APARTMENTS
STAGE 4

SPECIFICATION FOR MEP

AUTOMATIC CONTROLS AND BUILDING MANAGEMENT SYSTEMS

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REVISION T1

Contents

1 AUTOMATIC CONTROL SYSTEM

This section of the specification deals specifically with the building management system & automatic control systems, whether this be provided by the BMS specialist or other controls specialist or controls provided by any other contractor, where the standard of workmanship and materials applies equally to both.

Whenever the term controls specialist is used in this document, it shall be applicable to every controls specialist not particularly the BMS specialist

The Mechanical Contractor shall design, supply, install, set to work, test and commission the complete automatic control system required to serve all building services installations, inclusive of the apartments specified, in the project specification, unless specifically stated otherwise hereafter.

The automatic control systems are a contractors design portion of the project and as such the contractors shall provide all necessary control equipment to provide a complete system, whether or not these are specifically detailed in the contract documents.

All control systems shall be BACnet compliant to CEN ISO 16484-5 and provided with PIC statements for all equipment.

All system shall be based on Tridium technology with fully open configuration and unrestricted licences.

1.1 OUTLINE WORK SCOPE

The mechanical contractor shall employ specialist controls suppliers for this portion of the works that shall generally include but are not limited to:

- the site wide BMS
    - control and monitor the central plant
    - interface to and monitor third party equipment for status and fault
    - monitor the apartments for status and fault
    - monitor the apartment heat and grey/softened water system meters and generate tenant bills
    - interface to the apartment control system allowing the apartment user to view current energy use and system bills
    - monitor the utility meters and generate tenant bills
    - monitor the apartment refrigerant leak detection system
    - Provide web enabled multi-user head end supervisor

- the apartment automation system
    - enable, provide set points and monitor the apartment fan coil units via local Modbus connection and hardwired input.
    - Provide backlit user displays and adjustments in each room
    - Provide interface with apartment AV system display unit
    - Enable, monitor and control the apartment heating system.
    - Provide interface to the BMS sitewide system allowing tenants to view energy bills
    - Provide interface to the BMS sitewide system allowing remote monitoring of such items as: heating demand, water leak detection alarm, refrigeration leak detection alarm.

    - Monitor the apartment ventilation fans
    - Monitor the AV room space temperature and control the local fan
    - monitor third party apartment equipment for status and fault

- the apartment DX cooling control system
    - control the fan coil unit via demands from the apartment automation system
    - Provide Modbus interface for connection to the apartment control system.
    - Provide hardwired connection for remote on/off from the apartment control system
    - Provide the apartment refrigeration leak detection system
    - Provide the site wide DX network between all apartments and external vessels heat pumps.
    - Provide controls for the air source heat pumps
    - Provide billing data for each fan coil unit based on valve positions and time run
    - provide system head end supervisor graphics to display all information regarding the operation of the FCUs and the air source heat pumps
    - provide a high-level interface for connection to the sitewide BMS

- the refrigerant leak detection system
    - Provide all sensors and controllers associated with the refrigerant leak detection system
    - Provide all controls wiring and network system associated with the system
    - Provide BACnet interface for connection to the sitewide BMS.

- the AHU control system
    - Provide all control sensors and actuators associated with the ventilation plant
    - Provide all power and controls wiring and starters associated with the ventilation plant
    - Provide all control strategy engineering solutions associated with the ventilation plant.
    - Provide BACnet interface for connection to the sitewide BMS.

- the car park control system
    - Provide all control sensors and actuators associated with the car park ventilation plant
    - Provide all power and controls wiring and starters associated with the car park ventilation plant
    - Provide all control strategy engineering solutions associated with the car park ventilation plant.
    - Provide BACnet interface for connection to the sitewide BMS.

- the staircase smoke and corridor ventilation control system
    - Provide all control sensors and actuators associated with the system
    - Provide all power and controls wiring and starters associated with the system
    - Provide all control strategy engineering solutions associated with the system
    - Provide BACnet interface for connection to the sitewide BMS.

- the landlord area underfloor heating control system
    - Provide all control sensors and actuators associated with the system
    - Provide all power and controls wiring and starters associated with the system
    - Provide all control strategy engineering solutions associated with the system
    - Provide the circulation pump with sensorless control and remote enable/monitoring status.

All specialists shall provide

- Control and starter panels
- all fan and pump inverters/controllers/starters
- necessary power and controls wiring and carrier systems
- all installation all Commissioning and setting to work
- all documentation required for safe operation by the user

1.2 THIRD PARTY EQUIPMENT INTERFACE

The automatic control systems are required to interface to third party equipment such as mechanical services plant, boilers, CHP, pumps, fans and electrical equipment such as meters, energy meters such as heat meters, and other such services.

The MEP contractor shall ensure that these interfaces are provided with suitable handshaking devices to ensure compatibility across the project.

Specifically, the following should be noted:

Heat meters

All heat meters, required for billing shall be MID approved and complete with M-bus connectivity for connection to the M-bus and the metering network.

Water meters

All water meters, required for billing shall be MID and WRAS approved. The meters shall be provided with M-bus connectivity for connection to the sitewide M-bus metering network.

Electrical meters

All electrical meters shall be provided with Modbus output for connection to the sitewide Modbus metering network. Where switchboards and distribution boards are provided with more than 1 meter, the electrical contractor shall wire all meters together to a common ELV section of the panel such that the sitewide BMS required only one connection for each switchboard or each distribution board.

Electrical Breakers

All electrical breakers are to be provided with M-bus conductivity for monitoring of open/closed/tripped status. The electrical contractor shall wire all breakers, fire daisy chained to a common point in the ELV section of the panel.

Small ventilation fans

The small ventilation fans generally single phase shall be provided with integral starters/protection/speed devices all wired direct to the fan.

The apartment extract fans shall ne provided with integral run on timers.

All fans shall have VFC for fault and run status and ELV terminals for remote on/off commands.

Small pumps

All small pumps (HWS, underfloor heating) generally single phase shall be provided with integral starters/protection/speed devices. The speed control shall be via sensorless operation.

All pumps shall have VFC for fault and run status and ELV terminals for remote on/off commands and speed control.

Large pumps and fans

The large pumps and fans generally, three phase and greater than 2.2kW shall be provided with integral inverters or free standing inverters. The inverters shall be provided with key pads that form part of the inverter package, the use of handheld electronic devices is not an acceptable solution. These pumps and fans must be able to be operated manually at the inverter, albeit subject to password protection on the inverter keypad.

Inverters

The specialist contractor supplying the inverter shall set to work and commission the units to match the system operations. The inverter supplier shall be responsible for all technical aspects of the inverters as described both in the mechanical specification and within this document.

The BMS Contractor shall, however, provide management of all inverters and shall provide support during commissioning to establish the operation of all inverters.

Where critical system fans are provided with inverters they shall be set to operate in the fire mode utilising the fire jog commands. If other speeds are required during a fire mode these shall be set using combination of relays wired direct to the inverter jog command.

All inverters shall be placed local to the plant they shall be IP54 rated and provided complete with RFI filters. If the plant is external to the building, the inverter shall be located either in the plant housing or in an IP 65 enclosure provided and installed by the BMS Contractor. Any externally mounted panels shall be provided with internal heating by the panel provider.

All inverters serving essential plant shall be located within the fire protected plant room.

All inverters keypads shall be brought to the front of any enclosure, allowing operation and interrogation without opening the panel and where mounted external to the building shall be covered with a weather proof but clear plastic lid.

AHU

The AHUs serving the gym and the business suite are self contained units complete with all instruments, actuators, wiring, motor protection, fan starters and speed control.

The equipment shall be provided with hardwired interfaces or high-level interface via BACnet.

Apartment heat interface unit

The apartment heat interface unit shall be provided with integral thermal controls and safety interlocks. The HWS is provided through both instantaneous and storage calorifiers. The integral heating circulation

pump shall be enabled by the apartment controller through hardwired interlocks to suit the HWS and the heating demands stop

The heat meter shall be MID approved and complete with battery backup and two spare pulsed inputs to which devices, such as the water meters can be connected. The integrator shall have M-bus connectivity for connection to the sitewide M-bus energy network.

Sump pumps

The sump pumps shall be provided with integral controls and motor starter protection panels form 2 type 2. Hardwired interlocking shall be provided for monitoring.

Water booster sets

The water booster sets, shall be provided with integral motor starter and protection devices and all interlocking required between the tanks and the booster sets. Where appropriate (described in the public health specification) the Tanktronic system shall be used in this shall be monitored by the sitewide BMS.

Other equipment

Generally the other equipment shall be provided with hardwired interfaces or high-level interface via BACnet.

1.3 PROJECT DESCRIPTION

The description of plant is described more closely in the mechanical schedules and specification for guidance the following should be noted.

The project is the development of an apartment block that is primarily high-end apartments with the back of house services such as the gym, swimming pool and business lounge.

A number of separate control systems are provided all of which require to be interfaced either via Modbus for electrical meters, M-bus for water/heat meters and BACnet for central plant.

The control system in the apartment should be integrated with the apartment AV/lighting control system and it can be either an integral part of the system, or stand-alone with Modbus connectivity between the two.

1.3.1 Apartments

The apartments are provided with DX fan coil units for cooling with heating provided from underfloor systems.

Ventilation in the apartments is provided by local fans that are switched via lighting circuits and monitored for fault by the apartment control system.

The AV room has a space temperature sensor, which via the apartment control system enables the fan on high temperature and monitors the fan for a run status,

Heating to the apartment is provided from the central plant via a heat interface unit complete with integral controls and heat meter. The heat meter provided with M-bus conductivity is connected to the sitewide BMS/EMS allowing the BMS to generate tenant energy bills for this service.

Domestic potable water is provided to the apartment from the cold water booster set located in the basement. The water meter for this system is provided to the local authorities specification and is billed direct to the local authority and is not connected to the sitewide tenant billing system.

The electrical meters are provided to the specification of the local authority and billed direct to the local authority and are not connected to the sitewide bidding system.

Softened and grey water services are provided to the apartments from systems located in the basement. Water meters associated with these will have a M-bus connectivity and be connected to the sitewide BMS/EMS system allowing the BMS to generate tenant energy bills for these two water services.

The DX cooling system is provided with a tenant billing system based on fan coil unit valve position and energy used at the external condensers. The DX system energy bill (if Dakin) requires to be manually transferred from the DX head end supervisor to the BMS head end supervisor where manual calculations are necessary to generate bills.

Within the apartment a specialist apartment control system shall be provided. This may either be an integral part of the AV system or a stand-alone controller integrated to the AV system via a BACnet. The controller shall be provided with a BACnet connection for interface to the sitewide BMS.

In each room a back lit LED display shall be provided that shall display the room temperature and the room temperature set point and allow the user to start/stop the fan coil unit and adjust the FCU speed. This controller that shall include the room temperature sensor and shall be connected to the apartment control system via a high-level network.

An apartment HVAC control display shall be provided with SVG/HTML 5 graphics. The graphics shall be held within the controller not the display screen. The user can via this screen access all information regarding the apartment control systems such as:

- Room set points and adjustments
- Time clocks/calendars
- Energy (electrical DX/heat/water) - used/billing information
- Plant status – running/fault
- Select FCUs to auto/off/on.

The underfloor heating shall be enabled by a pseudo-optimiser that assumes a constant external temperature of 10°C and attempts to achieve nominal room temperature of (20)^{o}C at occupancy time. The underfloor heating valves shall be wired direct to the apartment controller and controlled to achieve set point with floor temperature sensors provided to limit the floor to an upper value nominally (28)^{o}C. The control system shall provide low space temperature protection of nominally (14)^{o}C

The fan coil units shall be complete with integral controls and return air temperature sensors. The fan coil unit shall be provided with a Modbus card allowing a local Modbus network to be constructed within the apartment and connected direct to the apartment controller. The FCU shall also be provided with a hardwired connection, four-star command from the apartment control system. The fan coil unit shall only run when selected by the user and operate to maintain the return air set point that shall be reset by the apartment controller based on demands from the user via the wall controller. The fan coils shall automatically be stopped after (4)hours continuous operation. The unit shall operate automatically to maintain a maximum high temperature within the apartment of nominally (28)^{o}C.

