Construction Services

Heating and Hot Water Services Controls General Technical Specification

Version 1.0

Environment
# Heating and Hot Water Services Controls
## General Technical Specification

## Contents

1. **Preamble** 3
2. **Regulations** 3
3. **Definitions** 3
4. **Preface** 3
5. **The BMS System (General)** 4
6. **The BMS System (Operation)** 5
7. **Pump Control** 8
8. **Remote Relays** 9
9. **Plant Room Wiring** 9
10. **Sensor and Control Wiring** 9
11. **Isolation** 10
12. **Control valves/AHU Dampers** 10
13. **Hot Water Services (HWS) Controls** 11
14. **Responsibilities (Heating/HWS Plant)** 11
15. **Controls Specialist** 11
16. **Data Link (where applicable)** 12
17. **Alarms** 12
1. **Preamble**

It is intended that this specification shall be read in conjunction with all mechanical and electrical briefing documents published by the Strategic Planning and Standards team.

2. **Regulations**

The installation shall be designed, installed, tested and commissioned in accordance with:

- The Health and safety at Work Act etc 1974
- The Building Regulations Part L 2006
- The Electricity at Work Regulations 1989
- The Electricity Safety, Quality and Continuity Regulations 2009
- Construction (Design and Management) Regulations 1994
- Control of Substances Hazardous to Health – COSHH
- The Control of Asbestos Regulations 2006 including future amendments and editions

The above shall not be seen as definite list of relevant standards and regulations and, unless stated otherwise, the whole of the works shall comply with the requirements of all relevant British Standards and European Harmonised standards and documents pertinent to the works.

Relevant Standards and Regulations shall be those that are in force three months prior to the return of tender or commencement of work unless stated otherwise in the particular specification documents.

3. **Definitions**

For the purpose of this document, terms and definitions shall be as those of the most recent edition of BS 7671 2008(2011)

4. **Preface**

This specification is written as the definitive requirement of Building Management Systems (BMS) for Cornwall Council. However, there may be occasions when a variation to the contract will be required because of site specific issues and these will need to be agreed with the Project Manager (who will consult with the relevant Cornwall Council officer(s)).

It shall be read in conjunction with the Energy Management Systems Control Panel Construction Specification.

The requirements and standards for Building Management Systems will however apply for all projects.
5. The BMS System (General)

The Building Management System (BMS) Controller shall be a fully microprocessor controlled system which can be used to control heating, hot water and ventilation plant. The controllers will have a self learn facility which will determine the optimum warm up time of the building from the inside and outside sensors fitted in various locations within the building.

The BMS system shall be capable of providing automatic changing between British Summer Time (BST) and Greenwich Mean Time (GMT), password protected operator access with multiple levels of access and that any licences to use software applications are owned by the client.

The BMS system shall, where practicable, provide a graphical ‘head-end’ interface capable of internal and remote access to the system.

The BMS system must be capable of dealing with a future 20% increase in the number of points without compromising the systems functionality or speed of operation.

The BMS system shall provide a time schedule that can be defined on a weekly and a yearly time schedule that can be defined 12 months in advance.

The system shall be capable of providing a time schedule override facility to accommodate holiday periods etc.

The BMS system shall be capable of providing optimum start/stop routines for the heating system to compute the daily minimum pre-heat period necessary to achieve target comfort conditions at the start and end of occupation.

The BMS system shall be capable of providing weather compensation to the heating system in relation to external weather conditions. Timeclocks must not be used.

Only one BMS manufacturers system shall be installed on any given site.

The BMS system shall be capable of remote access via a suitable modem or by TCP/IP protocols. If a modem is used, an analogue telephone line shall be provided with a connection box located adjacent to the control panel. Where TCP/IP protocols are used, a CAT-5 data cable shall be provided from the buildings IT server and terminated at both ends into a suitable data network point. A fixed IP address shall be provided to the Controls Specialist to enable firewalls to be configured.

The BMS system shall be capable of data logging that can be set up from the operator workstation and that logging times and logging intervals are user adjustable between 1 second and 24 hours.

