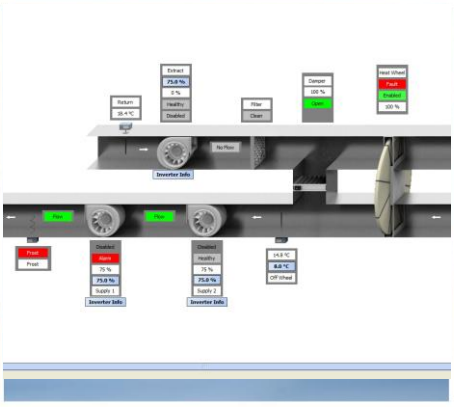
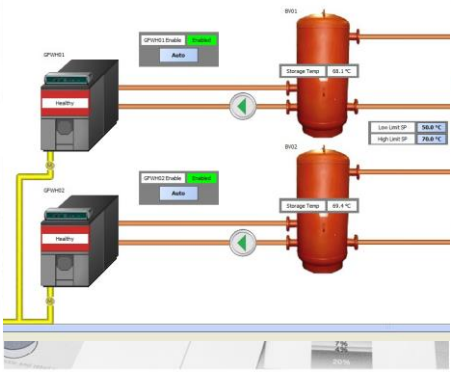
BUILDING MANAGEMENT SYSTEMS GENERAL SPECIFICATION.





NG Bailey

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VERSION CONTROL

The tables below provide the current revision approval and revision history for this document.

Current Revision Approval

	Name	Job Title	Date
Compiled By: (Author)	Paul Hayman	BMS Technical Manager	Dec. 2018
Checked By:	Peter Dalby	BMS Technical Manager (Northern Region)	Feb. 2019
Checked By:	Will Pitt	Divisional Mech. Engineering Manager	Feb. 2019
Checked By:	Chris Coath	Head of Energy. Facilities Services.	March. 2019
Approved By:	Steve Campbell	Technical Director	March. 2019

Revision History

Revision	Revision date	Revision description
00	February 2019	First issue.
01	March 2019	MCC panels now Control Enclosures. Metering strategy updated
02	Oct 2019	General update and published

INTRODUCTION

A key philosophy of NG Bailey's ethos is Safety First & Foremost. Our suppliers and sub-contractors shall be expected to embrace safety with the same diligence.

The purpose of this specification is to set out the NG Bailey material and workmanship quality standards for the most commonly used building management systems (BMS)

This specification is not a 'particular specification' but rather a general specification for BMS controls that aims at providing the BMS specialist with a minimum requirement for standards of BMS design, documentation, products, installation and commissioning.

The purpose of this specification is to set out the NG Bailey material and workmanship quality standards for building services electrical / BMS installations.

The specification should be read in conjunction with the following documents:

- NG Bailey 'MySupplychain' catalogue
- NG Bailey 'MyMaterials' catalogue
- NG Bailey internal policies and procedures and best practices guides
- Where reference is made in this standard specification to In-house and industry, design / technical guides. These guides give in-depth information on the technical requirements of particular systems and should be referred to when necessary

Delete this paragraph and the below options as appropriate to suit the purpose of the specification/document at tender/bid submission or prior to entering in to contract in conjunction with the Bid manager and commercial director

Option 1: The NG Bailey materials and workmanship specification shall take precedence over the client's specification and / or Employers Requirements.

Option 2: The intent of this specification is to provide a standard materials and workmanship technical specification (to be supplemented by a project specific particular specification)

Option 3: The intent of this specification is to set out the NG Bailey material and workmanship quality standards for building services, where NG Bailey have provided 'Contractors Proposals', in the absence of, or alternative to a client specification.

References may be made in this standard specification to In-house and industry, design / technical guides. These guides give in-depth information on the technical requirements of particular systems and should be referred to when necessary. The ethos of this specification narrative is for the BMS to conform to industry good practices and for the BMS design and implementation to comply with the BSRIA AG 9, BSRIA AG10 and CIBSE Commissioning Code C guidelines, wherever possible.

The BMS controls specialist shall employ good practice philosophies throughout and are encouraged to engage with NG Bailey with respect to imaginative and practical alternative solution proposals that could benefit NG Bailey.

Where the controls specialist is carrying out electrical installation, reference shall be made to the NG Bailey Standard Electrical Workmanship Specification and the NG Bailey Mechanical Workmanship & Materials Specification.

SPECIFICATION

1.0 BMS SYSTEMS OVERVIEW

1.1 General Requirements

1.1.1 The BMS tender submission shall make the necessary allowance in their proposal to conform to the latest BSRIA AG 7 and AG 9 guidelines. Also, CIBSE Commissioning Guide C.

1.1.2 The BMS tender submission shall make the necessary allowance in their proposal for the latest Building Regulations Part L metering requirements, as detailed in the latest CIBSE TM39.

1.2 BMS Tender Submission

1.2.1 BMS tender submission documentation shall, as a preference, include the controls specialists' proposed BMS points list, or as a minimum, the total number of hardware & software points allocated.

1.2.2 **The BMS tender submission must be broken down with costings for the following;**

1.2.2.1 Design engineering, project management & documentation;

1.2.2.2 Control panels, controllers & panel devices;

1.2.2.3 Field devices;

1.2.2.4 Head end supervisor, licenses & software;

1.2.2.5 Controls wiring & containment;

1.2.2.6 Power wiring & containment;

1.2.2.7 Commissioning;

1.2.2.8 Witnessing, demonstration & training;

1.2.2.9 Seasonal commissioning.

1.2.3 The BMS tender submission shall include sufficient resources for witnessing and training. The number of days allocated for these shall be stated.

1.2.4 The BMS tender submission shall detail the form and type of proposed control panels.

1.2.5 The BMS tender submission shall include option price for seasonal commissioning.

1.2.6 The BMS tender submission shall clearly detail and identify all qualifications and exclusions. Else the controls specialist shall be deemed to be fully compliant.

1.3 BMS Design

1.3.1 Software control strategies shall be based on the latest BSRIA AG 7 guidelines. Where the Controls Specialists wish to deviate from these software strategies, they must notify NG Bailey and obtain their approval.

1.3.2 Hardware design shall be based on the latest BSRIA AG 9 guidelines. Where the Controls Specialists wish to deviate from this, they must notify NG Bailey and obtain their approval.

1.3.3 The Controls Specialist shall produce a suite of technical submissions to include as a minimum the following;

1.3.3.1 Comprehensive bespoke Description of Operation - to include time schedules, setpoints and parameters;

1.3.3.2 Control Panel Drawings - to include parts list, fascia and back plate details;

1.3.3.3 Input & Output (I/O) Schedules;

1.3.3.4 Field Equipment Schedule;

1.3.3.5 VSD Equipment Schedule, where appropriate;

1.3.3.6 Valve Schedule, where appropriate;

1.3.3.7 BMS Controller Network Schematic;

1.3.3.8 E to M power requirements;

1.3.3.9 Sample Graphics;

1.3.3.10 Commissioning/Witnessing Sheets.

1.4 Control Enclosures

1.4.1 Control Enclosures shall comply to BS EN 60947 and BS EN 61439.

1.4.2 Unless indicated otherwise, all BMS controllers shall be housed in Control Enclosures, rather than Mechanical Control Centers (MCCs). 230V and above power to field equipment shall be distributed via NG Bailey distribution and panel boards.