The refrigeration leak detection system shall provide local alarm and be connected to the apartment control system for monitoring and to the refrigerant leak detection central alarm panel. If the alarm is active this shall be repeated on the sitewide BMS head end supervisor system.

Electric underfloor heating is provided in the bathrooms complete with integral controls. The system shall be enabled by the apartment control system to the apartment fixed time clock.

The heat interface unit is provided with integral controls and safety interlocks and for all apartments, apart from 2, provides hot water distribution system via a local calorifier.

There are two apartments that have instantaneous hot water provided by the heat interface unit.

All apartments are provided with heat maintenance tape that is monitored by the apartment control system with alarms raised as necessary.

The DX condensers are located in the lower ground floor and are powered from two separate power boards. The boards have power meters that are wired to the condensers to form part of the tenant DX billing system.

The apartment controller shall be interfaced to the apartment AV/lighting control unit allowing the user to access the settings and information regarding the HVAC and energy services via the AV interfaces.

This user interface shall be via tablets/phones and any system utilising web browsing facilities. The graphic interfaces shall be developed by the apartment control provider and include touch screen dynamic SVG/HTML 5 graphics. Access to the required information such as room set point/adjust shall be no more than 3 screens.

1.3.2 Refrigerant leak detection

The refrigerant leak detection system is provided by specialist supplier, and described within the mechanical specification.

The specialist shall provide the detectors in the rooms, a local alarm enunciation panels. These alarm panels shall be connected via a contracted provided network to a central alarm handling system. A BACnet Gateway shall be provided for connection to the sitewide BMS. This gateway shall provide full read facility for all sensors.

1.3.3 Central plant

The central plant system comprising boilers, CHP, circulating systems is controlled and managed by the sitewide BMS.

The CHP is the lead heat source shall operate wherever possible, the boilers complete with integral pumps shall backup system on high heat demand.

Gas is provided to the boilers and the CHP via gas booster set and gas/CO detection is provided in the boiler house.

There are two heating distribution systems operating at variable volume constant temperature, one serving the apartments and the other serving the back of house areas such as the gym and the pool.

The ventilation systems serving the business lounge and gym area are mechanical ventilation heat recovery units complete with LTHW terminal reheat coil and operate to fixed time clocks.

Ventilation is provided to basement stores and electrical switch rooms by local fans operating on fixed time clocks.

The boiler house is ventilated by run and standby constant speed fans.

Domestic water system storage tanks and the softened water storage tanks are provided with local Tanktronic controllers with these and the booster sets monitored by the sitewide BMS. The mains incoming water pipe is fitted with a BREAM water leak detection system.

The grey water system is a packaged unit monitored by the sitewide BMS.

Domestic hot water to the changing rooms is provided from LTHW fed storage calorifiers complete with system circulation pump and local heat maintenance tape.

Trace heating is provided to the domestic services in exposed locations in the lower ground floor areas.

The shower /changing areas are provided with an underfloor heating system.

Water treatment systems and sump pumps are provided and monitored by the site wide BMS.

The life safety smoke control system is provided by a specialist and includes corridor temperature sensors working in conjunction with a make up dampers and an exhaust fan to provide corridor temperature control.

The car park control and fan starter system is provided by a specialist supplier. The two jet fans are controlled from the specialist provider's package by way of a roof mounted air flow direction sensor. The system is interfaced to the sitewide BMS via a BACnet connection. The system is provided with a timeclock start stop from the central system BMS.

The pool area services are provided by a specialist MEP supplier with integral controllers. The site wide BMS monitors the system for status and a heat demand.

1.3.4 Energy monitoring systems

The sitewide BMS provides energy monitoring to all systems, apart from the apartment electrical and domestic water service.

The electrical meters in switchboards and distribution boards are provided with Modbus connectivity and connected to the sitewide BMS.

The water meters, both those serving the landlords and the apartments areas should be provided with a M-bus connectivity and these all connected back to the sitewide BMS for monitoring and bill generation.

The apartment heat/water meters shall be networked together with each apartment terminating at a junction box in the riser. The riser M-bus network shall be connected to the apartment block control panel which shall in turn be connected back by the layer 2 managed switch to the BMS PC.

The DX system is provided with an energy management system for generating energy used as a proportion of the power consumed at the external condenser by each fan coil unit. This data requires to be manually transferred to the sitewide BMS for inclusion in any tenant billing system.

1.3.5 EMS network

The sitewide BMS specialist shall provide the BMS network comprising M-bus and Modbus from all energy meters, both those serving the apartments and those serving the central plant.

The apartment metering network shall be M-bus with the apartment meters daisy chained together and then wide to a junction box in the riser shaft. Each apartment shall be separately wired to this junction. The M-bus network shall terminate at a BMS provided outstation and converted from M-bus to BACnet and hence onto the BMS head end supervisor, where tenant billing shall be generated.

The electrical meters shall be connected to a Modbus network again terminating at a BMS provided outstation, converted to BACnet hence to the BMS head end supervisor, where energy management shall be provided.

1.3.6 Tenant billing

The BMS specialist shall provide the tenant billing system from a standard billing package from Onesite solutions.

The package shall provide tenant billing on a bespoke agreed landlord pro forma in the bill shall include: heat meters, grey water meters, softened water meters and electrical power from the DX system. The data from the deck system requires to be manually input, if the Dakin system is used. Otherwise .CSV file transfer shall be provided.

1.3.7 BMS networks

The sitewide BMS as well as controlling and monitoring central plant also monitors the status of equipment in the apartment and via the high-level interface to the DX system the status of the fan coil units and external condensers.

Each apartment is provided with an apartment controller that is connected via the MSTP network to a BMS Panel provided in the general riser shaft. These panels are connected by ethernet cables back to the layer 2 managed switches, which in turn are linked by a dual redundant trunk to provide a robust network.

The BMS head end supervisor is connected to a switch and provides dynamic SVG HTML 5 graphics and web browser capability. The head end supervisor, provide management of the system and provides unlimited concurrent user access via the landlords IT network.

1.4 WORK SCOPE

The BMS and automatic controls specialists shall design, supply, install, set to work, test and commission the complete automatic control and building management system required to serve all building services installations specified, in the project specification, unless specifically stated otherwise hereafter. The scope shall incorporate all control outstations, software, control field devices, valve and damper actuators, inverters, all controls wiring, including carrier systems, all power wiring from isolators provided by the electrical contractor, setting to work, commissioning and all documentation and training necessary to allow the user to operate the installation both reliably and safely.

The information provided in the specification is for tender purposes only. The controls specialists shall establish all requirements based on the final selected equipment and provide the control system to match that equipment.

The systems shall follow the principles of CIBSE Guide H ‘Building Control Systems’ and BSRIA Application Guide AG 7/98 ‘Library of system control strategies’.

The controls specialist shall submit for all review all functional design specifications, wiring diagrams, plant layouts and proposed equipment.

1.5 STANDARDS, CODES AND REGULATIONS

The automatic controls will be designed, installed, tested and commissioned in accordance with the following:

- Statutory Acts.

- Local Standards and Standard Codes of Practice.
- Local Authority Building Regulations.
- Health and Safety at Work Act.
- Electricity at work act
- The requirements of the relevant Local Authority.
- The requirements of the relevant Water Authority.
- The requirements of the relevant Fire Authority.
- The fire officers committees/the loss prevention councils rules and recommendations.
- The Factories Act.
- Current Institute of Plumbing Standards.
- The current Wiring Regulations with amendments.
- The Environmental Health and Safety Office.
- Manufacturer's recommendations for Installation Testing Commissioning.
- The Landlord's Regulations and Approvals.

Reference will be made to BS 7002, BS EN 55022, BS EN 61000, BS EN 55014, BS EN 60439, CIBSE Guides and Commissioning Code C, BS EN ISO 9000 and the Controls Group Publications.

All equipment furnished for the project will be suitable for their location and suitable for purpose.

Materials and installation will conform to the relevant current Local Standards where applicable. Where no such standards exist, the equipment will include for the known factors and requirements and will be installed to suit the manufacturer's recommendation.

1.6 QUALITY CONTROL

The contract will be carried out under following the principles of the contractors Quality Assurance documentation.

All equipment supplied will receive commercial tests to comply with IET Regulations.

All equipment will be CE marked.

No materials shall be installed which are potentially damaging to the Environment and as described in the European commission for the environment- Red list of building materials.

All electrical equipment shall be designed and fitted with interference suppression devices to comply with BS EN 6100-4-3 and components and filter units shall comply with BSEN 55011-1A.

1.7 RESPONSIBILITIES

1.7.1 Design

The Specialist control systems suppliers shall examine all drawings and documentation and will produce for approval the basis of design. The design will be carried out by competent engineers and will be suitable for the intended purpose. The design will incorporate any necessary statutory requirements with respect to Health and Safety.

The BMS & specialist control systems suppliers shall produce the system description of operations. These shall clearly show the system operation, hardwired and software interlocks, the operation during fault conditions, alarm handling and user adjustments.

The Automatic Controls Systems are a Contractors Design Portion of the project and the Automatic Controls Specialist shall provide all necessary controls equipment necessary to fulfil the requirements of the project whether or not these are specifically described in the contract documents.

1.7.2 Supply

The BMS & specialist control systems suppliers shall supply all materials and equipment necessary to be installed for the complete control and monitoring system. All materials and equipment will be suitable for purpose and location. All materials and equipment either manufactured by the specialist controls contractors or bought from an outside source will conform to all relevant Local Standards. The equipment supplied will all be of a standard type and readily available for replacement in the event of damage or malfunction.

The specialist controls contractors will provide schedules of all equipment indicating the site reference, manufacturer, type and serial numbers two weeks following the placing of the order. Where it is necessary that others install equipment, e.g. pipeline probe pockets, then the specialist controls contractors will hand this equipment to the appropriate Contractor.

1.7.3 Installation

The BMS & specialist control systems suppliers will install and wire all equipment necessary for the complete operation of the control system and it will be installed by competent engineers regularly employed by the BMS & specialist control systems suppliers.

The complete system will be installed under the supervision of an experienced field supervisor familiar with all parts of the control system. He will ensure that the work is of the highest standard and will carry out the daily co-ordination and system interface as required to ensure the completion of the project within the agreed programme of works.

The installation shall include all necessary carrier systems and supporting steel work for control panels and inverters.

1.7.4 Co-ordination with others

The BMS & specialist control systems suppliers will liaise closely with all other contractors to ensure that the installation works proceed in an orderly and co-ordinated manner.

It is a requirement of this document that the BMS & specialist control systems suppliers provide floor plans showing the location of every control device that is to be mounted in the occupied space.

1.7.5 Setting to work the automatic controls

The BMS & specialist control systems suppliers shall be responsible for setting to work the system of their supply. In addition the BMS & specialist control systems suppliers shall allow for the integrated testing required to set the building services plant to full operation.

The integrated testing shall include ‘low level’ operation such as running fan coil units, fans and pumps, through to full integrated testing of the building services to include loop tuning of heating, cooling and ventilation systems and integrated building tests covering such activities as : fire cause and effect and power failures.

The BMS & specialist control systems suppliers shall demonstrate and validate the energy data gathering.

1.7.6 Handover

The BMS & specialist control systems suppliers shall work in conjunction with all other contractors to enable the complete project to be handed over as set out in the contract documents.

Where necessary and as described by the MEP contractor during the tender process the automatic control system specialist shall include for any sectional handover. At these handovers sufficient documentation shall be provided to demonstrate that the automatic control systems has been tested witnessed and commissioned all generally as described in this specification. The automatic control services required for the sectional handover shall be detailed by the MEP contractor these shall be set to work by the automatic control specialist..

1.7.7 Documentation

The BMS & specialist control systems suppliers shall provide all documentation necessary to allow the user to operate the plant both efficiently and safely. The controls specialist shall provide sufficient information to and co-operate with the mechanical contractor for the production of the building log book.

The apartment control specialist shall provide a single A4 sheet of paper encapsulated that shall describe the operation of the apartment control system for a future tenant.

The apartment control specialist shall provide a video training package that demonstrates to the future tenant, the operation of all systems and provides guidance on fault finding. This video shall be posted on a privately hosted section of YouTube. The video shall also be stored on the BMS head end supervisor.

1.7.8 System completion report

The BMS and all other controls specialists shall provide a close out report that shall include the installation snagging sheets; the commissioning sheets the installation report and the environmental report.