The system shall provide a facility to allow the export of logged data to
other software packages.

The BMS system shall ensure that field controllers can be fully configured directly via a laptop type computer and via the operator workstation.

6. The BMS System (Operation)

The BMS system shall provide frost protection routines to operate plant and pumps in order to protect building services systems and their components from frost damage. Should the BMS system fail, then all plant will run to protect the building fabric and its contents from the affects of low internal temperatures.

The BMS system shall provide the following two stages of protection:
- Ensure that when the outside temperature falls to the operator set minimum frost-protection temperature, the selected pumps start and circulation is established through pipework systems and their components.
- Ensure that when the inside space temperature falls below the operator pre-set minimum, the full frost-protection facility is initiated. Ensure that for heating systems, the heat source is turned on and operated to maintain the return flow temperature above the pre-set minimum.

The controller will start the pump(s), fire the boiler(s), open the valve to each zone (where applicable) and energise the supply to heat emitters (eg fan convectors - where applicable) to heat each zone as required.

When each heating zone is up to temperature, the controller may close or modulate the valve to that particular zone.

In the case of mixed flow (variable temperature) circuits with modulating valves, the pumps shall continue to run to provide circulation.

For constant temperature circuits fitted with 2 port isolating valves, the pumps shall be stopped as soon as the valve closes by the use of an auxiliary switch within the valve actuator.

When all heating zones are up to temperature and switched off by the controller, the boiler shall be shut down.

Primary loop pumps (where applicable) or selected zone heating pumps (dependant upon the type of installation) shall continue to run on for a predetermined time to dissipate excess heat within the boiler.

In general, the boiler and loop pumps (where applicable) shall be interlocked such that if the loop pump trips, the boiler will be shut down.

If a pressurisation unit is fitted to the system, high and low pressure switches shall be fitted. Operation of either switch will indicate an abnormal system pressure condition and shall cause all plant to be shut down. This may be achieved by wiring the main control circuit through the pressure switch system.
Pressure fault indication shall be made available to the BMS in the form of a volt free normally closed contact.

Compensation/Optimisation of the system shall be achieved by the use of immersion type flow and return sensors within the system pipe work.

The type and number of such sensors will be dependant upon the requirements and degree of control required for each project.

Control of air handling plant shall be achieved in the same way except that the sensors shall be of a type suitable for installation within ducts.

Internal Space temperatures shall be set to a maximum of 19 Degrees C for all users with the exception of special needs schools and vulnerable adults where a maximum of 21 Degrees C shall apply.

Internal frost protection shall be set at 5 Degrees C.

### LPHW Heating Systems Control Philosophy

<table>
<thead>
<tr>
<th>If</th>
<th>Then</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating Zone calls for heat</td>
<td>Valve opens (2 or 3-port)</td>
</tr>
<tr>
<td></td>
<td>Loop Pump starts (where fitted)</td>
</tr>
<tr>
<td></td>
<td>Zone heating pump starts</td>
</tr>
<tr>
<td></td>
<td>Fan Convecto circuit energised (Where fitted)</td>
</tr>
<tr>
<td></td>
<td>Boiler(s) fire</td>
</tr>
<tr>
<td></td>
<td>Run indication for each item to BMS and on panel</td>
</tr>
<tr>
<td>Zone up to temperature (variable temp Circuit)</td>
<td>3-port valve modulates under BMS control</td>
</tr>
<tr>
<td></td>
<td>Pump continues to run to circulate pipework</td>
</tr>
<tr>
<td>Zone up to temperature (constant temp circuit)</td>
<td>2-port isolating valve (where fitted) closes</td>
</tr>
<tr>
<td></td>
<td>Circulating pump stops</td>
</tr>
<tr>
<td></td>
<td>Fan convecto zone controls (where fitted) switched off.</td>
</tr>
<tr>
<td>All zones up to temperature</td>
<td>Boiler stops</td>
</tr>
<tr>
<td></td>
<td>Loop pump (where fitted) runs on to dissipate heat in boiler.</td>
</tr>
<tr>
<td></td>
<td>This may be a zone pump if no loop pumps fitted.</td>
</tr>
<tr>
<td>Pressurisation unit failure (where applicable)</td>
<td>All plant stops</td>
</tr>
<tr>
<td>or system pressure fault</td>
<td>Alarm signal sent to BMS</td>
</tr>
<tr>
<td></td>
<td>Pressure fault indication on control panel.</td>
</tr>
<tr>
<td>Boiler Lockout occurs</td>
<td>Alarm signal to BMS</td>
</tr>
<tr>
<td></td>
<td>Lockout indication on control panel</td>
</tr>
<tr>
<td>Zone pump trips</td>
<td>Alarm signal to BMS</td>
</tr>
<tr>
<td></td>
<td>Trip indication on control panel</td>
</tr>
<tr>
<td>Loop pump trips (where fitted)</td>
<td>Alarm signal to BMS</td>
</tr>
<tr>
<td></td>
<td>Trip indication on control panel</td>
</tr>
<tr>
<td></td>
<td>Boiler shuts down</td>
</tr>
</tbody>
</table>
### Plant override switch operated
- All valves open
- All pumps run
- Boilers fire (controlled by integral stats)
- Fan convector circuits energised

