CONTROL SYSTEM DESCRIPTION OF OPERATIONS

GENERAL SYSTEM DESCRIPTIONS

Control System Contents and General Description

The complete mechanical services automatic control system installation shall be BACnet "Open Protocol" so as Churchill Insurance can benefit now and in the future from the following :-

- Scope for use of the estate-wide IT, Ethernet, Internet or Web Browser systems for this and other buildings or for another phase of these premises.
- Standardisation on an "Open protocol" and not dependency on a single BMS System manufacturer.
- Potential for greater co-ordination and efficiencies between automated systems within each building and estate-wide.
- Forward compatibility to any future advances made by any BMS system that conforms to the BACnet "Open Protocol" standard – example wireless technology.
- Greater flexibility and lower installation costs.

The BMS system shall be designed, manufacture, supplied, electrically installed, programmed, engineered and commissioned by Total Control Services Ltd – the nominated control system specialist, tel : 01732 770773, fax : 01732 770206, and shall be based on Alerton Technologies BACtalk for Windows range of Direct Digital Control and BMS equipment. All in accordance with the Total Control System quotation reference Q7443/AB.

The BMS/DDC control system shall be "Open Protocol" based solely on BACnet : the **B**uilding **A**utomation **C**ontrol **net**work standards and the package of works provided by the nominated control system specialist shall include but not be limited to :-

1. The installation of a native BACnet-based system, including a Microsoft Windows XP BMS Operator's Terminal, based on a distributed intelligence control system in full accordance with this specification. The BMS Operator's Terminal, all outstations and controllers, and all other input/output devices shall communicate using the protocols and network standards as defined by the ISO16484-5 Standard : BACnet. In other words, all workstations and controllers, including unitary controllers, shall be native BACnet devices. No gateways shall be used for communication to controllers covered by this specification.

2. The preparation of a detailed design package which shall include control panel drawings, descriptions of control system strategies and DDC drawings – all to fully comply with the requirements of this specification. The nominated control system specialist shall submit this package for approval by the Engineer before commencing that element of the works.

3. The supply of all necessary BACnet-compliant hardware and software to meet the system performance requirements. The nominated control system specialist shall provide to that engineer all applicable "Protocol Implementation Conformance Statements" (PICS) to prove BACnet compliance of the Windows-based BMS Operator's Terminal software and every controller in system, including terminal unit controllers.

4. The supply of all necessary control and input field devices such as sensors, switches & stats, damper motors, control valves, inverters, etc., itemised in the following Technical Schedules.

5. The design, manufacture and provision of all equipment enclosures, control panels and motor control centres itemised in the following Technical Schedules. The size and location of control panels or small enclosures shall be to achieve the best application of DDC controllers by fulfilling the overall system application while reducing field wiring to a minimum.

6. The full electrical installation of all power, control, communication network wiring emanating from all equipment enclosures, control panels and motor control centres supplied by the nominated control system specialist and associated with the BMS/DDC control system. In plant room and plant areas this shall include all containment and first & second fix works. In risers and for communications network wiring to FCU's on floors the nominated control system specialist shall be at liberty, with the agreement of the Electrical Services Sub Contractor arrange to share conduit, trunking and tray wherever possible. The Electrical Services Sub Contractor shall provide, install and terminate all power supplies and fire alarm interlock wiring to equipment enclosures, control panels and motor control centres supplied by the nominated control system specialist. The Electrical Services Sub Contractor shall also provide, install and terminate all power supplies to all items of mechanical services plant that does not derive it's power supply from any equipment enclosures, control panels and motor control centres supplied by the nominated control system specialist. Such as packaged chillers, fan coil units, booster sets, sump pumps, etc.

7. The whole of the Specialist BMS Installation shall be tested and commissioned in accordance with the manufacturer's recommendations and regulations and to the entire satisfaction of the Engineer. Where appropriate, tests shall be carried out in accordance with the relevant British Standard or Code of Practice. Test Certificates and tables of results for works tests and site tests etc. shall be submitted in duplicate to the Engineer for approval.

8. The site tests shall be witnessed by the Engineer and any defects of workmanship, materials, performance, maladjustment or other irregularities which become apparent during the tests shall be rectified by the nominated control system specialist at his expense and the tests shall be repeated to the satisfaction of the Engineer.