The MEP contractor shall provide an overall system completion report for all services and their interaction with the BMS.

1.7.9 Training

The controls specialist shall train the user's staff in all aspects of the automatic controls and BMS.

1.8 POWER REQUIREMENTS

The BMS & specialist control systems suppliers shall provide all power wiring to the mechanical services equipment unless indicated otherwise. The following is provided for guidance and shall be agreed by the contractors.

- The BMS specialist shall provide form 4 type 2 and form 2 type 2 control panels that shall be used to power the DX external condensers, the packaged air handling plant and the general extract system systems. The BMS specialist shall provide all power wiring from this panel to the attached plant and equipment.
- The BMS specialist shall provide form 2 type 2 control panels that shall provide power for the MEP central plant and equipment such as the booster sets, sumps, ventilation plant, underfloor heating system, HWS immersion heaters, water treatment systems. The BMS specialist shall provide all power wiring from this panel to the attached plant and equipment.
- The BMS specialist shall provide a form 4 type 2 control panel for the boiler house segregating run and standby pump sets into separate cubicles. The BMS specialist shall provide all power wiring from this panel to the attached plant and equipment.

- The fan coil units associated with the DX systems shall be powered from the electrical contractors distribution boards. The final connections between the unswitched fused spurs and fan coil units shall be made by the electrical contractor.
- The DX specialist shall provide all interconnecting power and controls wiring between internal and external units.
- The AHU package supplier shall provide all interconnecting wiring both power and controls between the packaged air handling plant and its associate equipment.
- The car park specialist shall provide form 2 type 2 starter control panel and shall include all necessary power and controls wiring associated with the system, including the roof mounted wind direction sensor.
- The staircase smoke control specialist shall provide control panels associated with the staircase system inclusive of the corridor temperature sensors and environmental fan. The staircase smoke control specialist shall provide all power and controls wiring from the panels to the associated plant and equipment.
- The electrical contractor shall provide all power to mechanical plant and equipment services in the apartments.

The last 300mm of all power cables to mechanical services plant and equipment shall be installed within a flexible steel conduit.

The final 300 mm of all controls cabling shall be installed in a suitable pigtail allowing devices to be removed from plant and equipment without the necessity for electrical disconnection.

1.9 MONTHLY RETURN VISITS

The Automatic controls specialist contractors shall include in the contract costs three return visits after contract completion. These shall be at four monthly intervals and have a duration of at least two days at each visit. During this time, the BMS specialist and other system specialists shall review the operating parameters of the plant to ensure efficiency of use, provide enhanced training to the user, modify head end displays as appropriate, verify the remote interfaces such as SMS and web browsers, review the maintenance and management reports. The time shall not be spent correcting contract defects, nor carrying out maintenance.

1.10 OPERATING AND MAINTENANCE MANUAL

The automatic controls specialists shall provide the operating and maintenance manuals for their part of the works.

The BMS specialist shall incorporate where appropriate the specialist O & M manuals within the overall automatic control solution operating and maintenance manual.

The manual shall contain hard copies of:

- Outline work scope
- functional design specification
- detailed plant operation
- Software diagrams
- general arrangement drawings showing the location of all field sensors and actuators
- schematic drawings showing the location of all field sensors and actuators
- Wiring diagrams of all control panels

- equipment plant schedules with unique identifiers for each plant item, instrument and actuator
- System nominal operating set points at time of handover
- maintenance instructions for all plant and equipment
- health and safety-related functions associated with plant and equipment

The BMS specialist shall arrange for all automatic controls manuals to be loaded onto the BMS head end supervisor. Jump tags shall be provided on each main plant graphic to the appropriate section of the manual that contains the detailed plant operation, the software diagrams, the panel wiring diagrams and the set points and time of handover.

1.11 TRAINING

The BMS & specialist control systems suppliers shall train the user's staff in all aspects of the automatic controls.

1.12 BUILDING LOG BOOK – PART L COMPLIANCE

The Building Services Contractors shall provide the user with the building logbook to comply with the Building Regulations Part L. The BMS specialist shall provide simplified versions of the description of operations and simple system schematic drawings that shall be incorporated in the logbook.

1.13 PROPOSED AUTOMATIC SYSTEM WORKS SCOPE

The BMS and automatic controls specialists shall design, supply, install, set to work, test and commission the complete automatic control and building management system required to serve all building services installations specified, in the project specification, unless specifically stated otherwise hereafter. The scope shall incorporate all control outstations, software, control field devices, valve and damper actuators, inverters, all controls wiring, including carrier systems, all power wiring from isolators provided by the electrical contractor, setting to work, commissioning and all documentation and training necessary to allow the user to operate the installation both reliably and safely.

1.13.1 Technical work scope

The technical work scope for each automatic control specialist shall be determined by the main contractor. The following is given for guidance

Provide – includes design, supply, deliver, off load, move to work location, install, set to work test and commission, documentation and logbook.

Supply – includes purchase, provide warranty for product, transport to site, unload, move to and fix in final location.

Design – includes the review of the specification with positive suggestions for improvement of the works, the sizing and selection of all control equipment, the sizing of all enclosures, the configuration of relay logic and plant interlocks, the generation of the functional design specifications, the writing and configuration of software routines, the sizing of control and power cables and associated carrier systems, the sizing and selection of all protective devices (such as fuses/MCBs), co-ordination of the installation with all other Contractors.

Install – includes all fixing, brackets, supports, builders work, and fire protection.

Install – includes all software, outstation configuration, integration to the head end, networks and configuration, graphics and management reports.

Set to work (automatic controls) – includes all electrical safety checks, stroking actuators, calibration of sensors, operational strategy documentation, software and testing procedures.

Set to work (electrical services) - includes all electrical safety checks, motor rotations, operational strategy and documentation and testing procedures and the provision of all IET test certificates associated with the automatic controls works.

Commission – includes commissioning plan, co-ordination and management of third party suppliers, testing the system both on and off site and demonstration to the Client.

Documentation – includes all: test certificates, testing procedures records, record drawings, operating and maintenance manuals and the health and safety file.

- Log book – as described in CIBSE TM31.

The BMS & specialist control systems suppliers shall provide all works necessary to provide a fully compliant installation, the works shall include but are not limited to those described below. The BMS & specialist control systems suppliers shall refer to all contract documents and provide all necessary controls instruments, engineering and commissioning to ensure a coherent installation, whether or not they are described in this section.

1.13.2 AHU controls specialist

The AHU specialist shall provide all works as described in the MEP specification and the following.

1. Provide all drawings and documents required for the Automatic Controls design and installation.
2. Provide all necessary equipment controllers, software, instruments and actuators and the like to provide a complete air handling unit system.
3. Provide the form 2 type 2 control panel of inclusive of all motor safety devices, motor starters, motor speed controllers/inverters and all safety interlocks, complete with all power wiring from the panel to the drive motors
4. Provide the system control panel complete with DDC controllers, and all interconnecting wiring to the field instruments and actuators
5. Provide all control strategy, engineering, configuration and attendance to the sitewide BMS specialist for system integration.
6. Provide the BACnet high level interface between the AHU package controller and the site wide BMS
7. Provide allowance for hardwired connection between the BMS the AHU package controller for the enable signal.
8. Provide information to the BMS specialist for the generation of all dynamic graphics which shall include read and write to all field and virtual points.

1.13.3 Apartment DX controls specialist

The DX specialist shall provide all works as described in the MEP specification and the following.

1. Provide all drawings and documents required for the Automatic Controls design and installation.
2. Provide all necessary equipment controllers, software, instruments and actuators and the like to provide a complete DX cooling system.
3. Provide all necessary fan coil units complete with DX cooling coil and an integral controller. The controller shall include a Modbus card for connection to the apartment automatic control system and a DX specialist network card for connection to the DX specialist site wide DX network system. The controller shall also include a hardwired connection for interfacing to the apartment controller for remote On/Off control.

4. Provide all necessary instruments and actuators including return air temperature sensor that shall have its set point reset by the apartment control system, the return air sensor shall control the DX output.
5. Provide the external condenser units complete with all thermal controls and safety interlocks.
6. Provide all interconnecting cabling and carrier systems for power/controls/network required between the external units, the internal fan coil units and any intermediate refrigeration devices.
7. Provide the site wide DX network integrating all refrigerant devices and terminating with a specialist provided user interface. This interface shall allow the landlords to view the status and reset control parameters of the apartment fan coil units and associated external condensers.
8. Provide a BACnet interface and full supporting information for connection to the sitewide BMS. This interface shall allow the landlords to view the status and reset control parameters of the apartment fan coil units and associated external condensers.
9. Provide attendance to the BMS specialist to allow all points to be read and where necessary written to from the sitewide BMS supervisor.
10. Provide and configure an energy billing system for each individual apartment and export this to a.CSV file.

1.13.4 Apartment control system specialist

The apartment control system specialist shall interface to and control apartment building services equipment that shall include but is not limited to the following:

1. Provide all drawings and documents required for the Automatic Controls design and installation.
2. Provide all necessary equipment controllers, software, instruments and actuators and the like to provide a complete apartment control system.
3. Provide backlit wall mounted temperature sensor/adjustor complete with display of room temperature and fan coil status in each room. This device shall incorporate the room temperature sensor and user on/off/fan speed control for the fan coil unit. The device shall be connected to the apartment controller via a high-level network.
4. Provide floor screed temperature sensors and wire these to the apartment controller.
5. Provide underfloor heating valve actuators wired and controlled from the controller.
6. Provide wall mounted backlit colour touchscreen suitable for permanent display that provides access for the user to complete operation of the apartment control system. Through this touchscreen all room temperature set points can be adjusted, all room temperatures can be viewed, all fan coil unit status viewed and all fan coil units, set to auto or on or off control. The display shall allow the user to adjust all calendars (at least 3 time channels per day) set the system to continuous or time operation and off and provide a holiday and boost heating mode selection and shall display all energy used and current billing status.
7. Provide monitoring of the water and refrigerant leak detection systems.
8. Provide monitoring of the heat maintenance tape system.
9. Provide enable signals to the electric underfloor heating systems.
10. Provide the controller with BACnet/MSTP connection for interface to the sitewide BMS.
11. Provide the controller with BACnet connectivity for connection to the apartment AV control system. It should be possible by the AV control system to replicate all user interfaces apartment mechanical services plant and equipment.
12. Provide the user with current energy information/bills through a high-level interface to the sitewide BMS. Provide attendance and assistance, to the sitewide BMS specialist to configure this interface and display necessary information. The energy information shall be displayed on the apartment controller display panel.
13. Provide to the sitewide BMS status, alarm functions plant and equipment in the apartment. Alarm should include such things as water and refrigeration leak detected and heating required signals.
14. Provide control instruments and strategy for the AV room ventilation fan
15. Provide interconnecting power wiring to the lighting systems and the extract fans
16. Provide control signals for the under floor heating pumps.

1.13.5 Car park ventilation specialist

The car park ventilation controls specialist shall interface to and control services associated with car park ventilation system that shall include but is not limited to the following:

1. Provide all drawings and documents required for the Automatic Controls design and installation.
2. Provide all necessary equipment controllers, software, instruments and actuators and the like to provide a complete car park ventilation control system. This instruments shall include CO detection systems and roof mounted wind direction systems.
3. Provide all fan inverters and install these in a fire protected space outside of the car park.
4. Provide form 2 type 2 motor control centre associated control panel for the operation of the impulse fans. The panel shall be located in a fire protected space outside of the car park.
5. Provide all power wiring including isolators between the MCCs and the fans. Control and power cabling shall be BS 8519 category three.
6. Provide a BACnet interface for connection to the sitewide BMS.
7. Provide hardwired connection to the sitewide BMS for critical and non-critical fault monitoring.

1.13.6 Lobby firefighting smoke control specialist

The lobby firefighting smoke control specialist shall interface to and control services associated with lobby smoke control system and the corridor temperature ventilation system that shall include but is not limited to the following:

1. Provide all drawings and documents required for the Automatic Controls design and installation.
2. Provide all necessary equipment controllers, software, instruments and actuators and the like to provide a complete lobby firefighting smoke control
3. Provide all necessary equipment controllers, software, instruments and actuators and the like to provide a complete corridor temperature control ventilation system.
4. Provide form 2 type 2 control panels for the systems.
5. Provide all fan starters and speed controllers.
6. Provide all power and control wiring to the control panels and the field instruments, actuators and automatic opening vents. All controls and power wiring shall be BS 819 category three.
7. Provide all motor smoke dampers and automatic opening vents.
8. Provide all automatic and manual control devices for the operation of the automatic opening vents.