### Control system fails
- All plant runs
- Boilers control on integral stats
- Fan convectors control on local room stats

### Fire Alarm operates (interlocked via f/a auxiliary contact in control circuit)
- All plant shuts down
- Gas solenoid valve closes (if fitted)
- Gas drop valve solenoid releases (if fitted)

### Ventilation and Air Handling Control Philosophy

<table>
<thead>
<tr>
<th>If</th>
<th>Then</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space requires Ventilation (over temp/ poor air quality)</td>
<td>Control system checks outside and inside air temperature</td>
</tr>
<tr>
<td>Outside air temperature low</td>
<td>Heater battery (if fitted) brought on line (operates in a similar way to a mixed flow heating zone except that 3 port valve is used for diverting rather than mixing)</td>
</tr>
<tr>
<td>Outside air temp below 5c (measured by stat on heater battery)</td>
<td>Fans held off to prevent chilling/freezing of heater battery</td>
</tr>
<tr>
<td>If above conditions satisfied</td>
<td>Supply and Extract fans start Dampers open to allow fresh air into space (incoming air tempered by heater battery if required)</td>
</tr>
<tr>
<td>Space at required temperature</td>
<td>Supply/Extract air dampers modulate to provide partial fresh/re-circulated air via heat exchanger</td>
</tr>
<tr>
<td>Summer Cooling Required</td>
<td>Supply and Extract fans start, dampers open allowing fresh air into space thus providing free cooling. Temperature within space monitored by duct sensor in return duct</td>
</tr>
<tr>
<td>Low space temperature</td>
<td>Heater battery brought on line, supply (external) air damper closes, system recirculates until space temperature comes up to required level. Dampers then modulate to maintain temperature/air quality. Space temperature monitored by return air duct sensor.</td>
</tr>
<tr>
<td>Space up to temperature</td>
<td>Heater battery 3 port valve modulates to divert flow away from battery. Valve controlled by system based on return air temperature as monitored by return air duct sensor. Dampers modulate to maintain temperature and air quality based on return air temperature as measured by return duct sensor.</td>
</tr>
</tbody>
</table>
| Air handling fans trip | Trip indication shows on control panel  
| Alar signal to BMS. |
| Fire alarm operates | All fire dampers close (where fitted)  
| Fans stop  
| System requires manual reset after fire alarm cleared. |

7. **Pump Control**

Zone heating and HWS pumps within the boiler house area shall be controlled by the BMS system via the control panel/outstation.

Remote pumps shall be controlled from the BMS system by the use of extra low voltage relays in the remote location, which will switch the pump/associated equipment. Supplies to remote equipment shall be derived from a local distribution board and suitably labelled.

If 2 port valves are used (where applicable), pumps shall be prevented from running until the two port valves are full open by the use of valve end switches. Under no circumstances should a pump be made to operate against a closed valve.