1.4.3 Control panels shall include suitable LED lighting that automatically illuminates when the door is opened.

1.4.4 On certain projects, and where indicated by NG Bailey, a hybrid type panel shall be utilized. Consisting of an industry standard distribution board and form 1 control panel. Where small remote outstations are required, and at NG Bailey's discretion, form 1 control panels may be utilized.

1.4.5 All control panels, control enclosures, marshalling boxes and control ancillaries supplied by the controls specialist shall be to the correct IP rating for the environment that they are to be installed in i.e. IP 54 for inside locations and IP65 for external installations.

1.4.6 If the control ancillary is not manufactured to the suitable IP rating, a suitably rated enclosure shall be supplied and installed by the controls specialist.

1.4.7 Control panels located outside shall be fitted with anti-condensation heaters.

1.4.8 The Controls Specialist shall provide heat gain calculations for control panels located outside. Adequate ventilation must be engineered to ensure the ambient temperature inside the panel is less than the component with the lowest ambient temperature limitation.

1.4.9 Control Enclosure panel lamps and switch positions shall be viewable. If the Controls Enclosure is outside and within a weatherproof enclosure, the door must have a transparent window to allow sight of the lamps & switches.

1.4.10 Control panels/enclosures mounted outside must have suitable hood with adequate drip relief. Suitable cowls shall be fitted over any ventilation grills.

1.4.11 'HAND-OFF-AUTO' rotary selector switches, installed on the Controls Enclosure fascia, will operate all plant as indicated throughout this specification. Suitable 'DUTY-STANDBY' rotary selector switches shall operate all items of plant configured in a 'DUTY/ STANDBY' arrangement, interlocks will prevent both items of plant from operating simultaneously.

1.4.12 As a minimum, the BMS shall monitor if any H/O/A switch is out of auto. This can be a single BMS monitoring point.

1.4.13 Use some imaginative software routine to use the H/O/A switch as a software alarm latch reset. For example, Auto to Off and Off back to Auto within 2 seconds resets any latched alarms within the Controls Enclosure controller(s).

1.4.14 Control Enclosure Live and control circuit HEALTHY lamps shall be installed on the fascia.

1.4.15 All Controls Enclosure indicator lamps are to be of 'LED cluster' type. The following colours are to be used for general status conditions, where applicable:

1.4.15.1	Controls Enclosure	White
1.4.15.2	Control Fuse Healthy	White
1.4.15.3	Fire Alarm Activated	Red
1.4.15.4	Safety Circuit Activated	Red
1.4.15.5	Frost Activated	Red
1.4.15.6	Trip/ Fault/ No Flow	Red
1.4.15.7	Filter Blocked	Amber
1.4.15.8	Enable/ Run/ Flow	Green

1.4.16 Certain sites (Power/industrial) may have their own established colour scheme and so the site requirements may take precedence.

1.4.17 The Controls Enclosure shall have a 'Lamp Test' push-button facility in all circumstances.

1.4.18 Lifting eyes shall be installed if the Controls Enclosure requires lifting by crane or other. Control enclosure weight to be provided by system specialist on their panel drawings.

1.4.19 Sequential start-up of all plant is required to limit potential high start-up loads. This shall operate when the Controls Enclosure is turned ON, timed start-up, fire alarm re-set etc. The controls subcontractor is responsible for sequencing the start-up and selecting relevant delays.

1.4.20 All internal panel wiring shall be identified by numbered ferrules, which are to be detailed and indicated on the wiring diagrams. The wiring diagrams are to be updated if modifications are carried out during the project and a fresh 'as-commissioned' set of wiring diagrams are to be placed in a plastic wallet in the Controls Enclosure

1.4.21 All circuit protection is to be provided by MCBs or MCCB's and not HRC fuses. An MCB schedule should be mounted within the Controls Enclosure to provide a quick reference for maintenance purposes and shall reflect the 'as-commissioned' wiring diagrams.

1.4.22 All relays are to have visual indication of their energised/ operating status by means of an indication ‘LED’ or ‘FLAG’. Relays should also have a physical means of being overridden to assist commissioning and functionality proving/ testing.

1.4.23 Relay and contactor schedules should be detailed within the ’as-commissioned’ wiring diagrams and reflect the device labelling.

1.4.24 Plant, pump and fan motor contactors are to be provided with suitably rated thermal overload protection with visual indication of tripped status. Contactor tripped status shall be monitored. Overload settings are to be recorded on the ‘as-commissioned’ wiring diagrams. Any motor greater than 1.1kW must have a variable speed drive (VSD) installed.

1.4.25 Blocks of terminals installed in the Controls Enclosure are to be ‘knife’ type terminals were applicable to provide safe isolation of the controls circuit during commissioning and maintenance activities.

1.4.26 All items of equipment installed in the Controls Enclosure i.e. terminals, transformers, MCBs, relays, contactors etc. are to be of a reputable manufacturer i.e. Siemens, Schneider, Finder etc. or equal and approved and require suitably descriptive labels.

1.4.27 A minimum of 15% spare space capacity is to be allowed in Controls Enclosure to enable future system expansion. If spare controller points are available, these shall be considered as an additional benefit to the 15% spare space capacity only.

1.4.28 A single or double 13A socket protected by a 30mA RCD shall be installed in the Controls Enclosure and labelled ‘for portable laptop PC use only’. This will be in addition to any sockets required for ‘fixed’ panel equipment, such as networking equipment or interface devices.

1.4.29 Unless agreed with NG Bailey to the contrary, at least one control panel shall be fitted with a fascia mounted keypad display to access the BMS.

1.4.30 The use of relay modules (2RM), or multiplexers (4DIX) are not permitted without specific agreement from NG Bailey. Where permitted, these must only be used on duty standby applications or on non-critical monitoring. They must not be used for flow proving or safety devices.

1.4.31 All power supplies to gas solenoid valves shall incorporate a UPS to prevent valve drop-out on minor power outages or brownouts.

1.5 BMS Supervisor Workstations & Controllers

1.5.1 General Requirements

1.5.1.1 Where required, provide a front end supervisor to meet the requirements of BSRIA AG9 (section 2)

1.5.1.2 BMS controllers shall be BACnet/IP Open protocol and must be BTL certified, all controllers shall be set up and configured ready for integration via Bacnet with 3rd party analytic platforms (platform supplied, installed and commissioned by others)". This functionality will need to be proved before the handover of the project. Visit: https://www.bacnetinternational.net/btl/

1.5.1.3 Provide field controllers that meets BSRIA AG9 (section 3)

1.5.1.4 The front end supervisor software shall be loaded onto a suitable PC/Server with enough processing power and memory to carry out the day to day tasks required by the operators, taking into account graphic usage, trend logs and other processor hungry BMS applications. The PC shall be loded with the latest Windows operating system.

1.5.1.5 Provide suitable monitor of at least resolution 1920x1080 to display the graphics and other Microsoft Windows applications.

1.5.2 Panel & Terminal Unit Controllers

1.5.2.1 The outstation controllers will be capable of stand-alone operation, but shall also be networked to the BMS supervisor.

1.5.2.2 Ensure controllers have sufficient memory size to allow for effective operation and transfer of data between controllers and for trend logging etc.

1.5.2.3 Ensure controllers have sufficient means, either via non volatile memory and/or on board rechargeable battery, or super-capacitor to maintain the integrity of its software, trend log data and time clock etc, during a power outage.