9. All controls shall be calibrated and adjusted with particular attention being paid to the following:-
    (a) Satisfactory operation of any automatic or manually sequence used in the event of fire.
    (b) Satisfactory operation in the event of failure or sudden resumption of electrical supplies.
    (c) Satisfactory operation of safety interlocks designed for the protection of personnel.
    (d) Satisfactory operation of equipment protection devices.
    (e) Satisfactory operation of all sequencing operations and automatic or manual changeover of duplicate plant.

10. All commissioning shall be in accordance with the latest relevant CIBSE codes of practice.

11. The nominated control system specialist shall provide as-built documentation, BMS Operator's Terminal software, diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents all particulars of the final system.

12. The nominated control system specialist shall include for site based system specific and comprehensive operator and technician training for personnel from Churchill Insurance and their appointed Building Services Maintenance Contractor.

DESCRIPTION OF THE BMS OPERATOR'S TERMINAL

Introduction

System access shall be via a PC based BMS Operator's Terminal within the existing maintenance engineers office. All plant status, alarms, sensor values, setpoints, time/holiday schedules and other system management facilities shall be accessible from this terminal – dependant on the password level of entry. Any critical alarms shall cause an automatic customised message display at the keypad/display together with activation of an audible alarm sounder.

The system shall include zone-by-zone / room-by-room / FCU-by-FCU control of space temperature, scheduling, optimum start, equipment alarm reporting and other management features.

Software shall be multi-tasking, capable of executing and displaying multiple instances in individual windows while running concurrently with other Windows programs such as word processors or database programs. Software shall strictly follow Microsoft Windows API guidelines. Systems using proprietary software or operating systems other than that described above shall be prohibited. Operation of the terminal software shall be simple and intuitive.

The BMS Operator's Terminal software shall contain an easy-to-operate system allowing configuration of system-wide BACnet controllers, including management and display of the controller programming. This system shall provide the capability to configure controller binary and analogue inputs/outputs.

The BMS operating system shall be capable of utilising third-party Windows-based programs for such things as spreadsheet analysis, graphing, charting, custom report generation, and graphics design packages. Graphics generation shall be done using standard Windows packages. No proprietary graphics generation software shall be needed.

Complete energy management firmware, including self-adjusting optimum start, demand limiting, global control strategies and logging routines for use with total control systems shall be supplied. All energy management firmware shall be resident in field hardware and shall not be dependent on the BMS Operator's Terminal for operation. The BMS Operator's Terminal software is to be used for access to field-based energy management control firmware only.

Priority password security systems shall prevent unauthorised use. Each user shall have an individual password. The user shall only be given access to the system functions required for individual job performance.

Equipment monitoring and alarm functions, including information for diagnosing equipment problems shall be included within the system.

The complete system, including, but not limited to field level controllers, outstations and BMS Operator's Terminals shall auto-restart, without operator intervention, on resumption of power after a power failure. Database information stored in outstation memory shall be battery-backed up for a minimum of 1 year. Field level controllers for all air handling units and other main plant and all zone reheat controllers shall utilise EEPROM for all variable data storage. Batteries on unitary controllers shall not be allowed.

System design shall be modular and have proven reliability.

All software and/or firmware interface equipment for connection to remote monitoring station from field hardware or the BMS Operator's Terminal shall be provided.

The system shall be capable of equipment runtime totalization of fans, pumps, major plant, etc. and capable of alarm generation and alarm dial-out if required at a future date.

System Displays

The number and type of system displays shall be at the discretion of the nominated control system specialist so long as they present all necessary system data and information in a clear and user friendly manner approved and accepted by the engineer.

The BMS Operator's Terminal shall display in dynamic and automated colour graphics all data associated with the entire system and as called for in this specification. The BMS Operator's Terminal software shall accept Windows BITMAP format graphic files for background displays. Graphic files shall be created using scanned full colour photographs of the system installation, AutoCAD™ drawing files of the as installed drawings and/or any graphic representation of system schematic. All to be submitted for approval by the engineer before use.

The system shall be capable of displaying a background graphic file, text and dynamic point data together on each display. Information shall be labelled with descriptors and shall be shown with the appropriate engineering units. All information on any display shall be dynamically updated without any action by the user. The BMS Operator's Terminal shall allow the user to change all field-resident Energy Management and Control System functions associated with the project such as set points, weekly schedules, exception schedules, etc. from any screen no matter if that screen shows all text or a complete graphic display. This shall be done without any reference to object addresses or other numeric/mnemonic indications.