Under normal operating conditions, the BMS system will control the valve, and the pump will only start when the end of travel switch within the valve actuator operates as the valve approaches the full open position.

The Controls Specialist contractor shall be made aware if there are valve end switches and their required function by the relevant design engineer.

The end switches are usually supplied as a separate item and will require fitting into the valve actuator at installation and adjusting to the required end of travel tolerance.

End switches shall not be used for direct control of signals or supply. End switches shall operate slave relays in the control panel only.

Switches shall be provided on the control panel for each pump. These switches shall be Off/Auto only. No hand override shall be provided.

Twin head pumps shall be controlled on an either/or basis and no automatic changeover shall be allowed.

All pumps shall be fitted with appropriately sized overload relays wired into the contactor control circuit or a suitable alternative.

8. **Remote Relays**

Remote relays used to drive equipment not located within the main plant room shall in general be an extra-low voltage type capable of being driven directly by the digital output from the BMS system or through a relay located within the control panel.
If the output from the BMS system is of insufficient capacity to drive the number of relays required, a suitable transformer shall be fitted within the control panel to provide an extra low voltage supply for these relays.

The remote relays must be wired such that they are energised to switch off the plant they control. For this reason, if they are controlled by a LV transformer and relay within the panel, the Control Specialist shall ensure that the system is capable of providing the required output. This is required so that in the event of a control system failure, all plant will run.

9. **Plant Room Wiring**

Wiring within boiler houses and/or plant rooms shall be in PVC single core tri rated cable to BS6231 2006 Type CK and UL/CSA 600/1000Volts grade contained within galvanised steel conduit and trunking. Final connection to sensors shall be made in flexible conduit with the cable drawn through.

Two compartment trunking shall be installed within the boiler house where required to carry extra low voltage and data and low voltage mains wiring.

It is not acceptable to run data cables and mains cables in the same conduit or trunking unless a metallic barrier is fitted (ref section 528 of British Standard BS 7671 2008(2011)). In all instances of cable routing the manufacturers recommendations shall be adhered to.

BMS data communications cable will be terminated in a suitable galvanised box. The box will have a numbered din rail mounted terminal strip. The cable will be numbered at both ends and the box lid will have a label stating DATA.

10. **Sensor and Control Wiring**

The zone sensors shall be wired in the type of cable as specified by the appropriate control drawing but generally to BS5308.

This cable shall physically isolated in the data isolation box for remote sensors and in by the compartment trunking in the boiler room.

Immersion sensors and outside sensors shall be wired in a cable to BS5308 to CT units (where applicable) and then to the BMS system via the terminal strip in the control panel.

Connection from the CT unit (where applicable) to immersion and duct sensors shall be run in flexible conduit with the data cable drawn through. Only one type of sensor shall be allowed on any one site e.g. 10K or PT100.

Connections to pressure switches etc shall be made as detailed for sensors.

Where room sensors are fitted to back boxes or other outlets, the end of the conduit or back plate of the sensor shall be sealed with a suitable non setting compound to prevent the ingress of air and draughts from areas.
external to the controlled space.

Sensors and thermostats shall be mounted at 1650mm above finished floor level. The fused connection unit for the room thermostat shall be mounted at 150mm below finished ceiling level and shall have a visible ‘neon’ indicator lamp to show when the zone is active.

In rooms containing both thermostats and room sensors, the units shall be mounted adjacent to each other in the same location within the space.

11. Isolation

All boilers shall be fed via a multipole isolator mounted adjacent to the equipment for mechanical maintenance purposes. This shall be capable of interrupting all live conductors of the supply to each boiler/boiler module. (Note as BS7671 2008(2011) the neutral is viewed as a live conductor).

Pumps shall be fed from the control panel via 16A European standard IEC plug and sockets and use a heat resisting flexible cable to the pump heads.

The socket shall be installed socket facing downwards

Pressurisation units shall be fed on a permanently live supply from the control panel via a 16A IEC plug and socket.

12. Control valves/AHU Dampers

Control valves shall be 2-port for isolation and 3-port for mixing or diverting.