1.5.2.4 Ensure Controllers download their trend data buffer to the supervisor before the buffer gets overwritten.

1.5.2.5 Ensure controllers are configurable and do not come with set applications only.

1.5.2.6 All panel controllers shall have a minimum of 10% physically installed spare capacity of each type.(DI,DO,AI & AO) and also spare room to add additional I/O module(s)

1.5.3 Front End Supervisor

1.5.3.1 Provide suitable QWERTY keyboard, Mouse and printer commensurate with the supervisor P.C.

1.5.3.2 Automatic controls will be provided via an IP based Building Management System (BMS).

1.5.3.3 The automatic building management and control system (BMS) will be an integrated system of intercommunicative programmable outstations, using an open 'data communication' protocol to control all mechanical plant.

1.5.3.4 Ensure that the control of the plant is independent of the operator workstation. If the front end supervisor fails, the network of field controllers shall continue to operate.

1.5.3.5 Ensure that the operator workstation can communicate with all addressable field controllers.

1.5.3.6 Ensure that all monitored point data are displayed at the operator workstation.

1.5.3.7 Ensure relevant BMS points are trendable, configuring sufficient points to be able to prove the operation of the plant by looking at historical data. All analogue points must be 'trend' points. Once the plant has been witnessed the active trend point requirements can be revised if this helps with the efficacy of the system.

1.5.3.8 Where possible ensure that historical trend charts/logs can be accessed via the supervisor as simple click box, rather than convoluted path structure.

1.5.3.9 Ensure that no data of a control nature is transferred between field controllers via the operator workstation, i.e. data relating to control strategies. (In some circumstances control data may be transferred via the operator workstation, e.g. where integration between systems is performed via a gateway that resides on the operator workstation. If such an approach is required The NG Bailey BMS Technical Manager, or Project Manager shall be informed.

1.5.3.10 Provide complete system integrity such that the network of field controllers will continue to fully operate following a failure of the operator workstation.

1.5.3.11 Ensure that the appropriate control strategy configuration data can be downloaded to all addressable field controllers.

1.5.3.12 Provide a means of displaying and modifying each addressable field controller's control strategy, time schedules and set-points via the operator workstation.

1.5.3.13 Ensure that all control strategies and associated control parameters can be altered via the operator workstation.

1.5.3.14 Allow the operator to re-schedule plant operation times. Ensure that re-scheduling can be applied globally to a number of items of plant at one or more sites (or one or more controllers on one site) as selected by the operator.

1.5.3.15 Ensure that the operator workstation incorporates a data storage management system that warns against impending on-line storage overflow and allows for data archiving to, and retrieval from, off-line non-volatile media. Ensure that the operator is prompted at pre-defined intervals to carry out the data archiving procedure.

1.5.3.16 Ensure that it is possible to perform a complete backup of the operator workstation comprising control strategies, set-points and logged data.

1.5.3.17 Provide an electronic data archival device that uses readily available non-volatile media that is appropriate for long term storage of system software, configuration data and logged data (including alarm data).

1.5.3.18 Allow the transfer of data from the system memory and other storage devices to the archive mediums, and vice versa for the preparation of reports.

1.5.3.19 Ensure that the backup data can be fully re-loaded.

1.6 Specific Software Routines

1.6.1 The BMS software shall have the following routines built in as mandatory requirements:

1.6.1.1 Flushing Routine (Where LTHW or CHW is utilized)

1.6.1.2 Plant/component exercise routine

1.6.1.3 Energy Metering to CIBSE TM39 requirements (Daily/Weekly/Monthly kWh consumption)

1.6.1.4 Water Balancing Routine (Where LTHW or CHW is utilized)

1.6.2 Flushing Routine

1.6.2.1 To ensure that the pipework remains in good condition it is essential that water treatment chemicals are regularly distributed throughout the system. This can be problematic when valves shutdown due to lack of demand. The Controls Specialist shall therefore devise a software routine that activates on a calendar schedule during out of occupancy hours. The schedule shall be defaulted to daily. The software routine shall open all the valves (including boiler/chiller back end valves) and run the associated circulating pumps to distribute the medium. The heating and cooling generators do not need to be run, unless there is a 3rd stage frost protection requirement. The calendar schedule shall run the pumps for 30 minutes but shall be operator adjustable. Where TRV's are utilized end of line bypass valves shall be employed to ensure there is a viable flow path.

1.6.3 Plant Exercising

1.6.3.1 To ensure equipment doesn't seize up or stay in the same position for prolonged periods the Controls Specialist shall devise a software routine that periodically runs plant for a minimum period. Motors that are VSD controlled only need to spin at slow speed.

1.6.3.2 The plant exercising mode shall be implemented by the BMS and shall run, via a suitable time schedule, when the plant has remained shutdown for a period of typically 7 days. This period can be adjusted, via the BMS.

1.6.3.3 When the plant shutdown period has elapsed its respective dampers, valves,pumps, fans and other motor driven movable equipment shall be operated. Pumps and fans need not run at their full design speed. When the pumps and fans run, ensure their respective valves/dampers are open. The object of this exercise is to rotate the motor shaft to prevent bearing damage.

1.6.3.4 The plant exercise run time only needs to be as long as it takes to stroke the valves/dampers. Typically, 10 minutes.

1.6.3.5 The BMS shall not carry out this plant exercising routine on safety systems, or plant that is not meant to run in normal conditions. These types of plant shall have a separate means of servicing, typically highlighted in the suppliers O&M manual.

1.6.4 Energy Metering – kWh Consumption

1.6.4.1 Refer to CIBSE TM39 documentation and produce software routine that provides daily/weekly and monthly calculation of kWh usage for the various energy consuming systems. Refer to section 1.8 for more information.

1.6.5 Water Balancing Routine

1.6.5.1 Provide a means to globally override BMS control valves to allow for the balancing of water systems.

1.7 Specific Equipment BMS Routines

1.7.1 Open/Closed Damper Actuators.

1.7.1.1 End switches shall be fitted to these damper actuators. The end switch shall be hardwired interlocked to prevent its respective fan from operating until the damper is at least 90% open.

1.7.1.2 Where modulating damper actuators have been used as open/close these too require an end switch, as detailed in 1.8.1.1.

1.7.2 Frost Stat.

1.7.2.1 Activation of the frost stat shall raise an alarm on the BMS. BMS software shall allow for three auto frost stat resets within a period of 1 hour. On the fourth trip the software shall shutdown the AHU and latch off. An operator reset, at the controller or supervisor, will be required in order for the AHU to run.

1.7.3 Humidification Units.

1.7.3.1 Where humidifiers are required in AHU's/ductwork, the controls specialist shall install supply air humidity sensor and a separate supply air humidistat. The supply air humidity sensor is used for cascade control of the return air humidity sensor, to prevent the supply air humidity rising above 90%RH. The humidistat is hardwired interlocked with the humidifier enable.

1.7.4 Pressurisation Units.

1.7.4.1 Unless otherwise stated, the BMS shall monitor pressure sensor, water meter, low & high pressure alarm and Common Fault. The low & high pressure alarm shall shutdown the respective system pumps and generating source (boiler or chiller, for example)

1.7.5 CWS Storage Tanks.

1.7.5.1 The BMS shall monitor high level, low level and temperature.

1.7.5.2 The low level switch shall be interlocked with the CWS booster set to disable it.

1.7.5.3 Where split tank system is used, then ensure the booster set only shuts down if both low level switches are activated.