1.13.7 BMS controls specialist

The BMS specialist shall provide all works as described in the MEP specification and the following.

1. Provide all necessary equipment controller, software, instruments and actuators and the like to provide a complete sitewide BMS. The system shall incorporate all areas excluding the controls within the apartments.
2. Provide all necessary BMS/EMS networks, software communications, licences, graphics user interfaces and the like to form a complete system.
3. Provide all necessary control and safety strategy both hardwired and software
4. Provide management of the interfaces of each disparate control system onto a common sitewide BMS platform.
5. Provide hardwired and high level interface to the Business Lounge and Gym air handling units.
6. Provide hardwired and high level interface to the car park ventilation system.
7. Provide high-level interface to the firefighting lobby smoke control and corridor temperature ventilation system.
8. Provide high-level interface to each apartment automatic control system.
9. Provide the M-bus metering network monitoring system to all apartment and central plant energy meters. The meters (heat and softened & grey water) in each apartment may be daisy chained together but each apartment shall be connected separately to the main backbone M-bus network.

10. Provide all central plant fan and pump inverters, and associated instruments and actuators. Although small fans may be provided with integral starters the BMS specialist shall include costs for the starters within the BMS works package.
11. Provide all controls interfaces, instruments and actuators for the central plant general and boiler house ventilation supply and extract fan systems
12. Provide all control interfaces and instruments are making/actuators associated with the boilers.
13. Provide all control interfaces and instruments/actuators associated with the CHP.
14. Provide all controls interfaces instruments and actuators for the LTHW pumps and distribution systems.
15. Provide all controls interfaces to the pressurisation units.
16. Provide all controls interfaces and remote instruments and actuators associated with the LTHW circulation pumps.
17. Provide all controls interfaces instruments and actuators associated with the HWS system calorifier and local distribution.
18. Provide the high temperature cut out associated hardwired interlocked spring shut safety valve for the calorifier.
19. Provide all controls interfaces associated with the HWS circulation pump.
20. Provide the pump start and control monitoring for the landlords underfloor heating systems
21. Provide monitoring of the domestic hot water heat maintenance tape system and cold water trace heating systems.
22. Provide monitoring of the potable cold water booster set - Integral controls and starters supplied, installed and commissioned by the mechanical contractor. The controls specialist shall carry out all interconnecting wiring between the tanks and the pump control panel.
23. Provide controls interface to the incoming water leak detection systems.
24. Provide temperature sensing and water level sensing in the mains incoming water tanks.
25. Provide monitoring of the storage tanks Tanktronic systems.
26. Provide monitoring of the grey water system tanks and boosters
27. Provide monitoring of the softened water system tanks, boosters and softeners
28. Provide monitoring of the sump pumps
29. Provide monitoring of the LTHW and domestic water water treatment systems.
30. Provide monitoring of the gym/pool plant and equipment.
31. Provide monitoring of water treatment systems such as the Hydromag and the UV
32. Provide gas & CO detection system for the boiler house and gas detection system for the gas meter room. The system shall auto reset following a power failure, or when the fire alarm is reset .
33. Provide motorised gas valves and associated interlocks to the gas detection/fire alarm system.
34. Provide monitoring of the gas boosters
35. Provide monitoring of the gas meters
36. Provide monitoring of all electrical meters mounted in the switchboards and distribution boards
37. Provide all domestic water meters WRAS approved complete with M-bus conductivity and connect these to the M-bus BMS/EMS energy monitoring system.
38. Provide monitoring of all apartment heat meters and connect these to the M-bus BMS/EMS energy monitoring system.
39. Provide central plant heat meters (alternatively, mag flowmeters with matched temperature sensors) complete with separate outputs for flow monitoring and connect these to the sitewide BMS. These meters do not form part of the energy billing system but they form part of the energy monitoring and control strategy systems.
40. Provide monitoring of the LV board electrical meters and connect these to the sitewide BMS. These meters are used for part L compliance and are not necessarily part of any billing system.
41. Provide monitoring of the main switchboard breakers via Modbus connections.
42. Provide monitoring of the MCC electrical meters via Modbus interface.
43. Provide pulsed output from the MCC electrical meters serving the external condensers to each condenser to form part of the DX billing system.
44. Provide monitoring of the fire alarm system

45. Provide monitoring of the electrical ATS(s)
46. provide monitoring of the passenger and vehicle lift.
47. Provide all actuators for ventilation dampers that require to be operated by the BMS
48. Provide all control valves and actuators that require to be operated by the BMS.
49. Provide a weather station
50. Provide the form 2 and form 4 type MCCs for the central plant, equipment, including the external condensers associated with the apartments.
51. Provide all control panels and support frames. All panels located outside the building shall be IP65 rated and complete anti-condensation heating.
52. Provide all power wiring and carrier system from the MCC to the MEP plant and equipment.
53. Provide all controls wiring and carrier system from the MCCs/control enclosures to the MEP plant and equipment.
54. Provide a fully configured BMS head end supervisor operating as a thick client server suitable for unlimited simultaneous users, inclusive of all operating software, complete with web browser, email and SMS functions. The BMS specialist shall provide a 30 minute UPS for the head end workstation. The system shall be complete with HTML 5 SVG, dynamic graphics and display on demand all field and virtual points that form the project.
55. Provide fully configured DDC controllers complete with all necessary operating software to manage and supervise the MEP plant and equipment.
56. Provide fully configured DDC controllers, with suitable interfaces to monitor the apartment controllers in the apartment energy meters and meters associated with the landlords system.
57. Gather data from the energy readings of all energy meters (heat, water gas , electric) whether these be landlords or apartments or other tenants and generate tenant billing. Make use of a standard package (such as OneSite solution or similar) that may require modification to suit the end users requirements.
58. Provide fully integrated BMS/controls and plant testing, setting to work and commissioning; a detailed test and commissioning plan along with the handover plan shall be provided by the BMS specialist. The Mechanical and Environmental reports shall be constructed and completed by the Building Services Contractors.

1.13.8 All controls specialist

All control specialists shall provide the following:

1. Provide all controls instruments and actuators that form the automatic control system
2. Provide all drawings and documents required for the Automatic Controls design and installation.
3. Provide general arrangement drawings showing the location of all field mounted instruments and actuators. The equipment shall be identified on the drawings with unique reference numbers.
4. Provide schematic drawings showing the location of all field mounted instruments and actuators. The equipment shall be identified on the drawings with unique reference numbers.
5. Provide all operating software, firmware and licences. Licences shall allow 100% increase of all field and virtual points at contract closure.
6. Provide all MCCs and control panels and support frames. All panels located outside the building shall be IP65 rated and complete with anti-condensation heating.
7. Provide all power wiring, including carrier systems.
8. Provide all control wiring, including carrier systems
9. Provide the complete control system engineering and configuration
10. Provide all plant testing, setting to work and commissioning of automatic control system.
11. Provide integrated plant and equipment testing for the combined automatic control systems
12. Provide a full witness of the automatic control systems to the main contractor.
13. Provide a full witness of the automatic control systems to the client.
14. Provide a test plan for the testing, setting to work and demonstration of the automatic control system on a system by system basis.

15. Provide a test plan for the testing, setting to work and demonstration of and integrated control system across the complete site.
16. Provide attendance for all fire alarm and black building testing associated with the MEP plant and equipment.
17. Provide a completion report of the installation, testing and demonstration of the automatic control systems.
18. Provide seven-day running (environmental testing) continuous operation of the plant and equipment to demonstrate plant stability.
19. Provide the automatic control system Operating and maintenance manuals
20. Provide assistance with production of the building log book
21. Provide training of operators and documentation for apartment tenants
22. Provide return visits to retune the system operations.
23. Provide all necessary consumables for the project

1.14 SYSTEMS AND INTERFACES AND OPERATION

The following describe the minimum requirements for packaged plant over and above that set out in the package plant section of project documentation.

1.14.1 Boiler house ventilation

The boiler house is ventilated by duty standby constant volume supply and extract fans.

The duty fans are enabled, assuming interlocks are healthy by the BMS whenever the boilers are required to run or if the boiler room temperature is >(26 ± 2)^{o}C.

The hardwired interlocks include other fan not running, fire system healthy. The software interlocks include hardwired interlocks and no existing fan alarm.

The fan shall duty rotate on a weekly basis and if in a fault mode.

1.14.2 Business suite ventilation

The business suite ventilation is provided by a specialist who shall provide all controls, power and control wiring for the AHU.

The system shall be enabled, by the BMS on a fixed time clock or if the plant extension button or PIR is operated, when it shall run for (4) hours and then revert to normal operation.

The hardwired interlocks include, fire system healthy. The software interlocks include hardwired interlocks and no existing fan alarm

When required to operate and assuming all interlocks are healthy, the supply and extract fan shall be enabled and the face and bypass damper modulated to maintain a nominal return air set point. The return air set point shall be reset between limits (16 to 25)^{o}C to maintain the room air set point. The room air set point is adjustable between (18 and 24)^{o}C by the room mounted adjuster.

The systems are run at medium speed whilst the return CO_2 is <(800)ppm, or the return RH <(65)%. Above these limits the fan shall run at full speed.

Mismatch alarms shall be generated and displayed on the BMS head end supervisor.

1.14.3 GYM ventilation

The Gym ventilation is provided by a specialist who shall provide all controls, power and control wiring for the AHU.

The system shall be enabled, by the BMS on a fixed time clock or if the plant extension button or PIR is operated, when it shall run for (4) hours and then revert to normal operation.

The hardwired interlocks include, frost stat healthy fire system healthy. The software interlocks include hardwired interlocks and no existing fan alarm

When required to operate and assuming all interlocks are healthy, supply and extract fan shall be enabled and the heater battery and face and bypass damper modulated to maintain a nominal return air set point. The return air set point shall be reset between limits (16 to 25)^{o}C to maintain the room air set point. The room air set point is adjustable between (18 and 24)^{o}C by the room mounted adjuster.

The systems are run at medium speed whilst the return CO2 is <(800)ppm, or the return RH <(65)%. Above these limits the fan shall run at full speed.

The heating valve shall fully open/close once per day as a valve exercise routine the valves shall be open fully when the central plant water quality routine is active.

Mismatch alarms shall be generated and displayed on the BMS head end supervisor.

1.14.4 Plant room area ventilation

The Plantroom areas are ventilated by local extract fans complete with integral motor starters.

Each system is enabled by the BMS fixed time clock and monitored for running status.

Mismatch alarms shall be generated and displayed on the BMS head end supervisor.

1.14.5 Car park ventilation

The car park is ventilated naturally with two unidirectional jet fans operate on a fixed time clock and on high CO level.

The fan airflow direction which is adjusted automatically to match the external wind direction is measured at the roof mounted wind direction sensor.

The fans are enabled, assuming all interlocks are healthy and generally operate at low speed unless the local CO level is >(30)ppm with a run at full speed until the CO level is <(20)ppm.

If the fans off and the CO level is >(50)ppm then the fans shall run until the CO level is <(30)ppm.

1.14.6 Stair lobby smoke and ventilation control

The stair lobby smoke control system operates in the fire mode as required, and described in the mechanical specification.

The corridor temperature ventilation is initiated by wall mounted temperature sensors on each floor that open the floor and make up damper, the roof AOV air inlet and enable the environmental extract fan.

The system is enabled if the corridor temperature is >(24)^{o}C and disabled at <(20)^{o}C. The system shall be held off if rain is detected.

1.14.7 Heating system

The heating system comprises three gas fired boilers, a gas-fired CHP, storage vessel is and variable volume distribution pump sets.

The CHP is the lead heat producer and shall run whenever possible. Although a timeclock is provided for a nominal shutdown between the hours of (02.00 and 04.00).

The distribution pumps operate as duty standby and duty rotate on a weekly basis and speed controlled to maintain the system required differential pressure at the least favoured sensor.

The heating system is enabled if there is a heat demand from any apartment or from the HWS. However, a timeclock is also provided that will override the off demands from these two systems.

1.14.7.1 CHP OPERATION

The CHP is enabled whenever the system is required to operate and assuming all interlocks are healthy. When required to run the boiler ventilation plant, is enabled, as is the CHP primary circulating okay pump.