All displays shall be generated and customised in such a manner by control system specialist sub-contractor. Standard fixed displays shall not be acceptable. Systems requiring factory programming for graphics or DDC shall not be acceptable. All graphics and DDC programming shall be supported locally by the control system specialist sub-contractor without manufacturer dependency or assistance.

Digital points shall be displayed as ON/OFF or with any other customised text. Text shall be justified left, right or centre as selected by the user. The system shall also allow digital points to be displayed as individual change-of-state bitmap objects on the display screen such that they

graphically indicate a change of state as an overlay to the background graphic. Each digital point displayed in this manner shall be assigned up to three bitmap files for display when the point is ON, OFF or in alarm. For digital outputs the bitmap files shall be toggled as a response to an operator command when the bitmap is selected with the system mouse. In addition, the system shall allow digital object types to be displayed as animated graphic symbols.

Animated graphic object types shall be displayed as a sequence of multiple bitmaps to simulate motion. For example :- when a pump is in the OFF condition, a stationary picture of the pump shall be displayed. When the operator selects the pump picture with the mouse, the represented object's status is toggled and the picture of the pump's impeller rotates in a time-based animation. The operator shall be able to click on an animated graphical object to switch it from the OFF position to ON, or ON to OFF. The system operator shall be able to change bitmap file assignments and create new and original bitmaps on-line. The system shall be supplied with a library of standard bitmaps, which shall alternatively be used unaltered or modified by the operator. Systems that do not allow customisation or creation of new bitmap objects by the operator (or with third-party software) shall not be allowed.

Analogue points shall be displayed with engineering units. These units shall be accessible for modification and change by the operator. Analogue input points shall also be displayed as individual bitmap items on the display screen as an overlay to the system background graphic. Each Analogue input point shall be assignable to a minimum of five bitmap files, each shall be able to be customised for example as - in normal limits, high limit, low limit, high critical alarm, low critical alarm. Operator adjustable analogue outputs such as setpoints, shall when selected with the mouse, be displayed as a prompted dialogue box. Analogue output values shall be changed by selecting either the "increase" or "decrease" arrow in the analogue object spinner box. Pressing the button on the right side of the analogue object spinner box shall allow direct entry of an analogue value, and accesses various menus where any analogue value shall be used, such as trendlogs or time schedules.

Analogue input points shall also be assignable to an area of a system graphic, where the colour of the defined area can be made to change based on the analogue input point’s value. As an example, an area of a floor plan graphic served by a single control zone would change colour respective to the temperature of the zone or its deviation from setpoint. All editing and area assignment shall be created or modified on-line, using simple icon tools.

A customised menu label (push-button) shall be used for display selection. Menu items on a display shall allow access to further displays or additional menus. Dynamic point information and menu label push-buttons shall be mixed on the same display to allow sub-displays to exist for each system or topic. Each display shall be protected from viewing unless the operator has appropriate security level. A separate display security level shall be assigned to each full display and each individual display object.

A mouse shall be used to move the pointer arrow to a desired item for selection of a new display or to allow the operator to make changes to object data.

Displays shall be capable of being modified on site or via remote communications.

Display resolution shall be limited only by the monitor hardware and Windows™ software driver. As a minimum the system shall include a display resolution of 1024 x 768 on a 17” monitor.

The entire system shall operate without dependency on the BMS Operator’s Terminal.

System Security

The system shall include a security system that prevents unauthorised use unless an operator is correctly logged on.

The BMS Operator's Terminal shall provide security for a minimum of 200 users. Each user shall have an individual User ID, User Name and Password. Entries shall be alpha numeric and shall be case sensitive (except for User ID). The User ID shall be 0-9 characters, the User Name shall be 0-29 characters, and the Password shall be up to 5 characters. Each system user shall be allowed the individual assignment of only those control functions and menu items that they require access to. All passwords, user names and access assignments shall be adjustable on-line at the BMS Operator's Terminal, with the sufficiently high security level of system access. Each user shall also have a set security level, which defines access to displays and individual objects that the user shall control.

Time, Holiday and Event Scheduling

Operator terminal displays of weekly schedules shall show all information in easy to read 7-day (weekly) format for each schedule. This shall include all ON/OFF times (to the minute) for each day's events.

Non-normal schedules, such as holidays or special events, shall display all dates that are an exception to the weekly schedules. These special schedules shall be displayed at the BMS Operator's Terminal in a format similar to the weekly schedules and shall allow easy data entry. Schedule data shall be entered by the following methods: date entries (one day entries), date-to-date (a range or span of days), and by weekday (for example, a given day of a given week each month). The user shall be able to scroll easily through the months for each year as a minimum.