1.7.5.4 Ensure the temperature sensor is monitored, via the BMS and an alarm is raised if the temperature rises above 20°C A critical alarm shall be raised if the water temperature rises above 25°C.

1.7.6 CWS/CAT5 Booster Set.

1.7.6.1 The BMS shall monitor the common fault and raise an alarm.

1.7.7 Water Conditioning Units.

1.7.7.1 Where a chlorine dioxide water conditioning unit is fitted, the BMS shall monitor the common fault and raise an alarm.

1.7.7.2 Where an electronic water conditioner is fitted, the BMS shall monitor the common fault and raise an alarm.

1.7.7.3 Where water softener is fitted, the BMS shall monitor the common fault and raise an alarm.

1.7.8 Static Inverter

1.7.8.1 Where a static inverter is installed the BMS shall monitor the common fault and raise an alarm.

1.7.9 Trace Heating

1.7.9.1 Where trace heating controllers are installed, the BMS shall monitor the common fault and raise an alarm.

1.7.10 Photo Voltaic

1.7.10.1 Where photo voltaic controllers are installed, the BMS shall monitor the common fault and raise an alarm.

1.7.11 Solar Thermal

1.7.11.1 Where solar thermal controllers are installed, the BMS shall monitor the common fault and raise an alarm.

1.7.12 VRF System

1.7.12.1 Where a centralized controller is being utilized, use BACnet interface to read/write the room data. This may require liaising with NG Bailey and the installers to ensure all certificates, FCU groupings etc have been finalized.

1.8 Energy Metering

1.8.1 Refer to the NG Bailey Energy Management Systems General Specification.

1.8.2 A dedicated web based energy management system shall be employed. All electric, gas and energy meters shall be routed to the EMS and configured to meet CIBSE TM39 guidelines. A link to the BMS supervisor shall allow the data to be represented graphically. Refer to the NG Bailey Energy Metering Specification.

1.8.3 The EMS will be capable of exporting the energy usage (individual meters at half-hourly intervals) to a 3rd party system via .CSV files or other common format via email, FTP or Web services.

1.8.4 In order to comply with Building Regulations part L2 & CIBSE TM39 guidelines, the metering information from the EMS shall be displayed on the front end supervisor. Usage data for items detailed in section 1.8.6 shall be available for daily, weekly and monthly consumption. The time stamp must be commensurate with the date that the information relates to. For example, Monday's daily kWh value if sent at midnight would have Tuesday's time stamp, which is incorrect.

1.8.5 If a group of meters are deemed to be associated with an area an overall energy consumption profile for that area shall be generated.

1.8.6 The controls specialist shall ensure that major energy consuming systems (where present) are monitored using the BMS, for example – as detailed below;

1.8.6.1 Space Heating;

1.8.6.2 Domestic Hot Water;

1.8.6.3 Humidification;

1.8.6.4 Cooling;

1.8.6.5 Fans (major);

1.8.6.6 Lighting;

1.8.6.7 Small Power;

1.8.6.8 Other major energy-consuming items where appropriate – Lifts etc.

1.8.7 Electric meters will be connected to the BMS via MODBUS protocol. Information required as a minimum from the main incoming meter shall be as follows:

1.8.7.1 kW/hr;

1.8.7.2 kW;

1.8.7.3 kVA;

1.8.7.4 L1-L2-L3 Voltage;

1.8.7.5 L1-L2-L3 Current;

1.8.7.6 PF Overall.

1.8.8 Information required as a minimum from ALL sub-meters shall be as follows:

1.8.8.1 kW/hr;

1.8.8.2 kW.

1.8.8.3 Peak kWh

1.8.9 Further monitoring points may be required as indicated in the Client's specification.

1.8.10 Other meters such as heat/energy, steam, water, gas, and compressed air will be modbus, Mbus protocol or pulse facility as indicated in the specification. If only a pulse output is available this input will be collected via a dedicated pulse collector such as PadPuls or similar.

1.8.11 Energy meters serving LTHW & CHW are required to display the flow rate and temperatures (flow and return) on the BMS graphics..

1.8.12 A maximum of 30 meters will be allowed on a network to cater for expansion.

1.8.13 Where inverters are networked via BACnet etc the kW/hr consumption shall be logged as a typical meter on the BMS. AHU supply and extract fan inverter kW/hr's shall also be totalled to give a AHU kW/hr consumption.

1.8.14 "Virtual" kW/hr meters shall be included for items of plant with a known approximate kW and a run hour monitoring point such as an ENABLE signal, RUN feedback or flow switch etc.

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2.0 BMS FIELD EQUIPMENT

2.1 General Requirements

2.1.1 A control system is only as good as the sensor used to measure the controlled variable and transmit it as a measured value to its respective controller. It is crucial that the sensor should provide an accurate measurement of the controlled variable at the reference point in the control loop. The head end supervisor and MMI, if fitted, shall raise an alarm should a sensor fail.

2.1.2 Provide and install field equipment that complies with BSRIA AG9 & AG10 guidelines

2.1.3 Wherever possible use 24V power source. Where 230VAC or higher has to be used, provide means of local isolation and provide suitable voltage warning label.

2.1.4 Be aware of the effects of orientation on the functioning of the sensor.

2.1.5 The cable should be installed with a drip loop to prevent water entering the sensor housing.

2.1.6 Select equipment suitable for the environment they shall be subjected to.

2.1.7 Ensure there is enough space around equipment to allow for its removal.

2.1.8 Ensure sensors can be removed for testing, calibration and maintenance.

2.1.9 Dress cables appropriately and use appropriate cable markers and ferrules. The ferrules must be crimped with appropriate tool.

2.1.10 Ensure duct mounted sensors have sufficient cable slack to enable the sensor to be pulled out without disconnecting the wiring.

2.1.11 Drill test hole downstream of the sensor and plugged when not in use.

2.1.12 Sensors should not be positioned in deadlegs.

2.1.13 Always follow the equipment manufacturers installation instructions. Where this may not be possible, notify the NG Bailey project manager at the earliest opportunity.

2.1.14 Where equipment is mounted outside ensure it has adequate IP rating.

2.1.15 Where control panels, or other heat generating equipment, ensure anti-condensation heaters are used and carry out heat gain calculations to determine means of ventilation.

2.2 Air Sensors

2.2.1 Frost Stat.

2.2.1.1 For AHU’s mounted outside, the frost stat must be located inside the AHU. The ambient temperature of the controller must be higher than the temperature the capillary is measuring.

2.2.1.2 The controller should be mounted higher than the capillary.

2.2.1.3 The sensing head should always point downward.

2.2.1.4 Capillary frost stats are preferred to single point frost stats. The capillary shall be mounted serpentine fashion, at right angles to the pipes and on the downstream side of the first water coil that the intake air meets.The capillary must cover the whole width of the coil. Means of heating the frost stat capillary is required in order to reset it. For example, recirculated air or heating valve actuator opening fully.

2.2.1.5 Where the capillary passes through sheet metal, it must be protected with a suitable grommet.

2.2.1.6 Frost stats shall be auto reset, typically set at 2°C. Upon activation they shall be hardwired interlocked to the supply fan motor and fresh air damper actuator.

2.2.2 Duct Temperature Sensors.

2.2.2.1 Provide temperature sensors that meet the current BSRIA AG 9 guidelines.

2.2.2.2 Select the correct length sensor probe for the duct dimensions.

2.2.2.3 Ensure the sensor element protrudes fully into the airflow.

2.2.2.4 Position the temperature sensor so that it is not influenced by radiant heating effects from electric heater batteries or other.