The CHP shall only be allowed to run if the landlords time clock is active, this time clock is nominally set for (04.00 to 02.00) (7 days per week).

The CHP shall be disabled if the return water temperature measured at 9105/TI X/07 is >(60)^{o}C

the CHP shall be disabled if the water temperature measured in storage vessel 2 at either temperature sensor 9105/TIX/2/02 or 9105/TIX/2/03 is >(65)^{o}C.

the CHP shall be enabled, assuming all interlocks are healthy, if the primary heating flow temperature measured at 9105/TIX/03 is <(60)^{o}C for >(5) minutes and flow is proven from either the apartment heating or the pool pumping systems.

The CHP shall be enabled, irrespective of secondary pumping, assuming all interlocks are healthy, if the water temperature measured in storage vessel 1 at temperature sensors 9105/TIX/1/01 and 9105/TIX/1/02 are <(60)^{o}C for >(5) minutes.

The CHP shall be enabled, irrespective of secondary pumping, assuming all interlocks are healthy, if the water temperature measured in storage vessel 1 or 2 at any temperature sensor is <(45)^{o}C for >(5) minutes.

The hardwired interlocks include: boiler house ventilation proven running, gas system healthy, fire system healthy, flow proven from the CHP circulating pump, pressurisation unit healthy. The software interlocks include hardwired interlocks, no existing CHP alarm, CHP software hand off auto switch in auto.

The CHP circulation pump is enabled whenever the CHP is required to operate, assuming, all interlocks are healthy. The hardwired interlocks include system low pressure healthy. The software interlocks include hardwired interlocks, no existing pump alarm.

The CHP circulation pump will be enabled, assuming it has not run in the previous 192 hours, for (1) minutes.

The CHP circulation pump will run whenever the LTHW water quality circulation routine is active.

1.14.7.2 APARTMENT HEATING DISTRIBUTION

The apartment distribution heating pumps operate as variable volume, duty/standby to serve the apartment heat interface units.

The duty pump is enabled, assuming all interlocks are healthy, if either the time clock is active or there is a heating demand from the apartments. The pump will also run if the pump software hand off auto switch is in hand.

If a pump has not run in the previous 192 hours then it shall be enabled for (1) minute.

The duty pump shall also run whenever the LTHW water quality circulation routine is active

The hardwired interlocks include other pump not running, pressurisation unit low pressure healthy. The software interlocks include hardwired interlocks, no existing pump alarm, pump software hand off auto switch in auto.

When required to operate the duty pump is enabled and run at minimum speed to maintain the system differential pressure set point measured at the least favoured sensor. The system differential set point shall be determined during commissioning, but nominally (80)Kpa and adjustable by the user (+/- 40)Kpa.

If the pump is running at minimum speed (20)% [10] hz and the system differential pressure measured at both sensors is above set point the pump bypass valve shall modulate open to maintain the system differential pressure set point.

If the flow temperature measured at the top of each riser is <(65)^{o}C then the bypass valve at the top of the riser, shall be modulated from fully closed to fully open over a five minute time span and then closed over a five minute time span. The valves shall be open fully once per day for (1) minute and shall open fully during the LTHW water quality circulation routine.

The pumps duty rotate on a weekly basis and if in a fault mode.

Duty rotation can be forced or inhibited from the BMS head end by the user.

1.14.7.3 POOL/BOH HEATING DISTRIBUTION

The pool/BOH distribution heating pumps operate as variable volume, duty/standby to serve the pool plant, the AHUs, the HWS cylinder and the UFH systems.

The duty pump is enabled, assuming all interlocks are healthy, if either the time clock is active or there is a heating demand from the pool, the HWS or the AHUs.

If a pump has not run in the previous 192 hours then it shall be enabled for (1) minute.

The duty pump shall also run whenever the LTHW water quality circulation routine is active.

The hardwired interlocks include other pump not running, pressurisation unit low pressure healthy. The software interlocks include hardwired interlocks, no existing pump alarm, pump software hand off auto switch in auto.

When required to operate the duty pump is enabled and run at minimum speed to maintain the system differential pressure set point measured at the least favoured sensor. The system differential set point shall be determined during commissioning, but nominally (80)Kpa and adjustable by the user (+/- 40)Kpa.

If the pump is running at minimum speed (20)% [10] hz and the system differential pressure measured at both sensors is above set point the pump bypass valve shall modulate open to maintain the system differential pressure set point.

If the flow temperature measured at the end of the system is <(65)^{o}C then the bypass valve shall be modulated from fully closed to fully open over a five minute time span and then closed over a five minute time span. The valves shall be open fully once per day for (1) minute and shall open fully during the LTHW water quality circulation routine.

The pumps duty rotate on a weekly basis and if in a fault mode.

Duty rotation can be forced or inhibited from the BMS head end by the user.

1.14.7.4 PRIMARY BOILER SYSTEM

The 3 boilers are provided as back up heat suppliers after the CHP and the storage vessels are in use.

The boilers are provided with integral pumps which operate when ever the boilers are enabled from internal boiler strategy. Whenever the boilers are required to run the boiler house ventilation shall be enabled.

The boilers are enabled in sequence when additional heat is required for the distribution systems and only after the CHP has been enabled.

The boiler hardwired interlocks include: boiler house supply and extract proven running, gas system healthy, fire system healthy, pressurisation unit healthy. The software interlocks include : hardwired interlocks, no existing boiler alarm, boiler software HOA switch is auto and the pool or apartment heating pumps proven running.

The boiler will also be enabled if the boiler software HOA switch is in hand.

Boilers duty rotate on a weekly basis, Duty rotation can be forced or inhibited from the BMS head end by the user.

In a fault mode the number of boilers required is increased by one and the faulted boiler disabled.

The boilers are only enabled if either heating distribution pump is running in automatic control, if both pump sets are off then the boilers are disabled.

The lead boiler is enabled in a heating mode:

- If the secondary return water temperature in either system is <(35)^{o}C for >(5) minutes and at least 1 system pump is proven running
- If the primary flow temperature measured at 9105/TIX/03 is <(60)^{o}C for >(10) minutes and at least 1 system pump is proven running

The lead boiler is disabled if

- if the common system return measured at 9105/TIX/06 is > (45)^{o}C for >(5) minutes and no other boilers are enabled.
- if the total secondary flow rate is < (2)L/sec..

The assist 1 boiler is enabled:

- if the primary flow temperature measured at 9105/TIX/03 is <(60)^{o}C and the lead boiler has been enabled for > (10) minutes.
- if the total secondary flow rate is > (5)L/sec.

The assist 1 boiler is disabled

- if the common system return measured at 9105/TIX/06 is > (45)^{o}C for >(5) minutes and the assist 2 boiler is off.
- if the total secondary flow rate is < (3)L/sec.

The assist 2 boiler is enabled

- if the primary flow temperature measured at 9105/TIX/03 is <(60)^{o}C and the assist 1 boiler has been enabled for > (10) minutes.

- if the total secondary flow rate is > (7)L/sec

The assist 2 boiler is disabled

- if the common system return measured at 9105/TIX/06 is > (45)°C for >(5) minutes.
- if the total secondary flow rate is < (5)L/sec.

In a boiler fault is active then the number of boilers required is increased by 1 and the faulted boiler disabled.

1.14.8 Domestic hot water system

The domestic hot water is generated at the storage calorifiers by heat, delivered from the pool heating circuit. The HWS is enabled to a fixed time clock (07.00 to 23.00) (7)days per week or if the gym ventilation plant is running.

When required to operate and assuming all interlocks are healthy, the HWS calorifiers LTHW valve is opened fully when both temperature sensors are <(55)°C and closed when both temperature sensors are >(60)°C or if either temperature sensor is >(62)°C

When the calorifier is active the HWS circulation pump is set to work, assuming all interlocks are healthy.

The calorifier interlocks include: high temperature cut out healthy.

The pump interlocks include software: no existing pump alarm.

The high temperature cut out if tripped shall close the two port isolation valve and raise a BMS alarm. The high temperature cut out requires a manual reset.

The heat maintenance tape system is monitored by the BMS and an alarm raised in a fault.

The HWS is enabled once per day for a pasteurisation cycle, at (04.00). During this cycle the LTHW valve is opened fully and the circulation pump run until the HWS flow and return temperatures, and the two sensors in the calorifiers have been >(60)°C for >(60) minutes. The valve shall close if any sensor is >(63)°C and reopen when all sensors are <(60)°C.

Alternative solution for packaged equipment

If a packaged HWS is provided, then the sitewide BMS shall enable the unit on a fixed time clock and to monitor the unit for fault.

The HWS circulation pump shall be enabled throughout the operating time period.

The high temperature cut out shall be monitored from the integral controller and the spring shut valve closed in a fault status.

1.14.9 Apartments

The apartments are provided with DX fan coil units for cooling and underfloor heating.

The fan coil units are provided with integral controllers and return air temperature sensor. The unit is provided with ELV terminals for remote start stop which is derived from the apartment control system and a Modbus connection for general monitoring, reset of the control temperature and if technically possible useful start stop fan speed control.

The apartment extract fans in the bathroom operate to the lighting system and run whenever the lighting systems is on with a (10) minute run on timer. The apartment control system shall monitor the fans for fault status.

The AV room shall be provided with a wall temperature sensor monitored by the apartment BMS. If the space is above set point (25 ±2)° C, then the apartment controller shall enable the fan and monitor for running status.

The bathroom underfloor heating system is enabled by the apartment control system and maintains temperature using an integral control.

A house automation interface unit shall be provided that allows the user to set time clocks for the heating/HWS with two separate time channels per day, allows continuous or off operation of the plant and provides automatic advancement at weekends. The controller shall allow the user to override the out of hours operation of the underfloor heating system.

Within each apartment a refrigerant leak detection system shall be provided. Each apartment shall have an individual alarm panel with buzzer and indication lamp and the apartment control system shall monitor the system for alarm and raise an alarm at the BMS sitewide supervisor when active.

Operation

The underfloor heating shall be enabled by a pseudo-optimiser that assumes a constant external temperature of 10°C and attempts to achieve nominal room temperature of (20)°C at occupancy time. The underfloor heating valves shall be wired direct to the apartment controller and controlled to achieve set point with floor temperature sensors provided to limit the floor to an upper value nominally (28)°C. The control system shall provide low space temperature protection of nominally (14)°C

The house automation system shall enable the underfloor heating to suit the occupier's time clock. If however any space temperature is <(14)°C at any time or if the floor temperature is <(15)°C, the heating system shall be enabled until the space temperature rises by 2° C or the floor temperature is elevated to 17° C.

During the occupancy hours or for low space temperature protection the underfloor heating system control valves shall be modulated by the apartment automatic control system and the underfloor heating pump enabled assuming all interlocks are healthy. The pump enable shall be hardwired through the high temperature cut out and any pressurisation unit fault.

The cooling shall only operate when selected by the occupier using the wall mounted temperature sensor device. When selected for cooling the BMS shall enable the fan coil unit which will run under its own control strategy until the room temperature has fallen to that selected by the user. When set point is achieved the BMS shall stop the fan coil unit until the temperature has risen by (2)°C above set point. The BMS shall disable the fan coil unit if it is still running at the end of the users occupancy period and the fan shall only restart when selected again by the user for cooling.

If at any time during occupancy and if the user has not selected cooling then the apartment automation system shall enable the fan coil unit if the room is >(28)°C, and stop operation with the temperature has fallen to (26)°C.

TWO ALTERNATIVE SOLUTIONS DEPENDENT ON FCU/MODBUS CAPABILITY

- The fan coil unit shall operate with a return air temperature sensor that is nominally set at (18)°C. This set point can be adjusted by the site wide BMS system BACnet interface to the DX cooling system. However, this operation and the graphic is not for general use and shall only be available and visible to the central operator who has the highest level of FM access (other than of course the

BMS specialist). The fan coil unit is enabled by a hardwired connection whenever cooling is selected by the user or for its high space temperature.

- The fan coil unit shall operate with the return air set point reset by the apartment control system via a Modbus connection to suit the set point selected by the user on the room display unit. The fan speed control shall be selectable by the user from the room display unit and reset by the Modbus connection.

