), and ancillary items must be rated for an outdoor environment and rated at IP54 minimum and then further provided with weatherproof bags.
   c. All external panels must be manufactured to IP56 and installed with internal thermostatically controlled anti condensation heaters. All external panels must have an overhanging roof to give shelter to maintenance technicians and also be complete with separate front glass door to enclose and fully cover the panel facia.
9. The Project contract specification shall ensure that the following works are undertaken by the services contractor at RIBA stage 4b and 4c.
   a. The services contractor shall organise a series of meetings with the University project team and BMS subcontractor to discuss the controls philosophies in detail and to develop the controls strategies prior to any commencement of software writeup and compilation.
   b. These discussions shall be based upon the detailed services schematic drawings provided by the services subcontractor.
   c. The meetings shall then firstly agree a detailed plain English text write up of the controls strategies required.
   d. Then the meetings need to look at compilation of hook up diagrams showing interface with all plant items. Plant item interfaces need to be agreed.
   e. The software then needs to be written and factory tested and the University engineers need to be invited to witness this testing works.
   f. Schematic graphics need to be compiled at this stage with the meetings continuing such that these are subject to discussion and approval.
   g. Finally and only on completion of these meetings site works may progress.
10. The Project design engineers shall ensure the following requirements are included within their tender documents before issue to the tendering contractors:
   a. The Controls Specialist Contractor shall allow in their contracted works a minimum of ten working days notice of the following key stages:
   b. Familiarisation with almost complete installation, prior to formal commissioning (proposals for Graphics Slides, Software, Alarm Priorities, IP Addresses, head end networking, Alarm Routing and Logging for the Supervisory PC shall be tabled at this stage)
   c. The project designer shall specify that the controls specialist issues a schedule of alarm priorities and BMS handling processes which shall be submitted to the university BMS control officer prior to commissioning for approval.

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d. Demonstration - the system shall be presented to the University's Project Manager and BMS/Controls Engineer after seven days of logged performance with all systems operating under fully automatic control under the dictates of the BMS. This demonstration shall include all software, completed Graphics Slides, Logging, Alarms, and control installation - using a laptop computer. A Snagging List of items that have still shall be completed shall be prepared with a timetable for completion.
e. Office Handover of As Fitted O&M Manuals and installation of completed software, Log Configuration, Alarm Routing and Graphics on to the Supervisory PC at the Works Division.

11. The project design engineer shall ensure that Seasonal commissioning and fine tuning of control systems for the first 12-month period post completion, in accordance with the BSRIA soft landings guidelines, is provided by the controls specialist and that this requirement is included within the contract. This requirement must be specifically written into the contract specification including the below.
    a. Seasonal commissioning cannot commence until all snags, control issues or associated plant are fully operational and all snagging items have been cleared.
    b. A minimum allowance of 3 days site attendance for the first quarter and 1 day per quarter thereafter shall be allowed to undertake assessment and adjustment of set points and control profiles to ensure optimum energy benefits and user profiles.
    c. A commissioning engineer will be required to attend as required to satisfy the above minimum requirements.
    d. Following each post occupancy evaluation (POE) amendments to the BMS commissioning shall be documented and corrective actions recorded. Comfort and performance improvements shall be monitored and any energy reductions noted also within the report. Final POE shall be completed just prior to the defects completion period where any defects or alarms and any non-performing plant or systems are recorded.
12. Areas where there is sensitive equipment such as Data Servers, critical freezers, critical laboratories etc and UPS equipment.
    a. Each area shall be monitored via room sensors which will raise a prioritised alarm when temperatures are exceeded within the space.
13. Third party controls equipment can be used within individual plant items and packaged plant (rather than general BMS). However, where they are used, these shall utilise BACnet/IP to connect to the site BMS controls.
    a. Care needs to be taken to interface, as a minimum, to all the required parameters as noted in the BMS specification plus others as may give benefit to the University.
    b. There is a preference for the third party BACnet systems to include the provision of a front-end web based graphics driven arrangement to enable interrogation adjustment and trend logging by means of the building management system.
14. Module interface toggle switches shall be identified with a permanent label showing what is connected to assist in fault finding and servicing.
15. Each controller shall be clearly identified with a permanent label stating the controller number (where applicable), IP address and gateway address on the front to assist in fault finding and servicing.
16. Field equipment shall be fully accessible for inspection and maintenance and due consideration should be given to the CDM regulations when locating and installing equipment.
17. All sensors must be capable of being removed from ductwork / pipework for inspection and maintenance purposes. All water sensors shall be complete with suitable pockets.
18. Where plate heat exchangers are required on schemes these shall be standard units, not incorporating the manufacturers standard controls offerings, i.e. they shall be non-packaged and the BMS shall control the plate heat exchangers directly by BMS controlled temperature and limit sensors and valves.