At the BMS Operator's Terminal, the system user shall be able to change all information for a given weekly, or non-normal schedule if logged on with the appropriate security access level.

Alarm Handling

The BMS Operator's Terminal shall provide audible, visual and printed means of alarm indication. The alarm dialogue box shall always become the top dialogue box regardless of the application(s) being run at the time (such as a word processor or spreadsheet)

The system shall include a log of all alarm messages. This alarm log shall be archived to the hard disk of the system terminal. Each entry shall include a description of the event generating the alarm; time and date of alarm occurrence; time and date of when the alarm state returned to normal; and time and date of alarm acknowledgement.

Alarm messages shall be in user definable text and shall be enterable either at the BMS Operator's Terminal or via remote communication.

Trendlogs

The system shall periodically gather historically recorded selected samples of point data stored in the field equipment (global controllers, DDC controllers) and archive the information on the BMS Operator's Terminal hard disk. Archived files shall be appended with new sample data, allowing samples to be accumulated over several years. Systems that write over archived data shall not be allowed. Samples shall be viewed at the BMS Operator's Terminal in a trendlog. Trendlog displays shall be in spreadsheet format. The system shall provide capability for operator to scroll through all trendlog data. All trendlog information shall be displayed in standard engineering units.

System software shall be capable of graphing the trendlogged point data. Software shall be capable of creating x-y (two-axis) graphs that display up to six point types at the same time in different colours. Graphs shall show object type value relative to time.

In addition the operator shall be able to change trendlog set-up information. This shall include the information to be trendlogged as well as the interval at which information is to be logged. All input, output, and plant status/alarm conditions in the system shall be logged. All trendlog operations shall be password protected. Trendlog set-up and viewing shall be accessed directly from any and all graphical points within any display.

The system shall include the means for an operator to directly export to a comma delimited file format, all trendlog data for use in third-party spreadsheet or other database programs. Operation of the system shall not be affected by this operation

Energy Logs

The system shall periodically gather energy log data stored in the field equipment and archive the information on the operator terminal's hard disk. Archive files shall be appended with the new data, allowing data to be accumulated over several years. Systems that write over archived data shall not be allowed unless limited file size is specified. Display all energy log information in standard engineering units.

The system software shall be capable of graphing the Energy log data. Software shall be capable of creating graphs in x-y (two-axis) format that show recorded data relative to time. All data shall be stored in comma delimited file format for direct use by third-party spreadsheet or other database programs. Operation of the system shall not be affected by this operation.

In addition the operator shall be able to change energy log set-up information. This shall include which meters to be logged, meter pulse value and what type of energy units is being logged. All meters monitored by the system shall be logged. All energy log operations shall be password protected.

The system shall provide means for operator to export to a comma delimited file format all energy log data for use by other spreadsheet programs. All data shall be stored such that it shall be possible to be directly used by third-party spreadsheet or other database programs. Operation of system shall not be affected by this operation

Configuration and Set-up

The system shall provide means for an operator to display and change system configuration. This shall include but not be limited to :- system time, day of the week, date of daylight savings set forward/set back, printer termination, port addresses, modem port and speed, etc. Items shall be modified utilising easy to understand terminology by means of simple mouse/cursor key movements.

BMS OPERATOR'S TERMINAL HARDWARE

The BMS Operator's Terminals shall be provided at the locations shown on the tender drawings. It shall include the following hardware as a minimum:

Compatible PC (computer) capable of utilising AT bus cards
Pentium IV processor
128MB SDRAM
12.7GB HDD
512k cache
16MB graphics accelerator
17" monitor
6x DVD-ROM drive
Sound card and speakers
v.90 56K modem
Internal Ethernet card

An event report and log printer shall be provided adjacent to the BMS Operator's Terminal. This shall be the minimum A4 colour inkjet printer with printer speed at least 6 sheets per minute with sufficient buffer capacity to ensure no unreasonable delay in printing any system screens or data.

CONTROL PANELS

The system shall include multiple control panels located adjacent to plant and wherever a concentration of DDC control points exist. As such control panels shall be either wall or floor mounting and single compartment wardrobe type.