The underfloor heating system shall be enabled under the optimised time clock and the pump enabled whenever there is a heating demand. When all rooms are satisfied, the pumps shall be disabled. The valve shall modulate to maintain the room/floor temperature.

On start up each morning all valves shall be open fully and the pump run for (15) minutes before the temperature control regime is initiated.

Whenever heating is required heat interface unit shall be enabled.

If the pumps have not run for (196) hours then all valves shall be open fully and the pump run for 15 minutes. Is not necessary to enable the heat interface unit this time.

The apartment controller user interface shall be provided with a touch screen allowing the user to: set all time clocks, adjustable room temperature sensors set points, provide an away mode operation, provide a constant running selection, show the status of each fan coil unit, show the status of each underfloor heating valve, show the status of the heating pumps.

In the away mode operation the fan coil units shall not operate and the heating shall only be enabled if the space temperature is less then (12)^{o}C and it shall run until the space temperatures are >(14)^{o}C. In the away mode the underfloor heating valves shall be open fully once per day and the pump run for (5) minutes without the heating being enabled.

1.15 SITEWIDE BMS CONTROL SYSTEM

The site wide BMS shall provide control and management of the central plant services, energy monitoring and bill generation and monitoring of third party equipment.

The MCCs shall comprise of form 2 type 2 and form 4 type 2 MCCs. The type 4 constructed such that all of the duty drives are one enclosure and standby drives, and the other. This is for operational reliability, rather than life safety. The control panels associated with his MCCs may either be alongside or as an integral section. As an alternative the bidders may offer a cost saving for power assembly style distribution boards and form 1 control panels.

The main plant control controllers that shall be web enabled with embedded graphics shall be networked via the BMS ethernet solution using layer 2 managed switches and cat 5A cabling. These switches shall be linked by a dual redundant trunk with the network cable taking diverse routes in the basement.

The apartment control system that may be a proprietary style (KNX) shall have a BACnet interface that shall be connected to the BMS sitewide control panels located in the riser shaft is via an MSTP network. These remote panels are connected to the switch is via the cat 5A cabling.

The site wide BMS specialist shall provide the energy monitoring systems and will primarily be M-bus from the apartment heat meters and the apartment water meters. Each apartment meters may be daisy chained but each apartment shall be connected separately to the M-bus main backbone, which in turn shall terminate at a BMS sitewide controller. This controller again is connected back to the switches.

The apartment cooling system should be provided with a BACnet interface that will be connected via a switch into the sitewide BMS.

The packaged AHUs shall be provided with a BACnet interface that shall be connected to a local BMS outstation and hence via the switch to the head end supervisor.

The site wide BMS shall be provided with a user interface, head end supervisor with SVG HTML 5 dynamic graphics. All field and virtual points associated with the sitewide BMS, the apartment control systems, the car park systems and the packaged air handling plants shall all be displayed and user adjustable at the head end supervisor.

The site wide BMS shall incorporate the energy monitoring system and the tenant billing system. The tenant billing system shall be a standard start package developed to the requirements of the landlord.

The BMS controllers shall be web enabled with expansion modules held within the control panel. Under no circumstances shall remote dumb I/O be networked to controllers other than those within the same control enclosure.

1.16 CONTROL PANEL ENCLOSURES

The BMS specialist and automatic controls providers shall provide door interlocked MCC form 4 type 2 and form 2 type 2 IP54 rated panels for plant and equipment of their supply. The panel shall be two sections, one containing the LV power and the other the ELV controls.

The 230V/24V cables shall not be in the same trunking system.

The power section shall have a door interlocked isolator and a power meter and a power on lamp. The power section shall contain the BMS controls transformer.

The control section shall have :

- Control circuit healthy lamp.
- Outstation alarm lamp and rest button.
- 13A socket with RCD.
- BMS/specialist suppliers comms socket.
- BMS/specialist suppliers outstation(s) c/w i/o modules.
- 24 v ac/dc power supplies.

The number of panel switches and lamp shall be limited such that each system is provided with a system hand/off/auto switch and each system shall have a running & fault lamp.

1.16.1 Power Wiring

The BMS specialist & specialist controls suppliers shall provide all power wiring and carrier systems for MEP plant equipment connected to the MCC.

All cables shall be manufactured by a BASEC certified company.

The use of PVC cabling is not permitted, all multi-core cables shall be SWA, and cables shall have a LSOH outer sheath, tested in accordance with BS EN 60754 and BS EN 60332.

All power cabling shall be installed in conduit, trunking or on tray as appropriate. All power cables shall be single core LSF in conduit or trunking and shall be single core XL/LSF 6491B with XLPE/LSF/SWA being used on tray or any exposed surfaces. Low voltage power cables shall have a minimum csa of 2.5mm^2. Conductors shall be stranded throughout.

All cabling within control panels shall be tri-rated and all cables in common carrier systems shall have the same insulation rating.

For details of power, cabling and carrier systems refer to the electrical specification.

Where cables are mounted externally these shall be protected from UV degradation.

1.16.2 Controls Wiring

The BMS & specialist control systems suppliers shall provide all control wiring and carrier systems for equipment connected to the MCCs and the CEs.

All control cables will be to suit the specialist controls contractors system with the minimum sizes as detailed in this document and finished with an LSOH outer sheath.

All low voltage cables will be single core, with an LSOH outer sheath and screened if necessary to the relevant specification, having stranded copper conductors. All control system wiring will conform to the current edition of the IET regulations. Cables will not be connected directly to the controllers. All cables will terminate at screwed terminals and subsequently be wired to the outstation. Electrical screening will be provided to the extra low voltage cable by the use of screened cable.

The use of PVC cabling is not permitted; all cables shall have a LSOH outer sheath, tested in accordance with BS EN 60754 and BS EN 60332.

Low voltage cables will have a minimum cross sectional area of 1.5 mm^2.

Extra low voltage cables will have a minimum cross sectional area of 0.75 mm^2 (7/0.37 mm dia) with due regard to cable resistance for sensors and shall be in conduit or trunking. All final connections to equipment shall be via flexible steel conduit.

Loose laid controls cabling is not permitted.

All controls cabling shall be screened and shall be located at least 200mm from any power cabling and not run parallel to the ELV/LV system cables. Screening will be provided by an aluminium/polyester foil shield with a multistrand drain wire (7/0.37). All low voltage control cables will be sheathed in LSOH material.

All controls cabling will be screened, installed within conduit or trunking have a LSOH outer sheath. The final connection to devices may be through flexible galvanised conduit.

All controls wiring will be carried out in twisted pair cables, each pair being individually screened. Any unused conductors will be terminated to earth at both ends.

1.16.3 Network Wiring

The BMS specialist and the VRF specialist shall provide the network cabling system for their works.

The use of PVC cabling is not permitted; all cables shall have a LSOH outer sheath. Tested in accordance with BS EN 60754 and BS EN 60332.

The cabling shall be mechanically protected and shall be to a standard specified by the equipment supplier.

1.16.4 Damper actuators

The BMS specialist and specialist contractor shall provide all damper actuators required for the operation of the ventilation systems.

All actuators shall be 24V AC and where mounted outside the building shall be IP54 rated. Protective bags shall not be provided.

Isolation dampers shall be motor open/spring closed and provided with end switches. These switches shall be wired as part of the fan safety circuits.

1.17 SYSTEM OPERATION

The BMS & controls specialist(s) shall be responsible for development of the description of operations, based upon the information provided in the contract specification and on the drawings. The description of operations shall include all necessary explanation for the plant operation, the construction of the software and shall include but not be limited to the following information:

The controlling outstation and or MCC, complete with LAN and outstation number. All controlling and monitoring instrument complete with unique identifying reference. NB 'Supply air sensor' is insufficient. The type of sensor e.g. temperature, humidity, pressure shall be indicated along with the instrument reference number;

- The normal method by which the plant is started and stopped
- Hardwired interlocks
- Software interlocks
- Normal operations
- Operation on a sensor fault
- Operation in a power failure and restart
- Operation in a fire mode
- Demands sent to other systems
- Demands received from other systems
- Initial operating set points
- Initial alarm set points
- The reaction of each plant item to a fault condition
- Head end adjustments
- Head end displayed information
- Information transmitted remotely
- Alarm messages and the response required from the operator.

1.17.1 Alarm handling

Wherever possible all alarms shall auto reset at (00.01) and the plant control enclosures shall be provided with a reset button that will clear all alarms within the outstation.

The only alarms that are required to be manual reset will be those associated with safety interlocks this would include but is limited to the high temperature cut out associated with the HWS.

The alarms associated with the DX condensers will not be latched within the BMS as it may be assumed that a manual reset is most likely provided at the particular specialist provided plant item.

Whenever critical alarms occur that require to be brought to the immediate attention of the user these should generate a clear banner on the BMS head end supervisor and the specialist suppliers graphical

interface. Whenever these alarms are acknowledged by the user the graphical interface shall immediately display the appropriate graphic holding the critical alarm.

Non critical alarms shall be displayed on the appropriate graphic and within the alarm log.

All alarms shall always populate the alarm log and be available for inspection at any time by the user.

1.18 AUTOMATIC CONTROLS - STANDARDS AND MATERIALS

1.18.1 Submittals

The controls specialists will submit for comment full details and samples of all sensing and controlling equipment to be used on the contract. These submittals will be made within the agreed programme period. The submittals will include physical dimensions and any specialist requirements. Approval of the documents will not relieve the controls specialist of any responsibility in the respect of providing equipment suitable for purpose.

The controls specialist shall submit for comment general arrangement drawings showing the position of all equipment and wiring routes. Approval of the documentation will not relieve the controls specialist of any responsibility for errors or omissions.

The controls specialist will provide for comment, samples of any component that is to be mounted within the occupied space.

The controls specialist will provide block wiring diagrams and schedules appertaining to the interfaces between the BMS specialist works and other parties. All block wiring diagrams will be complete with the Contractors terminal numbers.

Where the controls interfaces with other equipment the BMS specialist will co-ordinate the interface wiring diagrams and provide the necessary interface hardware.

1.18.2 Inspections/approval/requirement

The contract requires that the works of the controls specialist will be to the inspection, approval, agreement, satisfaction or requirements and the like of the Client Representative. No such inspection, approval, agreement, satisfaction or requirements and the like of the Client Representative will in any way imply or be construed as relieving the controls specialist of his responsibilities for performance and dimensions or other responsibilities described in this contract or otherwise at Law.

Where the Client Representative is required to affix their inspected stamp to the controls specialists detailed specification, drawings, manuals, samples and the like, no such inspection or stamp will in anyway imply or be construed as relieving the contractor of his responsibilities for performance, dimensions or other responsibilities described in this contract or otherwise at Law.

No alteration to the performance or other requirements of this specification will be made unless a variation instruction is issued by the Client Representative, which expressly requires such alteration.

1.18.3 Control enclosure and outstation panels

All panels shall be constructed in accordance with ES EN 61439-2 IP54 rated. Panels containing heat generating equipment shall be ventilated to maintain a maximum of 30^{o}C in the panel.

Where units are split for delivery the BMS specialist shall include for all reconnections and insulation and flash testing of all rebuilt power sections.

The control enclosure shall incorporate all the necessary equipment and shall be delivered to site complete with internal wiring. All connections shall be arranged within the panel in a neat symmetrical and logical manner.

1.18.4 Construction

All panels shall be folded sheet steel construction not less than 2.00 metric gauge or constructed on a modular metric gauge flush sheet steel finishing. Panel doors shall not exceed 750mm and panels no higher than 2.2 m. All switches are to be no higher than 2m from the floor level.

The panels shall be dust and damp proof enclosures generally to IEC 529 (BS 60947) IP54 rated. All access doors shall be fitted with a common key operated lock for the particular project.

Lifting eyes shall be provided for convenience in handling large and heavy panels.

The controls section of the panel will be constructed in two parts. One part will contain the extra low voltage direct digital control processors. The other part will contain all hard wired interlock relays and terminals. However where cubicleised panels are used the hardwired interlocking relays shall be located in the starter cubicle. Common relays shall be in the common control section.

Each control panel will have a RCD switched 240V 13 amp socket and a 24V light in the controls section, the light being operated by a PIR.

All panel isolators shall be lockable in the off position and of a rating such that it will be capable of carrying for three seconds, without distress, a through fault current equivalent to the three phase short circuit of the system specified.