2.2.2.5 Wherever possible, position the sensor where it can be easily accessible for maintenance.

2.2.2.6 Use appropriate gaskets where the probe penetrates the ductwork.

2.2.2.7 Where averaging duct temperature sensors are used, ensure the entire length of the averaging sensor is fully inside the air duct.

2.2.2.8 Averaging sensors must be evenly distributed over the full cross section of the duct and adequately supported.

2.2.2.9 Where the temperature sensor is positioned outside, ensure the IP rating is adequate

2.2.3 Space Temperature Sensors.

2.2.3.1 Mount space sensor at the appropriate height, in accordance with best practice and current guidelines. Typically, this is 1.5m from floor level and at least 500mm from any adjacent walls.

2.2.3.2 The space sensor should be mounted in the same zone that it controls.

2.2.3.3 Do not mount space sensors near to any heat generating equipment, such as photo copiers or vending machines etc.

2.2.3.4 Avoid mounting the sensor on external walls. Where this is unavoidable utilise insulated back-plates. And seal entry hole to prevent draughts from cavity walls.

2.2.3.5 Where possible, do not mount space sensor adjacent to doors.

2.2.3.6 Where possible, avoid mounting in alcoves.

2.2.3.7 Where possible, avoid mounting where it may be subject to direct sunlight.

2.2.4 Outside Temperature Sensors.

2.2.4.1 Do not install under eaves, above windows or above ventilation extracts.

2.2.4.2 Where possible mount of north facing walls away from direct sunlight.

2.2.4.3 Use a solar shield if the sensor is going to be exposed to sunlight for any period of time.

2.2.5 Duct Humidity Sensors/Stats.

2.2.5.1 Provide and install duct humidity sensors that meet the current BSRIA AG9 & AG10 guidelines.

2.2.5.2 Ensure humidity sensor/stat is suitable for the environment it is monitoring. Swimming pool environments, for example, require specialist humidity sensors.

2.2.5.3 Select the correct length sensor probe for the duct dimensions. Ensure the sensor element protrudes into the airflow.

2.2.5.4 Ensure the humidity sensor/stat is suitable for the intended air velocity.

2.2.5.5 Position the humidity sensor/stat so that it is not within the humidifiers steam/water pattern. Ensure that it is located far enough so that the air has absorbed all of the water.

2.2.5.6 Wherever possible position sensor where it can be easily accessible for maintenance.

2.2.5.7 Use appropriate gaskets where the probe penetrates the ductwork.

2.2.5.8 Where the duct humidity sensor is positioned outside, ensure the IP rating is adequate.

2.2.5.9 Hardwire interlock the stat with the humidifier enable signal.

2.2.5.10 Set the stat to trip at 95%RH with auto reset with a suitable hysteresis.

2.2.6 Space Humidity Sensors.

2.2.6.1 Mount space sensor at the appropriate height, in accordance with best practice and current guidelines. Typically, this is 1.5m from floor level and at least 500mm from any adjacent walls.

2.2.6.2 The space sensor should be mounted in the same zone that it controls.

2.2.6.3 Do not mount space sensors near to any heat generating equipment, such as photo copiers or vending machines etc.

2.2.6.4 Where possible, avoid mounting in alcoves, or adjacent to doors.

2.2.7 Duct Air Quality Sensors.

2.2.7.1 Ensure duct mounted air quality sensors are mounted vertically.

2.2.7.2 Where air quality sensor is located in the return air duct, ensure it is as close as possible to the room extract point.

2.2.7.3 Ensure air quality sensor measures the correct air components (CO_2, CO, etc)

2.2.8 Space Air Quality Sensors

2.2.8.1 The air quality space sensor should be mounted in the same zone that it controls.

2.2.8.2 The sensor should not be mounted within alcoves.

2.2.9 Combined Temperature, Humidity & Air Quality Sensors.

2.2.9.1 Where combined sensors are used, ensure their physical location and mounting complies with the requirements of the equivalent individual sensors.

2.2.10 Duct Smoke Detector

2.2.10.1 Where duct mounted smoke detectors are required, ensure they are mounted according to the manufacturers requirements.

2.2.10.2 Select appropriate smoke detector (optical or ionization) for intended purpose.

2.2.10.3 Where possible, HVAC duct smoke sensors should be 24V AC/DC.

2.2.10.4 Ensure the smoke detector and sample tube assembly are suitable for the intended air flow velocity.

2.2.10.5 Locate the detector as far away as possible from any obstruction, such as deflector plates, bends, dampers etc)

2.2.10.6 Ensure the sampling tubes are of the correct length for the duct.

2.2.10.7 If possible, install duct smoke detectors upstream of air humidifiers and downstream of de-humidifiers.

2.2.10.8 To minimize false alarms, avoid mounting the detector in extreme high or low temperatures, in areas of high humidity, or in areas containing high amounts of dust.

2.2.11 Air Pressure Switches/Sensors

2.2.11.1 Provide and install D.P switch/sensor that meets the current BSRIA AG9 guidelines.

2.2.11.2 Select range suitable for device being monitored.

2.2.11.3 Check the correct range D.P switch/sensor is fitted by cross referencing specialist's equipment schedule.

2.2.11.4 Install to manufacturers installation data sheet. If mounting orientation affects the switching point take this into consideration when setting the value.

2.2.11.5 Ensure the BMS cabling inside the device does not obscure the switch setting knob.

2.2.11.6 Where filters are being monitored, ensure the switch setting corresponds to the filter manufacturers 'dirty' filter setting.

2.2.11.7 Where a sensor is used, ensure the software dirty filter value is set correctly. Refer to filter manufacturers recommended dirty filter value.

2.2.11.8 Install plastic tubing neatly and where used ensure the manufacturers approved pitot tubes are used. Use appropriate fixings to ensure the tubing does not catch on any access doors.

2.2.11.9 Ensure the D.P switch/sensor pressure input ports are tubed correctly with respect to the upstream and downstream pressures across filters and fans, for example.

2.2.11.10 Where the D.P switch/sensor is positioned outside, ensure the IP rating is adequate.

2.2.11.11 To avoid overload and possible damage to one side of the sensor, the connection must always be fitted with a bypass valve arrangement.

2.2.11.12 Probes that measure the static pressure in the duct must be installed parallel to the flow and with with or against it.

2.2.12 Air Flow Paddle Switches

2.2.12.1 Where paddle switches are used, for example, duct electric heaters safety interlock, ensure the switch is mounted according to the manufacturer's installation instructions.