Control panels shall house all power and control equipment associated with the control system installation, wired in PVC coated LSF cable to klippon type terminals within Noryl trunking or protected cable looms. All control circuit cables shall be identified at both ends and all internal components shall be labelled by means of engraved trunking lids. These shall be cross referred to a record CAD produced control panel wiring diagram - a copy of which shall be kept in a drawing pocket on the inside of the control panel door.

Any external control panels shall be to IP55 minimum and shall include bottom entry outgoing terminal connections. Internal control panels shall be to IP43 minimum. A suitable IP rated door-interlocked isolator shall be used, wired internally to shrouded incoming power supply terminally.

Door-interlocked isolators shall be the type that can allow control panel access by a qualified person using a special tool. There shall be no other items mounted on control panel doors.

All internal wiring shall be carried out to the control system manufacturer's recommendations with particular attention paid to screened cable requirements and earthing. All screened cabling for sensors and the communication network shall be taken to outgoing terminals with an additional, non-earthed, terminal for screen continuity. Suitably rated control circuit transformers shall be included to serve all DDC controllers and other 24VAC control devices. A separate 24VAC control transformer shall be included within the nearest control panel to serve the keypad/display unit.

Plant operation shall be automatic and any override shall be via the keypad/display unit. For commissioning and maintenance/service purposes there shall be means of overriding the operation of each item of plant and Hand/Off/Auto switches incorporated in the control panels.

When incorporated within a system, all safety interlocks such as high limit thermostats, airflow proving switches, H/T cutouts, panic buttons and gas safety devices shall be hard wired whether or not they are duplicated in the DDC software.

Motor starting shall be as follows :-

Under 0.36KW / 1ph	Contactor Switched
0.36KW / 1ph or any size 3ph, up to 5.5KW	Direct on Line
Over 5.5KW / 3ph	Assisted Star Delta

All control panels shall use Merlin Gerin MCBs and not fuses.

All material used shall be to British/European standards and CE tested and marked.

PARTICULAR SYSTEM DESCRIPTIONS

System Architecture

BACnet stand-alone programmable controllers shall individually and independently control all FCUs and all Main Plant. Individual floor isolation of fresh air, LPHW & ChW services shall be provided by riser mounted local BACnet controllers. There shall be four number control panels – one in each main plant room area, see the attached Technical Schedules for details.

A BACnet MS/TP communications network shall link all FCU DDC BACnet controllers, all riser mounted local BACnet controllers and each of the four Main Plant control panels.

The system shall include two BACnet "Global Controller / Routers" – each being capable of supporting 250 BACnet controllers. This shall allow backward up-grade of the adjoining phase 3 of the Churchill Court site without additional BACnet "Global Controller / Routers". At each of the floor levels 0, A, B, C & D shall be left a BACnet MS/TP communications network junction box to enable communication network extension to Phase 3 if required at a later date.

Between both BACnet "Global Controller / Routers" and the PC-based BACtalk for Windows BMS Operator's Terminal shall be a dedicated high speed, high capacity BACnet Ethernet

communication network. Both the “Global Controller / Routers” and the BMS Operator’s Terminal shall be BACnet Annexe J compliant. As such they shall support BACnet over TCP/IP which shall allow the client to up-grade their BACnet system to run over the Churchill Court IT existing IT network or over the existing Churchill Group estate-wide Intranet – should they choose.

Off-site access shall initially be by dedicated modem with an option of the future addition of web browser technology.

Fan Coil Units – General

Every Fan Coil Unit shall be factory fitted and wired with a full set of BACnet controls, including controller, supply & return flying lead type temperature sensors, 2-port heating valve and 2-port cooling valve – all as items 94 to 97 of the attached Technical Schedules. The nominated control system specialist shall free issue these items to the Fan Coil Unit manufacturer. FCU controllers shall all be pre-programmed, pre-addressed and labelled such that the FCU can be fitted with its specific controller. Any items further than the free issued items from the nominated control system specialist such as terminals, fuses, enclosures, relays (if requires), fan speed manual selector switch shall be provided by the FCU manufacturer.

Fan Coil Units – Open Plan Offices

All open plan general office FCUs shall all be controlled in a similar manner. Control shall be via a return air temperature sensor which shall modulate in sequence the pulse proportional 2-port control valve actuators on both the heating and cooling coils within the FCUs. Fan speed selection shall be from a manual fan speed switch fitted to each FCU and set at commissioning. For general on/off control each FCU shall have its fan enabled via a solid state relay on-board the BACnet FCU controller. Time schedules, holiday schedules and special event schedules shall be set at the BMS Operator’s Terminal.