The valves/actuators selected shall be dependant upon the particular project and may be either mains or low voltage operation.

All extra low voltage (e.g. 0-10V) operated valves shall be wired with a suitable multi-core cable with a cross sectional area of not less than 1.5mm² to allow for the possibility of voltage drop.

Telephony/Belden type cable shall not be used for this purpose.

Mains operated valves shall be terminated with in the valve head. Labels shall be installed to warn about voltage

The Control Specialist shall ensure that the panel is fitted with a suitable transformer, which is capable of supplying the total connected extra low voltage load.

13. Hot Water Services (HWS) Controls

In general, the HWS system shall be controlled by the BMS system by the use of a three port diverting valve on the primary circuit controlled via an immersion type BMS sensor located on the secondary flow pipework.
High limit control shall be achieved by a 230v 50Hz spring return, 2-port isolating valve that will cut off all primary flow to the cylinder. This shall be controlled by a high limit thermostat located within the cylinder.

Immersion heaters for standby/back-up use shall be fitted within the cylinder and controlled by the BMS system.

Electrically heated hot water is to be avoided. However, there may be occasions when a variation to the contract will be required because of site specific issues and these will need to be agreed with the Project Manager (who will consult with the relevant Cornwall Council officer(s)).

If trace heating is used on the secondary flow to sink outlets, it must be under the control of the BMS system.

All remote, point-of-use water heaters shall be controlled by the BMS system on a time schedule as a minimum.

14. Responsibilities (Heating/HWS Plant)

The electrical contractor shall be responsible for:-
- Mounting and positioning of all equipment.
- Running of all cables
- All wiring and final connections to sensors plant and control systems to clear and concise wiring/installation diagrams provided by the control specialist.
- All wiring and final connections to heating equipment as detailed on the project drawings.
- Supply and installation of all controls, sensors and ancillary equipment
- Full inspection and test of the whole electrical installation including mechanical control. Certificate to be produced.
- The purchase of all control equipment and associated items from one of the nominated controls specialists for the particular project.

15. Controls Specialist

The Control Specialist shall be responsible for:-
- Designing and building of the control panel/outstation.
- Final testing and commissioning of plant and control system.
- Liaison with the Project Manager and the relevant Cornwall Council officer(s).
- Provision of all wiring and interconnection diagrams as detailed within this specification. This shall include a fully annotated termination diagram giving terminal number/letters for all items of plant and the respective connections within the control panel terminal strip. It shall also give details of cable type, cross sectional area and colour coding where applicable. These diagrams will provide the Electrical Contractor with sufficiently detailed information to enable him to make all necessary interconnections between plant items and controls.
- As fitted controls drawings on completion of the project.
16. **Data Link (where applicable)**

The Electrical Contractor shall allow for the supply and installation of a BMS data link cable from any existing compatible BMS controls to the new control panel/BMS system. This link shall be a multi-core data cable to BS5308 and shall be run to the nearest BMS outstation within an existing building/area.

The data link between new and existing equipment shall be left disconnected until the new control system is ready to be commissioned. Failure to do this can result in damage to either the existing or new control equipment.

If the installation is a completely new project or there are no existing compatible controls, the above shall not apply.

17. **Alarms**

Only essential alarms shall be reported by the BMS system. These include:
- Boiler Lockout/overheat
- Pumps tripped
- Pressure fault
- High/low temperature limits
- Gas alarm
- AHU fans tripped
Prepared by:

Bob Smith
Property Services
29 November 2011

<table>
<thead>
<tr>
<th>Issue/Revision No</th>
<th>Date</th>
<th>Originator</th>
<th>Purpose for Issue/Nature of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>29/11/2011</td>
<td>R C Smith</td>
<td>First issue</td>
</tr>
</tbody>
</table>

If you would like this information in another format please contact:

**Cornwall Council**
**County Hall**
**Treyew Road**
**Truro TR1 3AY**

Telephone: **0300 1234 100**
Email: **enquiries@cornwall.gov.uk**
www.cornwall.gov.uk