2.2.12.2 Select the appropriate paddle size based on the duct size and air flow velocity.

2.2.12.3 If the paddle switch is mounted outside, ensure the IP rating is adequate.

2.3 Water Sensors

2.3.1 General Requirements

2.3.1.1 Ensure the sensor is suitable for the temperature range it shall be subjected to.

2.3.1.2 Ensure the sensor is suitable for the pressure it may be subjected to.

2.3.1.3 Ensure the full active length of the sensor is immersed in the medium.

2.3.1.4 Install sensors at the correct angle and against the direction of flow.

2.3.1.5 Ensure the sensor range is appropriate for the system being measured/monitored.

2.3.1.6 Ensure the sensor is suitable for the medium it is subjected to.

2.3.1.7 Ensure the sensor can be removed from its pocket without disconnecting the cable.

2.3.1.8 Ensure there are no obstructions preventing the sensor from being fully withdrawn.

2.3.2 Pipework Immersion Temperature Sensors.

2.3.2.1 Provide and install immersion temperature sensors that meet the current BSRIA AG9 & AG10 guidelines.

2.3.2.2 Use appropriate & sufficient conducting paste in the sensor pocket.

2.3.2.3 Ensure immersion pockets are made from stainless steel and are of appropriate length and pressure rating.

2.3.2.4 For mixed water ensure immersion sensor is located far enough from the mixing point to avoid stratification.

2.3.3 Pipework Strap-On Temperature Sensors.

2.3.3.1 If necessary use a file to ensure a clean smooth contact surface.

2.3.3.2 Use suitable conducting paste between the pipework and sensor contact area.

2.3.4 Pipework Liquid Pressure Sensors.

2.3.4.1 Provide and install pressure sensors that meets the current BSRIA AG9 & AG10 guidelines.

2.3.4.2 Ensure pressure sensor is suitable for the static pressure and has the appropriate sensing range.

2.3.4.3 Do not locate pressure sensor at top or bottom of pipework.

2.3.4.4 For differential pressure sensors, ensure bypass pipework is used with appropriate isolation valves.

2.3.4.5 Ensure there are no stop or balancing valves between the sensing tappings.

2.4 Actuators

2.4.1 Damper Actuators.

2.4.1.1 Provide and install damper actuators that meet the current BSRIA AG9 guidelines.

2.4.1.2 Ensure the actuator torque is sufficient to open its respective damper. Where this is not possible utilise additional actuators.

2.4.1.3 For open/close damper actuators provide bespoke actuator end switch for prove open status. Typically, set the switch at 90% open.

2.4.1.4 Install damper actuator to the manufacturer's installation instructions.

2.4.1.5 Where the actuator is positioned outside, ensure the IP rating is adequate.

2.4.1.6 Fit actuators with visual indication.

2.4.1.7 Ensure actuator can be manually disconnected and moved in the event of its failure.

2.4.1.8 If damper motors are required to fail open or closed, or provide an instantaneous open to closed or closed to open reaction, use a spring return mechanism, activated by a break in the electrical supply, connected to the motor.

2.4.2 Valve Actuators.

2.4.3 Provide and install valve actuators that meet the current BSRIA AG9 guidelines.

2.4.4 For two port valves, ensure its corresponding actuator has sufficient torque to close the valve.

2.4.5 Complete a valve sizing schedule to include valve authority, Kv rating, DN rating and submit the approved schedule within the BMS O&M manual.

2.4.6 Ensure 2-port valves are sized against the system pressure and not the coil pressure drop.

2.4.7 Install valve actuator to the manufacturer's installation instructions.

2.4.8 Ensure the valve orientation is correct with respect to flow, return and bypass.

2.4.9 Where valves have been free issued to NG Bailey, carry out pre-commissioning survey to ensure the correct valve and actuator has been installed by using the system specialist's valve schedule.

2.4.10 Avoid installing valves with stem horizontal. Where this is found, notify the NG Bailey project manager at the earliest opportunity.

2.4.11 Where the actuator is positioned outside, ensure the IP rating is adequate.

2.5 Variable Speed Drives

2.5.1 Size the drive to the motor it is controlling. Take into account the expected ambient temperature in case of de-rating requirements.

2.5.2 Install drive to manufacturer's mechanical installation requirements.

2.5.3 Ensure device has adequate ventilation.

2.5.4 Carry out electrical installation to manufacturers electrical installation requirements. In particular, the cabling from the drive to the motor.

2.5.5 Where RCD's are used to supply power to the drive only RCD type B may be used.

2.5.6 Use only cable that compiles to BS 7671. Please note YY, CY or SY cable is not permitted for power wiring.

2.5.7 Ensure EMC compliant installation is followed including the correct VSD harmonics filter.

2.5.8 Ensure all screening and earthing is carried out to the drive manufacturer's requirements. Use EMC clamps and avoid using pigtails. Where this is unavoidable, keep the pigtail to a minimum.

2.5.9 Where isolators are installed between the drive and motor, ensure the screening is contiguous and if metal the isolator is adequately earthed.

2.5.10 Select appropriate IP rating for task in hand and intended location.

2.5.11 If inverter is located inside the AHU, ensure keypad is accessible and suitably IP rated on external location of AHU.

2.5.12 If located inside weatherproof enclosure assess whether anti-condensation heaters are required and carry out heat gain calculations to verify type of ventilation required (natural or mechanical).

2.5.13 Where motor thermistors are utilised, wire these back to the drive's suitable digital input and configure accordingly.

2.5.14 Where metering is required to TM39 and L2 requirements, utilise BACnet or similar to extract the motor kWh consumption. If RS485 cabling is used, then ensure at least 3 cores and screen cable is used, for example Belden 9842NH.

2.5.15 Ensure all drive basic parameters match the motor and intended use. The minimum parameters setting to review are as follows, but not limited to:

2.5.15.1 Motor Power;

2.5.15.2 Motor Voltage;

2.5.15.3 Motor Frequency;

2.5.15.4 Motor Current;

2.5.15.5 Motor Nominal Speed;

2.5.15.6 Minimum Reference Signal;

2.5.15.7 Maximum Reference Signal;

2.5.15.8 Ramp Up Time;

2.5.15.9 Ramp Down Time;

2.5.15.10 Motor Temperature Protection;

2.5.15.11 Motor Frequency;

2.5.15.12 Motor Current;

2.5.15.13 Motor Nominal Speed;

2.5.15.14 Minimum Reference Signal;

2.5.15.15 Maximum Reference Signal;

2.5.15.16 Ramp Up Time;

2.5.15.17 Ramp Down Time;

2.5.15.18 Motor Temperature Protection;

2.5.15.19 Ensure all parameters changed from default are recorded and incorporated within the specialists BMS O&M manual.

2.6 Meters

2.6.1 General Requirements

2.6.1.1 Water, Gas, Heat and Electricity meters shall be monitored via the BMS to meet Building Regulations L2 requirements and comply with CIBSE TM39 guidlines.

2.6.1.2 Meters shall have as a minimum pulse output, representing consumption use.

2.6.1.3 Modbus or M-bus converters are encouraged where it is practicable. For example, Padpuls. These converters provide a M-Bus output from the pulse input signal and are battery backed up. This cuts down on the wiring from each meter to the BMS outstation.

3.0 POWER & CONTROLS WIRING AND CONTAINMENT

3.1 General Requirements

3.1.1 Refer to the latest NG Bailey Standard Electrical Workmanship Specification.

3.1.2 Ensure that the BMS can operate supplied with electricity conforming to BSEN 50160 – 2010 Voltage characteristics of electricity supplied by public distribution systems.

3.1.3 The electrical installation installed by the system specialist shall comply with the latest edition of the IEE regulations.

3.1.4 Ensure that the installation complies to the latest edition of BS7671 wiring regulations and amendments.

3.1.5 Ensure that the BMS complies with the following EC Directives:

3.1.6 Low Voltage Directive 73/23/EEC and amendment 93/68/EEC

3.1.7 Construction Products Directive 89/106/EEC

3.1.8 General Product Safety Directive 92/59/EEC

3.1.9 Ensure that the BMS installation complies with HD 60364-4-41:2007– Low voltage electrical installations. Protection for safety - protection against electric shock, 2007.