The supply air temperature sensor shall be used to limit the supply air temperature above a minimum and below a maximum with these setpoints adjustable from the BMS Operator’s Terminal. It shall also to be available to prove correct operation of each FCU. On the BMS Operator Terminal shall be specific screens showing tables of all supply air temperatures, which shall highlight at a glance whether any one FCU is underachieving compared to its neighbours and hence requires attention.

Each open plan office space, or sub-divided group of FCUs, shall operate to a common set point accessible via the BMS Operator’s Terminal. For flexibility of control the number of groups and grouping of FCUs shall also be determined and be alterable by the Maintenance Engineer from their BMS Operator’s Terminal.

At the Core E entrance to each floor shall be a local control unit to provide an “Out-of-Hours” override and a master “warmer / cooler” adjustment that shall influence all FCUs in the open plan areas on that floor. This unit shall include a backlit push button which shall be illuminated when the floor is ON (un-lit when OFF). When any “Out-of-Hours” operation is required pressing the un-lit push button shall :-

- Illuminate the back-lit push button
- Open that floor’s supply & extract isolation damper motors
- Open that floor’s LPHW & ChW isolation 2-port valves

- Start all necessary main plant
- Start all FCUs on that floor

All the above actions shall operate that floor "Out-of-Hours" for a period of time adjustable by the Maintenance Engineer from the BMS Operator's Terminal after which the whole floor shall be turned OFF and the push button shall be un-lit.

The local control unit "warmer / cooler" temperature adjustment shall influence all FCUs on that floor. It shall be un-scaled with a simple "W" & "C" for warmer and cooler. The degree of influence shall be determined by the Maintenance Engineer from the BMS Operator's Terminal – for example +/-4°C, +/-2°C, +/-0°C.

For a representative space temperature (rather that reliance on return air temperature sensors should they prove to be inaccurate) each floor shall have 4N° room temperature sensors. These shall be one on the local control unit at Core E entrance and three to be elsewhere in the open plan office area, wired to the nearest FCU. During unoccupied periods these temperature sensors shall operate the FCUs and LPHW service to maintain a night low limit space temperature of say 14°C (adjustable).

Fan Coil Units – Meeting Rooms (and First Aid Room)

Individual or multiple FCUs serving such rooms shall operate in unison through software interlock via the communication network. The general principle of FCU control shall be the same as the open plan office area FCUs other than the Meeting Room FCUs shall have 3-speed fan control with these fan speeds switchable via solid state relays on-board the FCU BACnet controllers. Each Meeting Room shall also have one wall mounted controller for temperature adjustment and fan speed selection. Operation of the FCUs in each Meeting Room shall be to PIR detectors : when occupation is detected the FCUs shall run to maintain the condition set at the wall mounted controller. When in office hours but unoccupied the FCU shall operate to maintain a background condition : i.e. heat to say 18°C and cool to 24°C (adjustable by the Maintenance Engineer from the BMS Operator's Terminal).

The First Aid Room FCU control system shall be single speed but shall include the operation of a dedicated local extract fan to be on when the First Aid Room is occupied.

Primary LPHW Heating

LPHW shall be generated in the South West Plant Room with all plant served and controlled from Control Panel MCC1. Refer to the DDC POINT LIST for detail of the minimum control and monitoring required.

The 4N° LPHW Boilers and their respective constant volume pumps shall be sequence controlled to a return water temperature sensor with a flow temperature sensor to ensure that a high limit condition is not exceeded. Duty sharing and standby operation of each boiler shall be included. Each Boiler shall be interlocked to the following :-

- Individual Boiler Pump water flow switch
- Gas Safety Circuit health (to include 4N° electro-thermal links, 1N° entrance knock-off button and 1N° gas solenoid valve
- LPHW Pressurisation Unit fault – confirmed by an independent hydraulic pressure sensor

Frost Protection

The LPHW Heating System shall be 2-stage frost protected against “Out-of-Hours” freezing of any part of the system. Stage one shall be to start all pumps on a drop in outside air temperature to 2°C adjustable by the Maintenance Engineer from the BMS Operator’s Terminal. Under over night natural temperature decay all LPHW heating system valves shall open. Stage two shall be to start the boilers and to prime the already circulating system with hot water up to when a temperature of 30°C, adjustable by the Maintenance Engineer from the BMS Operator’s Terminal, is sensed by the common boiler return temperature sensor.

Building internal low temperature protection shall be included as described under Fan Coil Units.