1.18.5 Painting and finishing

The panels shall be cleaned inside and out and all damage repaired to an approved method prior to handover.

1.18.5.1 PAINTING

For indoor use the cabinets shall have two coats of rustproof primer, filled as necessary and flattened to a smooth finish, then two undercoats followed by a final finish of two coats of epoxy resin paint, to an approved colour, the final coat drying to form a hard semi-gloss surface.

1.18.5.2 GALVANISING

Galvanising shall be applied to the galvanising thickness and quality of zinc conforming to BS EN ISO 1461. The zinc coating shall be smooth, clean and uniform thickness and free from defects. The preparation of galvanising itself shall not adversely affect the mechanical properties of the coated material. Sheradising or other special process shall not be used unless approved.

All drilling, punching, cutting and bending of parts shall be completed and all burrs shall be removed before galvanising is carried out.

1.18.6 Cable entries

Removable undrilled gland plates shall be provided at the top and 230mm above the floor level for terminating all incoming cabling. These plates shall be non-ferrous for MICC cables. All plates shall be sealed against the ingress of dirt, dust and moisture. These plates shall be easily detachable for drilling purposes.

1.18.7 Internal wiring

All wiring cables shall be BS 6231 Tri-rated cable, with a minimum size of 7/0.67 mm single or multi-stranded as required.

Where panels are located in office or riser spaces, PVC shall not be used, all cables shall have a LSOH outer sleeve.

The main current carrying conductors of each main circuit from the incoming terminals shall be capable of carrying for one second without distress, the through fault current equivalent to the three phase short circuit of the system specified.

All LV wiring shall be segregated from ELV cabling. All cables in the same carrier system shall have the same insulation rating.

Auxiliary and main wiring will be kept separate as far as practicably possible. All internal wiring will have numbered ferrules at each end; internal wiring will be securely fixed to the enclosures and will not impede the opening and closing of doors or removal of components. Where possible 'crimp' type connections will be used.

Cleats are to be fixed to the control panel structure at sufficient intervals to avoid cable sag. Adequate cable loops shall be allowed to accessories on doors to avoid cable stretch.

1.18.7.1 BUS-BAR WIRING

Bus-bars where installed shall be rated to withstand at any position the full fault level related to the largest protective fuse that could be used within the main panel feed isolators.

Bus-bars shall not be located in the panel base or any exposed position.

All points in the bus-bars shall be accessible for inspection and tightening when panels are in the final position on site.

1.18.7.2 POWER WIRING (220 VOLTS AND ABOVE)

All power wiring cables shall be BS 6231 Tri-rated cable, with a minimum size of 7/0.67 mm single or multi-stranded as required. Where such wiring is to be carried across door hinges in looms it will be in flexible cable to the relevant BS with a minimum size of 50/0.25 mm.

1.18.7.3 ELV WIRING (CONTROL, INDICATION OR ALARM CIRCUIT)

ELV cabling shall be to BS6500 with a LSOH outer sheeth with a minimum size 30/0.25mm.

1.18.7.4 NEUTRAL BAR OR LINK

A neutral bar shall be incorporated within the panel and shall be of sufficient size to allow each separate circuit neutral conductor to be connected into a separate circuit terminal.

1.18.8 Arrangement and Installation of wiring

All wiring shall, as far as possible, be grouped according to the circuits involved. It shall be run in insulated cleats of the limited compression type, flexible tubing, rigid steel conduit or plastic trunking and shall then be taken to terminal boards mounted not less than 230mm above the bottom gland plate or not less than 230mm from the top of the panel, as required. Sharp, tight bends shall be avoided.

All outgoing wiring will be clearly segregated with respect to the 240V and extra low voltage systems.

Bunching of cables into large looms will not be accepted. The maximum number of control cables in any one group will not exceed 25 conductors.

All unfused cables between bus-bars, isolators or fuses will be routed separately as individual looms. All controls cables, shall be in screened multicore flexible cable.

Where plastic trunking is used, the cable will not occupy more than 80% of the trunking volume.

All parts of the panel including the door will be earthed.

All incoming/outgoing terminals will be via screw type terminals.

The outgoing control circuits will be via knife edge disconnect type isolators.

All redundant cables within the panel shall terminate in suitable connectors and be identified as spare, both in the panel and in the field.

1.18.8.1 CABLE TERMINATION AND TERMINALS

Each wire shall be separately terminated with an approved crimped terminal to suit the terminal used.

Wires shall not be jointed or twisted between terminal points. Bus wiring shall be fully insulated and run separately.

1.18.8.2 TERMINALS AND TERMINAL BOARDS AND CONNECTIONS

All terminals and terminal boards for small wiring shall be the crimped type terminals and for ease of maintenance shall be the snap-on type. For power wiring, terminal boards shall be preferably be of the stud type, the studs for which shall be positively locked in position without the use of locknuts. Pinch screw terminal boards will not be permitted.

All connections shall be made on the front to terminal boards. Current shall not be carried through the board by the stud.

Terminal boards shall have separate terminals for incoming and outgoing wires and not more than two wires shall be connected to any one terminal. Insulated barriers shall be fixed between adjacent terminals. The height of the barriers and the spacing between terminals shall be such as to give adequate protection whilst allowing easy access to terminals.

Terminals shall be provided for the incoming main cable. All terminals shall be located so that they are accessible to straight screwdrivers and no terminals shall be located behind fixed panel work.

No live metal shall be exposed at the back of the terminal boards. Terminals shall be provided for all spare cores of outgoing multi-cables, where indicated. Any terminal which may be live when the panel is isolated from the supply shall be clearly identified and shrouded. All terminal boards shall be provided with sectionalised covers of transparent insulating material.

Outgoing terminals connected to equipment with terminal markings different from the internal wires shall be indicated by a double sleeve or ferrule on the internal wires showing both numbers and in a distinctive colour. These shall be shown on all diagrams.

1.18.9 Relays

All electrical relays used within the control panels shall be interchangeable and of the plug-in type with equal number of normally open and normally closed contacts of ratings adequate for their operating duties.

1.18.10 Control circuits

Control circuits shall be 24V.

Where the control system is used as low voltage AC, a transformer shall be supplied a rating suitable for the control system load of the panel plus 20% spare capacity. The transformer shall be in accordance with BS EN 61558.

1.18.11 Indicator lights and switches

Each panel shall have lamps and switches as shown on the tender drawings.

Where panels are not identified on the drawings the following shall take precedent.

- incoming mains isolator
- 3-phase healthy lamps (for 3 phase systems)
- Controls healthy lamp
- lamp test push button
- For panels greater than 5 kW - Electrical meter displaying - Kilowatt hours instantaneous and accumulative values. The meter shall display amps & volts per phase & frequency;

All panels shall have:

- A panel identification label
- The manufacturer's name, construction date and serial number
- Warning labels on any panel/doors containing LV equipment

Where panels are not identified on the drawings the following shall take precedent.

All panels shall be provided with the following:

- 13A socket with RCD.
- comms socket.
- outstation(s) c/w i/o modules.
- 24 v ac/dc power supplies.
- Transformers as necessary.
- 24V internal panel lamp operated by door contact.
- Indicator lights shall preferably be 4.5V LED4 cluster lamps.

1.18.12 Current transformers

Current transformers for the operation of the apparatus with which they will be associated and for the combined duty of over-current protection and efficiency test for the operation of instruments, ammetering equipment shall comply with the requirements of BS EN 61869.

1.18.13 Fuse protection

All fuses inside the panel are to comply with BS EN 60269 motor rated as appropriate.

1.18.14 Miniature circuit breakers

Miniature circuit breakers shall be manufactured to comply with BS EN 60898. Circuit breakers shall be type A, B, C or D as appropriate.

1.18.15 Residual current operated circuit breakers

All residual current operated circuit breakers shall comply with BSEN 61009. Operating residual current is indicated in the appropriate distribution schedule.

1.18.16 Earthing

An earth bar shall be provided throughout the length of the panel and provision shall be made for connecting onto this bus-bar from within the panel or outside the panel.

The sizing of earth conductors shall be proportionate to the fuse sizing.

1.18.17 Laptop power

A twin socket with RCD protection shall be installed in the controls section of the panel.

1.18.18 Drawing holder

A drawing holder shall be provided in the panel.

1.18.19 Component labelling

All components shall be labelled or otherwise designed to permit them to be readily identified on the circuit diagram.

1.18.20 Name plates and labels

Name plates and labels shall be provided for all starters and items of equipment. The labels shall be non-corrosive metal or traffolyte phenolic engraving material. They shall be engraved to give black letters on white background.

1.19 CABLES

All cabling installation including carrier systems shall be as described in this specification and the electrical section.

All cables shall be manufactured by a BASEC certified company.

The use of PVC cabling is not permitted, all multi-core cables shall be SWA, and cables shall have a LSOH outer sheath. Tested in accordance with BS EN 60754 and BS EN 60332.

Where cables are mounted externally these shall be protected from UV degradation.

All power cables will be sized by the automatic controls specialists to achieve minimal volt drop. All cables in a common carrier system shall have the same insulation rating.

All final connections to plant and equipment shall be via metallic flexible conduit.

1.20 ELECTRICAL SUPPLY

The equipment supplied will be suitable for operation on 400/220v, 50Hz supplies and the supply voltage and frequency tolerances permitted by the Electricity Supply Regulations and the Electricity Board Regulations.

The BMS specialist will provide all necessary screening and earthing to both the wiring and the control/outstation panels to prevent corruption of the controls installation. Due consideration will be taken of the effect of hand held radios and pagers within the vicinity of the system.

The complete controls installation will be protected from the effects of electronic interference and in turn will limit its interference to other sources all as outlined in the latest EMC Regulations. Particular care is to be paid to inverters which are to be fitted with internal RFI filters.

1.21 BUILDING MANAGEMENT SYSTEM

The automatic control systems shall be supported by a multi user server, the operation of the automatic control systems shall not rely in any way upon the server; it will only act as a window into the system and storage source of information. The unit will have automatic backup that runs on a daily basis. The head end will offer full graphics interfaces and all management reporting systems.

The complete system shall be based on peer to peer communication with all main plant control devices having unique IP address. The system shall be configured to allow the clients to access the system via a web browser. There shall be no limitation on the number of web browser access licences.

The installed system shall allow future expansion through the use of the open protocols: BacNet/IP, or MODBUS/IP.

The system will be supplied with all necessary BMS software, this will include but is not limited to:

Time Zones	(on/off control)
Calendar programmes with leap year capability	(programme up to a year in advance)
Alarm handling	(type, location, time and date)
Configuration	(adjustment of control parameters including password protection)
Data handling	(set point of temperature, humidity pressure etc.)
Adjustments	(change to all parameters e.g. set points and overrides)
Trend Logs	(display and analysis of data from controllers)
History logging	(hours run, change of state)
Power fail restarts, including staggered starts	
Weather compensation	
Optimum start	
Frost protection	
Report	(automatically or on demand)
Data Analysis	(transferable to spread sheets)
Dynamic graphics	(graphic display of status and conditions)

The server shall contain the complete database for the project and carry out all necessary BMS functions.

The client PC shall reside on the BMS network and perform all BMS functions. However, when this client or indeed any of the remote PCs change operating parameter then these shall automatically be recorded on the server disks.

1.21.1 Controllers

All hardware shall be capable of operating in a normal office environment. The environment will be controlled between 5°C and 40°C and 5-90% RH.

Where systems do not have a head end supervisor all main plant controllers shall be web enabled and supplied complete with web enabled graphics.

The controllers shall be capable of providing:

- Optimum start/stop
- PID control function
- Load cycling and maximum demand control
- Logic and sequence for interlock and time control
- Power fail restarts, including staggered starts
- Alarm handling
- Weather compensation
- Optimum start
- Frost protection.

1.21.2 System Supervisor

The BMS specialist shall provide an AX head end supervisor complete with dynamic graphics. The system supervisor (head end) equipment, shall include but not be limited to:

- Head end workstation utilising an industrial PC with full HD colour monitor 1080p resolution mounted in the facia of the basement MCC
- Operating system software and all necessary licences
- Web enabled software
- All necessary cables
- All consumables such as paper and ink for the project
- The system shall be configured to operate on the workstation as a thick client

The system shall be accessible via any web browser for full read/write operations..