3.1.10 Ensure that control panels comply with EN 61439-1 and 61439-2- Low-voltage switchgear and control assemblies.

3.1.11 Ensure that the BMS complies with the Electromagnetic Compatibility (EMC) Directive (89/336/EEC).

3.1.12 Ensure that the BMS complies with BSEN 50081-1: Generic emission standard and BSEN 50082 Parts 1 & 2: Generic immunity standard.

3.1.13 Ensure that the BMS meets the EMC requirements of pr EN 13646.

3.1.14 If the controls specialist is proposing to sub-contract out the electrical install, then they shall notify NG Bailey as to whom they shall be using.

3.2 Containment Management System (CMS)

3.2.1 Refer to the latest NG Bailey Standard Electrical Workmanship Specification.

3.2.2 The controls specialist installer shall provide a CMS that conforms to the latest BS EN 61537.

3.2.3 Suitable galvanised segregated CMS shall be installed. The CMS must comply with NG Bailey policy for brackets and support fixings. Refer to the NGB - Mandatory- Supports & Fixings for Sub Contractors document. Also, the NG Bailey Standard Electrical Workmanship Specification for further information.

3.2.4 All cabling should have adequate mechanical protection.

3.2.5 Cable and trunking sizes shall comply with the IEE Wiring Regulations with regards to grouping, bunching and enclosing factors. There shall be 25% spare capacity within the trunking.

3.2.6 In the absence of specific information, the controls specialist shall provide all primary and secondary containment (including supports) within all plantrooms or plant areas. Externally from these areas the controls specialist shall provide all secondary containment.

3.3 Power & Controls Wiring

3.3.1 Power cables, installed by the controls specialist shall have the necessary cable calculations results submitted to the Project Manager, and approved before Installation commences.

3.3.2 Controls cabling shall have sufficient cross-sectional area such that the cable resistance is not exceeded for the connected device such that it will receive its required current /voltage requirements.

3.3.3 Terminals for differing voltages and circuit types shall be segregated and labelled appropriately.

3.3.4 Analogue signal cable shall have an overall screen of either braiding or foil and a PVC sheath. Foil-screened cables shall contain a ‘drain wire’, running the entire length of the cable, which shall be used for terminating the screen. Conductors shall be of the flexible (stranded) type and shall be individually sheathed in PVC.

3.3.5 All control wires shall carry numbered ferrules at both ends. Spare, unused cores, must be suitably dressed with no bare wires visible.

3.3.6 Cable ferrules must be crimped with the appropriate tool.

3.3.7 BMS outstation terminals must only have one wire connected to its respective terminal.

3.3.8 All final connections to plant i.e. boilers, fans, pumps, etc. shall be the responsibility of the control specialist’s electrical installer and are to be wired from locally mounted isolators using fixed or flexible conduit as appropriate.

3.3.9 The control specialist’s electrical installer will supply isolators for all items of plant irrespective of panel mounted isolators being present on packaged plant such as CWS booster sets, pressurisation units, boilers, AHUs (only if a variable speed drive is to be installed) etc.

3.3.10 Isolators are to be installed on the supply-side and load-side of variable speed drives to allow maintenance of the drive or the motor to take place without unnecessarily isolating the distribution board or drive. Consult the VSD installation instructions for any requirement for the drive enable signal to be interlocked with an auxiliary contact on the load-side isolator to prevent the motor from starting on full load when the motor is re-energised.

3.3.11 Power cabling between a VSD and motor shall be of a suitable screened cable that complies with British standards and conform the VSD manufacturer’s requirements. Please Note; SY, CY & YY cable is **not** permitted for power cabling.

3.3.12 Gas solenoid valves should be electrically supplied via a locally mounted fused-spur with Neon indication of ‘power ON’ as a very minimum.

3.3.13 All BMS IP network related cables shall be installed by the BMS Controls Specialist. This will form a dedicated BMS network which can be linked to the client network at a later date if required. This requirement is designed to offer a robust BMS network.

4.0 LABELLING

4.1 General Requirements

4.1.1 Ensure that each control device has a reference label attached.

4.1.2 Where possible avoid placing labels on removable lids.

4.1.3 The subcontractor responsible for the electrical installation shall secure permanent traffolyte labels to all isolators. The label shall give a descriptive indication of the item of plant i.e. Boiler Shunt Pumps, Boiler No.1, LTHW Pressurisation Unit etc.

4.1.4 Labels shall be applied to all controls ancillaries to clearly identify what they are i.e. Supply Fan DPS, Panel Filter DPS, VT Temperature Sensor etc. This is intended to aid maintenance activities.

4.1.5 As a minimum space sensors should have a self-adhesive ‘tape’ type label applied to the interior of the sensor that clearly identifies the sensor location and reference in relation to the reference on the BMS graphics or user keypad. This is intended to aid building operation and maintenance activities.

5.0 COMMISSIONING

5.1 General Requirements

5.1.1 The controls specialist subcontractor shall, as a minimum, comply with CIBSE Commissioning Code C sections C5, C6 & C7.

5.2 Pre-Commissioning

5.2.1 Ensure that as much pre-commissioning work as possible is performed off-site.

5.2.2 Ensure that the following is followed:

Pre-Commissioning requirements:

PRE-COMMISSIONING ACTION	PRE-COMMISSIONING OFF SITE
Control application software	Yes (final commissioning on-site)
User interface software	Yes (final commissioning on-site)
Control panels	Yes (final commissioning on-site)
Terminal units (fan coil units, etc)	Yes (final commissioning on-site)
Wiring	No
Communication networks	No
Sensors	No
Actuators	No
Integration gateways	Partial (final commissioning on-site)

5.2.3 Ensure that a record of all settings, set-points and offsets are maintained throughout the pre-commissioning period.

5.2.4 Ensure that all final physical adjustments to the field devices are indelibly marked.

5.2.5 Ensure that all packaged plant interfaced with the BMS is fully tested and commissioned by the manufacturer or installer.

5.2.6 Ensure that the BMS is pre-commissioned in accordance with the following requirements of CIBSE Code C (Commissioning of automatic control systems).

CIBSE Code C automatic control systems pre-commissioning requirements:

PRE-COMMISSIONING ACTION	CIBSE CODE C SECTION REFERENCE
Control application software	C5.2
Control panels	C5.3

Wiring	C5.4
Communication networks	C5.5
Sensors	C5.6
Actuators and valves	C5.7
Digital inputs/outputs	C5.8
Pneumatic actuation with microprocessor control	C5.9
Field control devices	C5.10

5.2.7 Confirm that the following plant commissioning has been performed (by others) before commencing the final BMS commissioning:

5.2.7.1 Air Systems

5.2.7.1.1 Debris has been removed from the air distribution system;

5.2.7.1.2 AHU fan transportation fixings have been removed;

5.2.7.1.3 Tools and commissioning equipment shall not be stored within the AHU, unless agreed with NG Bailey Project Manager.