Frost Heater Battery frost protection shall be included as described under Air Handling Units.

Secondary LPHW Heating

There shall be two Secondary LPHW Heating Circuits : Constant Temperature (CT) and Variable Temperature (VT) with all plant served and controlled from Control Panel MCC1. Refer to the DDC POINT LIST for detail of the minimum control and monitoring required.

Both circuits shall be served by run/standby variable volume pump sets each with integral inverter control. The CT Pumps shall provide a constant temperature LPHW service to all AHUs and FCUs. Time schedule control shall be available via the BMS Operator’s Terminal but this time schedule shall be overridden should any “Out-of-Hours” or frost protection requirement occur.

The VT Pumps shall provide a variable temperature service to all Radiators. The flow temperature to this circuit shall be scheduled to outside air temperature as controlled by a flow temperature sensor, the common master outside temperature sensor and a 3-port modulating control valve. Time schedule control shall be available via the BMS Operator’s Terminal but this time schedule shall be overridden should any “Out-of-Hours” or frost protection requirement occur.

Each run/standby pump sets shall have a differential pressure type water flow switch that shall monitor successful operation of the duty pump and initiate automatic changeover on water flow failure.

HWS Services

There shall be a run/standby constant volume pump sets on a Primary HWS circuit to an HWS Cylinder with a single duty constant volume pump on the Secondary HWS circuit. With all plant served and controlled from Control Panel MCC1. Refer to the DDC POINT LIST for detail of the minimum control and monitoring required.

The run/standby pump set shall have a differential pressure type water flow switch that shall monitor successful operation of the duty pump and initiate automatic changeover on water flow failure.

HWS Cylinder temperature shall be controlled via a cylinder temperature sensor, which shall open and close a 2-port control valve in the HWS Primary flow circuit. This control valve shall include

an auxiliary switch to turn off the duty HWS Primary Pump should the cylinder be up to the required setpoint.

The HWS Cylinder shall also be fitted with a hand reset high limit thermostat, which shall stop the duty HWS Primary Pump and give an alarm at the BMS Operator's Terminal whenever the high limit temperature is exceeded.

Chilled Water System

The Packaged Water Chillers shall be located on the roof of level 3 Core E and served from Control Panel MCC3 but the Chilled Water Pressurisation Unit and Chilled Water Pumps shall be in the South West Plant Room with all plant served and controlled from Control Panel MCC1. Refer to the DDC POINT LIST for detail of the minimum control and monitoring required.

A run/standby variable volume pump set with integral inverter control shall serve the Chilled Water circuit. This pump set shall provide a constant temperature ChW service to all AHUs and FCUs. Time schedule control shall be available via the BMS Operator's Terminal but this time schedule shall be overridden should any "Out-of-Hours" requirement occur.

The run/standby pump set shall have a differential pressure type water flow switch that shall monitor successful operation of the duty pump and initiate automatic changeover on water flow failure.

All exposed ChW pipework shall be Trace Heated.

Chillers shall be sequence controlled from a common ChW return temperature sensor and interlocked to the following :-

- Primary ChW Pumps common water flow switch
- ChW Pressurisation Unit fault – confirmed by an independent hydraulic pressure sensor

Toilet Ventilation System

Supply and extract Toilet Ventilation shall be provided via a dedicated supply air handling unit and twin fan extract unit served and controlled from Control Panel MCC1. Refer to the DDC POINT LIST for detail of the minimum control and monitoring required.

On start-up, whether time schedule or "Out-of-Hours" override, the Toilet Extract shall start. The twin fan set shall be complete with its own local auto-changeover panel that shall start the duty fan and provide a status indication that the Toilet Extract is running. The Toilet Supply air handling unit shall then start.

The initial start command shall first open the fresh air intake damper motor and following an indication that this is open via a damper motor auxiliary switch, the supply fan shall start.

The LPHW frost heater battery shall be controlled to maintain an off-coil temperature at a minimum of say 6°C. Should this not be achieved and the air leaving temperature drop to say 2°C a fan hold-off frost thermostat shall shut down the supply fan and raise an alarm at the BMS Operator's Terminal.

Supply air temperature from the Toilet Supply AHU shall be controlled to at a minimum of say 20°C via a modulating 3-port control valve on the main LPHW heater battery. Return air temperature shall be monitored for information only and the panel filter shall have a differential pressure switch to provide a dirty filter alarm at the BMS Operator's Terminal.