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Design Components

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

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Design Components

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

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Design Components

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

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Design Components

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

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Design Components

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

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Design Components

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

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Design Components

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

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Design Components

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

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Design Components

Item	Manufacturer	Comments
Control Profiles	Lecture theatres Larger teaching spaces (30, 60 and 120 person) PC Clusters (30, 60 and 120 person) Seminar spaces. Catering Facilities	Occupancy times for the lecture theatre, teaching, Clusters, and catering areas are set on a weekly basis through room bookings, however, nominal times should be set for 08:00 to 17:00 hours Monday to Friday. In addition to the time scheduling PIR control is required to enable and disable the ventilation systems when the room are not in use. Catering facilities however do not need PIR control and need to run to time schedules to be agreed project by project. Ventilation plant shall only be run during occupied periods. It shall not be used for fabric heating. Lecture theatres, Seminar Rooms and catering facilities should be provided with radiator/fan convector capacity and should have optimisation to the desired room temperature of 20°C without the use of AHU ventilation plant. Heating Plant shall be started via Optimiser control for a boost period to achieve the desired wintertime room temperature of 20°C. (Always noting, irrespective of these operational requirements, that the heating emitters shall be designed to maintain a temperature as detailed on the room data sheets which is likely to be higher than these temperatures noted) During this boost period, the AHU fans shall be kept off. On termination of the optimised boost period ventilation plant shall be energised. The AHU ventilation system shall then achieve the desired wintertime room temperature of 20°C in parallel with the fabric heating system.. Where inverters are installed, natural cooling shall be achieved via the space temperature control loop acting on the AHU supply and extract fan speeds. Cooling will normally be by the AHU ventilation installation (no local cooling coils, DX). Where mechanical cooling is installed (cooling coils or DX) then cooling shall normally only be enabled if the extract/room temperature rises above the data sheet summertime temperature limits. The summertime temperatures in lecture theatres will normally be a maximum of 24c during occupancy. The summertime temperatures in other areas will normally be a maximum of 26c and/or TM52 requirements. Ventilation and cooling should be de-energised if spaces are not occupied. Carbon dioxide (CO2) sensors should be installed to control mechanical ventilation. Approved sensors shall override the normal AHU damper and temperature controls and try to maintain CO2 levels between 600ppm-1000ppm. If the AHU ventilation system has two-speed or inverter controlled fans, then the CO2 sensor shall be used to change the fan speed to

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Item	Manufacturer	Comments
		VAV systems should normally be considered for these types of spaces by means of a single room zone and fan speed control or where there are multiple spaces by VAV boxes and fan speed control. Generally large lecture theatres utilising dedicated air handling units shall incorporate variable speed fan drives to vary the amount of fresh air introduced into the lecture theatre space to maintain CO2 dilution.
Controls Profiles	Residential Accommodation	Standard occupancy times for these areas are continual use with structured holiday profiles. Plant shall be initiated to give a desired continual wintertime minimum room temperature in bedrooms and lounges of 20°C. (Always noting, irrespective of these operational requirements, that the heating emitters shall be designed to maintain a temperature as detailed on the room data sheets which is likely to be higher than these temperatures noted) Normal running, as noted, is continual use during 24 hour occupancy however optimisation facilities shall be provided but normally not used. (The facility shall be provided via Optimiser control with integral room low limit for fabric frost protection during “plant off” periods of 10°C On / 12°C Off and left as a background facility which may be employed if required.) If, and only if used, when occupancy time or temperature is achieved, whichever is first; compensated mixing valves or local zone valves shall take control of the building room temperatures to maintain a wintertime minimum heating temperature of 20°C. “Optimum Off” temperature shall be 19°C. Where the temperature is not achieved before occupancy time, compensated mixing valves or local control valves shall continue to be controlled by the optimiser in run-up mode while automatically adapting for the next day / run-up period.

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Design Components

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

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Framework Contractors (only these contractors to be used)		
Service	**Specialist**	**Address & Contact Details**
BMS Upgrades - Ecostrxure	Adi Electrical Ltd	David Williams dwilliams@adiltd.co.uk 07989 655132 01214512255
	Building Management Solutions Integrators Ltd	Ben Summers bsummers@bmsi.co.uk 01925 931 100 07464 647004
	Comfort Controls Midlands Ltd (eco structure, BMS)	Sam Heath sam.heath@learnd.co.uk 07970 429517
BMS Upgrades - Trend	ABEC Ltd	Paul Whitticase Paul.Whitticase@abec.co.uk 07436401994
	Building Control Specialists Ltd	Darren Hughes dhughes@bcspecialists.com 01455 240080 07740 733206

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