5.2.7.1.4 Dampers are in the correct location and fully functional;

5.2.7.1.5 Fire/smoke dampers are open;

5.2.7.1.6 Test holes have been drilled and sealed with removable plugs;

5.2.7.1.7 Flow measuring devices have been installed;

5.2.7.1.8 Ductwork air leakage testing has been performed (if specified);

5.2.7.1.9 Completion of proportional balancing of regulating dampers so that terminals share the air flow in the correct proportions;

5.2.7.1.10 Regulation of the fan(s) to provide the specified flow rate.

5.2.7.2 Water Systems

5.2.7.2.1 The system is cleaned and flushed to remove any debris;

5.2.7.2.2 All regulating, isolating and control valves in place and operating correctly;

5.2.7.2.3 Any flow measuring devices are in place and in the correct location for accurate measurement (including pressure tappings);

5.2.7.2.4 The system is vented;

5.2.7.2.5 That the proportional balancing is completed to obtain the branch flow rates in the correct ratio to each other (or through the use of and setting of self-balancing valves);

5.2.7.2.6 Pump flow rate has been adjusted to provide the specified flow rate;

5.2.7.2.7 Control valves supplied by the controls subcontractor have been fitted in the correct location and with correct porting orientation.

5.2.7.3 Packaged Plant

5.2.7.3.1 Ensure that plant and controls have been fully commissioned and are functional, ready for integration with other plant/systems.

5.2.7.3.2 That control equipment inputs/outputs are in the specified format for connection to the main control system.

5.3 Final Commissioning

5.3.1 Confirm that the following plant commissioning has been performed before commencing the final BMS commissioning:

5.3.1.1 Ensure that the BMS is pre-commissioned to allow the building services plant to operate under 'manual' running conditions.

5.3.1.2 Ensure that the control valves can be manually set in their fully open position to allow the balancing of pipe-work flows.

5.3.1.3 Ensure that dampers can be manually opened to allow the commissioning of air systems.

5.3.1.4 Ensure suitable software strategy is engineered to allow for global open/closed/auto commands of all valves /dampers, where applicable, to ensure ease of commissioning.

5.3.1.5 Ensure that the control system is commissioned to the requirements of the approved description of operation, and the commissioning activity is not merely confined to checking the operation of the software, which may not match the description of operation.

5.3.1.6 Ensure that the BMS is commissioned in accordance with the following requirements of CIBSE Code C (Commissioning of automatic control systems).

CIBSE Code C automatic control systems commissioning requirements (Refer overleaf):

COMMISSIONING ACTION	CIBSE CODE C SECTION REFERENCE
Control strategy checking	C6.2
Checking procedures for basic control functions	C6.3
Lighting controls	C6.4
Operator workstations	C6.5
Occupant interfaces	C6.6
Communication networks	C6.7
Integrated systems – gateways	C6.8
Integrated systems - direct interoperability	C6.9
Integration with fire detection systems	C6.10
Security systems	C6.11
Interruption of electrical power supplies	C6.12
Valves	C7.1
Dampers	C7.2
Fans - single speed	C7.3
Fans - variable speed	C7.4
Pumps	C7.5

5.3.1.7 Ensure that all equipment and devices used for commissioning are suitably calibrated and certificates issued.

5.3.1.8 Ensure the software control routines and sequences are commissioned against the approved Description of Operation.

6.0 WITNESSING & HANDOVER

6.1 General Requirements

6.1.1 The controls specialist subcontractor shall, as a minimum, comply with CIBSE Commissioning Code C section C8.1

6.1.2 The controls specialist subcontractor shall demonstrate the system to NG Bailey as required with a full functionality test to prove operation. This functionality test will take place during final commissioning and prior to or during consultant witnessing to ensure the system has been satisfactorily commissioned and automatic functionality has been proven.

6.1.3 The controls specialist subcontractor shall be expected to complete the 'BMS & Controls Project Completion Report' which will be issued by NG Bailey during the project.

6.1.4 An authorised signature will be required from both the subcontractor and a member of the NG Bailey project team when completion of commissioning and automatic functionality proving has been carried out to be used as a 'completion statement' to meet the requirements of Part L2.

6.1.5 The controls specialist shall also allocate a suitable time allowance to demonstrate and train the end-user on the system specifics and shall detail this time allowance in their quotation.

6.1.6 The following witnessing requirements shall be independently considered on a project by project basis and it is the responsibility of the NG BAILEY project manager to ensure that the appropriate level of witnessing is carried out to satisfy the requirements of commissioning code C. The BMS specialist shall allow sufficient time and resource to demonstrate the same.

6.1.7 The NG Bailey project manager's nominated representative shall implement the following witnessing requirements and ensure that on-site commissioning-staff carry out the witnessing process.

6.1.8 Ensure that the BMS hardware is installed in accordance with the particulars of this specification.

6.1.9 Verify any operator software and associated graphics.

6.1.10 NG Bailey shall witness the BMS system using the approved and signed off Description of Operation.

6.1.11 The BMS systems shall be witnessed at the head end graphics and out in the field, at the discretion of the NG Bailey witnessing engineer.

6.1.12 NG Bailey shall witness completely the control of any main and/or critical items of plant along with a random sample of other points.

6.1.13 NG Bailey shall; If less than 300 points, witness all points. Between 300 and 1,000 points witness 50% (minimum of 300 to be witnessed). If more than 1,000 points witness 20% (with a minimum of 500 points witnessed).

6.1.14 Reserve the right to witness 100% of the points if the failure rate is greater than 5%.

6.1.15 Witness a sample of specific functions, e.g. 10% of alarms and 10% of data logging.

6.1.16 Witness one of several identical items of plant in detail with the others witnessed on a random basis.

6.1.17 Verify the system security access.

6.1.18 Verify that all safety-related functions perform to that specified, e.g. plant shutdown on fire condition.

6.1.19 Verify all plant restarts according to that specified after building power failure and local power failure.

6.1.20 Witness all power meter data-points to ensure that they match the meters.

6.1.21 Ensure that trend logs are used when witnessing points in order to monitor the performance of control actions.

6.1.22 Verify the handover of all operating manuals and system documentation.

6.1.23 Verify the handover of backup copies of software.

6.1.24 Verify the completion of any specified system operator training.

7.0 TRAINING

7.1 General Requirements

7.1.1 The controls specialist subcontractor shall, as a minimum, comply with CIBSE Commissioning Code C section C8.3

7.1.2 The controls specialist shall allow sufficient time to carry out adequate training of the completed system, taking into account the complexity of the system.

7.1.3 Training shall be carried out before practical completion.

7.1.4 The training required before practical completion is to be sufficient to allow the occupier's staff to understand the purpose, function and operation of all of the services installations/systems throughout the building, together with understanding the operating and maintenance manuals and record drawings.

7.1.5 For large or complex systems the controls specialist shall provide suitable reference and training manuals for the attendees.

7.1.6 If the BMS system utilizes a front end graphical interface, the controls specialist shall set up the necessary basic, intermediate, advanced operator segregations/profiles and provide training details on these.

8.0 DOCUMENTATION

8.1 General Requirements

8.1.1 The final documentation shall reflect as built, with all red-line changes incorporated.

8.2 Operation & Maintenance Manual (O&M)

8.2.1 The BMS controls specialist shall provide two hard copies of the full O&M manual plus electronic version on a format agreed with the Project Manager.

8.2.2 The O&M manual shall be available before practical completion.

8.2.3 The final version of the O&M manual must contain the final commissioning settings and any soft landings changes. It may be necessary to send an Addendum section if the soft landings occurs after practical completion.

8.2.4 The O&M manual must contain all of the default software setpoint values.

8.2.5 The O&M manual must also list all of the Variable Speed Drive parameters that have been changed from their factory default settings.

8.2.6 The O&M manual shall also provide any other key software settings that may need to be re-entered should a device require replacement.