General Office Fresh Air Supply and Extract Systems

The general office FCUs shall be served by two Fresh Air AHU systems – each shall be controlled in a similar manner. Core F Fresh Air AHU shall be served and controlled from Control Panel MCC2. Core E Fresh Air AHU shall be served and controlled from Control Panel MCC4 and core E Extract shall be served and controlled from Control Panel MCC3. Refer to the DDC POINT LIST for detail of the minimum control and monitoring required.

Fresh Air Supply and Extract Fan air volumes shall be variable dependant on the number of general office floor in occupation and hence with their local supply and extract damper motors open. All such supply and extract fans shall be inverter controlled with the inverters supplied by the nominated control system specialist. Since the Core E Fresh Air AHU serves two thirds of the system it shall be provided with run/standby motors and shall require an inverter for each motor.

The initial start command shall first open the fresh air intake damper motor and following an indication that this is open via a damper motor auxiliary switch, the supply fan and respective extract fan shall both start. The supply and extract air volume shall be dependent on the amount of occupation and the number of floors to be served. End switches on damper motors serving each floor shall be monitored. Via a software lookup table set-up at the time of air balancing a sum total of the required supply and extract air volume shall be determined. Each of the 4N^{o} central supply and extract ducts (off of the AHUs and on to the Extract Fans) shall have Wilson Flow Grids – supplied and fitted by the Mechanical Services Sub-Contractor. The control system shall at all times monitor these flow grids and maintain the correct supply and extract air volumes.

Between the supply and extract shall be fitted a pumped run-around coil system. Via duct temperature sensors monitoring "air-on" to both the supply and extract run-around the control system shall determine availability of free heating or free cooling. Since the control system is also aware of the requirement for heating or cooling it shall then run the run-around coil pump when demand matches availability. The run-around coil system shall always be used as the first priority.

The LPHW frost heater battery shall be controlled to maintain an off-coil temperature at a minimum of 5°C or 10°C as specified elsewhere. Should this not be achieved and the air leaving temperature drop to say 2°C a fan hold-off frost thermostat shall shut down the supply fan and raise an alarm at the BMS Operator's Terminal.

Supply air temperature from the Fresh Air Supply AHU's shall be controlled at say 20°C via two modulating 3-port control valves one on the main LPHW heater battery and one on the ChW cooler battery. These shall operate in sequence.

Both the panel and bag filters shall have a differential pressure switches to provide dirty filter alarms at the BMS Operator's Terminal.

Comms Room A/C

Both Comms Rooms shall have packaged A/C Systems. The BMS control system shall monitor individual A/C Unit alarms and provide enable signal to each A/C Unit. It shall also monitor each Comms Room space temperature. All served from Control Panel MCC2. Refer to the DDC POINT LIST for detail of the minimum control and monitoring required.

Link Building Meeting Rooms Fresh Air AHU

The five Link Building Meeting Rooms shall be served with fresh air from this AHU and all control and power shall be from Control Panel MCC3. Refer to the DDC POINT LIST for detail of the minimum control and monitoring required.

Whenever any of the five Meeting Room are in use this fresh air AHU supply fan shall start. The initial start command shall first open the fresh air intake damper motor and following an indication that this is open via a damper motor auxiliary switch, the supply fan shall start.

The 3-step electric frost heater battery shall be controlled to maintain an off-coil temperature at a minimum of 5°C. Should this not be achieved and the air leaving temperature drop to say 2°C a fan hold-off frost thermostat shall shut down the supply fan and raise an alarm at the BMS Operator's Terminal.

Supply air temperature from the Meeting Rooms fresh air Supply AHU's shall be controlled at say 20°C via two modulating 3-port control valves one on the main LPHW heater battery and one on the ChW cooler battery. These shall operate in sequence.

Comms Room Outside Units and Existing Car Park Extract

The 6N^{o} Comms Room Outside Units shall have power supplied from MCC4. Refer to the DDC POINT LIST for detail of the minimum control and monitoring required.

Each Comms Room Outside Unit shall be monitored for an alarm and a room temperature sensor shall monitor local space temperature.

The existing Car park Extract Fan(s) shall also be monitored by an air flow proving switch and shall have a BMS system start/stop control signal added to the existing control panel that serves the Car park Extract Fan(s).

On a rise in temperature in the vicinity of the Comms Room Outside Units the Car park Extract Fan(s) shall be switched to operate at high speed to dissipate any heat build-up.