The head end shall be configured for the following functions:

- Web based software for full remote access
- Provide network between all outstations, the server and the head end
- Engineer the head end for full read and write to all field points and virtual points
- Full Dynamic graphics
- Alarm management system
- Transmit alarm messages to dedicated email address
- Transmit alarm messages via SMS text messages to dedicated phones
- Engineer and provide Management reports
- Fully integrated BMS/controls and plant testing and commissioning. 100% of points to be verified from field to head end and to remote clients
- Energy metering and maintenance package.

1.21.3 Router

A router shall be provided, by the BMS specialist complete with suitable fire walls to allow remote web browsing to take place. The router shall allow the transmission of automatically generated emails and SMS text messaging to dedicated mobile phones.

1.21.4 Outstations

The outstations provided by either the BMS specialist or the package plant control specialist shall comply with the following.

Each outstation will contain sufficient resident software and data storage capability to fulfil the operational functions detailed in the specification, schedules and drawings. The outstations will contain all the interfacing equipment between plant and equipment such that the CPU/outstation software is fully compatible with any such plant and equipment.

Outstations will have a standalone capability such that a failure of the CPU will still permit the plant and controls associated with the outstations to continue to operate normally. In the event of transmission failure the outstations will continue to operate with all sequence interlocks and control strategies operating normally excepting those that require global information. Default will then be assumed for these global parameters.

Outstations will be provided to house all the de-coding devices, interface relays where required, transducers and reset devices. The programmable software in the outstation will be capable of being updated from the CPU. It will also be possible to program the outstation from a portable plug in terminal. Any changes made locally will be automatically uploaded to the CPU.

Outstations will incorporate a self-test facility and be able to provide the CPU with status information concerning their internal operations. This information will include, but not be limited to: -

- Data transmission conditions and verification.
- Internal status.
- Battery condition, where applicable.

Any outstation failure will raise a critical alarm.

The outstation will be capable of accepting digital, analogue, pulse and pulsed inputs and providing digital and analogue outputs.

Where AO are specified in the BMS schedules a pair of BO will not be considered as an acceptable alternative.

1.21.4.1 CAPACITY

Each outstation will be provided with hardware, software and memory capacity for future additions of at least 25% of each type of point.

The outstations will be constructed so that the cabinets and internal terminal strips can be mounted, and electrical terminations made, with all electronics being added at a later date during the testing and commissioning phases of the project. The outstations will be provided with their own internal battery back-up power supply capable of maintaining the memory for not less than 72 hours.

1.21.5 Transmission system

The transmission systems will be configured to provide the lowest possible communication times between the CPU and outstations such that.

- Critical alarms will be displayed within 5 secs of occurrence.
- Normal alarms will be displayed within 10 secs of occurrence.

- Graphic displays will start to be displayed on the screen within 5 secs of the command for such a display and be completed within 10 secs of the command, complete with actual values, alarm values and status.
- The value of all analogue inputs will be checked at intervals not exceeding 10 secs, unless otherwise stipulated. Where shorter intervals are relevant, because of short time constants in a system they will be used.
- The graphics will be automatically refreshed every 10 secs.

1.21.6 Direct digital control (DDC)

This is the use of software based algorithms, to achieve on/off proportional, proportional plus integral and proportional plus integral plus derivative control loops. The relevant software will be resident in the outstations replacing discrete controllers. The control parameters will be adjustable by key pad operation and via a lap top.

1.21.7 Logic diagrams

The BMS specialist or package plant specialist control systems supplier will provide a full set of flow charts or logic diagrams to show the software logic for all the performance requirements of each and every plant.

1.21.8 Software

The system as a whole shall be designed so that software has adequate protection from corruption arising from:

- Disturbances due to magnetic, electrical, atmospheric or environmental influences, including noise or failure in the electrical supply
- Switching either the Central Controller or peripherals or outstations on or off
- Testing either the Central Controller or peripherals or outstations.

All programs will be tried and tested standard programs.

The BMS/package plant specialist control will be provided with software programs capable of providing the facilities and features detailed in the specification.

The supplier will place with a third party the full source code for the BMS installed. Both parties will agree an ESCROW which will allow access, by the end user to the source code if the supplier ceases to offer full support.

All data and messages displayed on VDU's and printers will be prefaced by the date and time at which the event occurs.

It will be possible to assign values, from the keyboard, to any digital, analogue or measured signal so that the specified performance responses may be checked and tested against the requirements.

1.21.8.1 SYSTEM START COMMANDS

Each system shall be provided with various start/stop commands to suit the project.

These shall include optimised start for all heating systems with anti-condensation and plant frost protection routines.

1.21.9 Access levels

Operator access to software for amendment, updating and changing of parameter values will be at several different levels ranging from direct access, through a minimum of four levels of password security.

1.21.9.1 OPERATIONAL PROGRAMMES

The operating strategies shall be developed by the controls specialist to provide a system that is energy efficient and based on standard procedures.

The controls specialist shall refer to and provide operating strategies and programs as described in BSRIA application guide AG 7/98 – Library of system control strategies.

1.21.9.2 HISTORICAL DATA PROGRAMME

The software will enable the storage of specified historical data. Hard drive storage for the necessary data will be provided as part of the BMS. This shall be capable of storing, as a minimum the following data:

- Analogue inputs – 50% of installed at 1 minute intervals for 1 year
- Analogue outputs – 50% of installed at 1 minute intervals for 1 year
- Set points – 50% of installed at 1 minute intervals for 1 year
- Digital inputs –100% of installed 1000 change of states
- Digital outputs – 100% of installed 1000 changes of state
- Energy metering record retention is detailed in the appropriate sections.

1.21.9.3 SENSOR DEFAULT CONTROL

Where sensors, used for controlling plant, fail during operation the controlled devices or the measure sensor value will default to an agreed value.

1.21.9.4 ALARM PROGRAMME

The software within each outstation will scan all alarm inputs in less than five second intervals. Whenever faults or system mismatches occur, an appropriate alarm shall be raised at the BMS head end. The principal of alarm handling is that where ever possible alarms shall not latch and shall clear automatically.

All other alarms are acknowledged at the head end or the CE alarm reset button. Alarms shall automatically clear when the system returns to normal, when the CE reset button is operated, when the head end reset is set and automatically at (00.01)

All critical alarms are to be brought to the attention of the user immediately. Acknowledgement of this display shall be logged and the system graphic containing the alarm is to be automatically displayed on the screen.

Necessary alarms shall automatically generate emails and text messages to appropriate addresses.

Alarms shall be prioritised as: Critical, Non critical, General

When an alarm condition is displayed it will be independent of any other possible alarm or cause that may initiate a string of further alarms.

1.21.10 Graphics

Every field and virtual point of the system is to be displayed as a dynamic value on the appropriate system graph. The graphic display is to be as clean as possible and constructed in a simple to read form. Dynamic graphics shall be provided for all plant that the BMS controls and monitors.

All graphics shall be based on logical tree construction with a silhouette of the building being the normal point of access. This would lead onto floor plans showing plant locations that will display the current room temperatures and any specific alarms such as water leak detection.

An overview graphic should be provided that is a text based page indicating all the main plant and equipment and its general status either an, off, fault . Jump tags from this page allow the operator to access directly the associated detail plant graphic.

1.21.11 Field Mounted Equipment

All equipment located in public spaces shall be approved for appearance by the architect.

All field mounted equipment shall be 24V.

1.21.11.1 SENSORS

All sensors shall be selected and installed in accordance with the Building Controls Group document – Control Sensor Installation. All temperature sensitive devices will be positioned or protected from the effects of radiation.

Temperature sensors

Will have an accuracy of +/- 0.5°C and a yearly drift of not more than 0.1K per year.

Sensors in ducts > 600mm shall have sensors serpentine across the unit.

Relative humidity sensors

The unit will have an accuracy of + 2% and be located in a suitable enclosure.

Pressure switches

These will be diaphragm operated. The set point will fall within 40 - 70% of the scale range and they will have differentials adjustable over 10 - 30% of the scale range. They will be provided with changeover contacts suitable for 240v AC 2 amp rating.

Where pressure sensors are used on smoke extract fans the sensor shall be fire rated to 300°C for one hour and all tubing shall be in copper.

Thermostats

Thermostats sensing outside air, return air and water temperature will have liquid filled bulb type sensing elements. Thermostats sensing off coil-air and mixed temperatures will be liquid filled averaging elements mounted so that the element senses across the duct.

Where thermostats are used for frost protection, high or low flow temperature they shall be of the auto-reset type unless otherwise indicated.

1.21.12 Standard design functions

The following control requirements shall be common to all systems except where specified to the contrary in subsequent sections of the specification:

- Terminal units such as FCUs shall stop through software commands in the event of a fire.
- System control loops for temperature and pressure shall be initiated, when air or water flow is proven at the system drive.
- Heating systems shall be disabled when outside air temperatures are above (18)°C, unless demands exist for such strategies as dehumidification.
- All field mounted control devices and cables will be of the 24v type.

- All controls cables carrying signal voltages shall be segregated from any 240v circuits.
- All damper actuators shall be sized to suit the damper torque
- Any flying leads associated with the actuators are to be of a LSOH material and have a maximum length of 1500 mm. Where the dampers are used for fire or smoke control the control cabling shall be fire rated.
- Each point in the control system will be connected to a single outstation terminal. The use of multiplexers or the like is not permitted.
- Sufficient hardware/software will be provided to allow global commands to be sent to the terminal units for: stop/start, change temperature set point, open fully all control valves, 100% output on electric heaters.
- The response time of all control sensing and actuating equipment shall be related to the needs of the installations under control in order to ensure quickness of response consistent with freedom from "hunting". The control systems shall be sufficiently sensitive to meet the control band requirements specified without "hunting".
- Terminal devices, such as fan coils, shall continue to operate in their last state if the communications network to the central plant fails. The contractor shall provide an interface to the terminal device network to allow all of the units to be started or stopped, if communications have been lost to the central supervisor network.
- All set points shall be adjustable between reasonable limits at the head end of the VRF master controller.
- All controls wiring will be carried out in twisted pair cables, each pair being individually screened. If multicore cables are used a common outer screen may be employed.
- All power cabling shall be installed in conduit, trunking or on tray as appropriate. All power cables shall be single core LSF in conduit with XLPE/LSF/SWA being used on tray or any exposed surfaces. Low voltage power cables shall have a minimum csa of 2.5mm2.

1.22 COMMISSIONING REQUIREMENTS

The works provided by the automatic controls specialist shall comply with the following:

The testing and commissioning shall be as described elsewhere in the specification and conform with the following requirements:-

The Main contractor shall be responsible for the commissioning of the controls installation. It shall, however, be carried out by the Controls specialist.

The main contractor's responsibility for commissioning shall extend over the duration of the contract and defects liability period.

The Automatic Controls testing includes all central plant and the apartments stop

The automatic controls specialists shall be responsible for inspecting and checking the complete electrical works associated with the automatic control installation by him or installed by others to his detailed requirements. The inspections shall include a check of power and control wiring; fuses, starters and isolators appropriate to installed motors; setting of timers or time clock controls; setting of transformer output voltages; fitting flexible electrical connections and provisions of earthing, bonding and screening as necessary.

The automatic controls specialist shall advise the Client Representative of any site tests and give seven days notice in writing of final tests so that they shall be carried out in the presence of the Client Representative or his representative.

All contractors shall provide services of skilled commissioning engineers, certified test equipment, tools and instruments for any tests and make good any defects.

The automatic controls specialist shall test, calibrate, adjust, check and reset thermostatic and automatic controls and shall provide all test certificates and calibration charts.

The Contractors shall provide all necessary temperature and humidity records and charts and attendance so that records can be taken of plant performance in such areas that the Client Representative may decide.

The automatic controls specialist shall test all electrical equipment associated with the automatic controls installation and provide test certificates.

The automatic controls specialist shall check the operation of all alarms, safety devices and plant interlocking by simulating fault conditions.

During the defects liability period the automatic controls specialist shall make several visits to the site and shall carry out thorough checks for continued satisfactory controls operation.

Such adjustments that are necessary to the controls installation under actual working conditions shall be made by the BMS specialist and reported to the Client Representative and shall take due account of variation due to occupancy of the building, seasonal changes or variations in the operation of mechanical plant under control etc.

Until the final check and adjustment has been carried out the contract shall not be considered for final acceptance and the balance of retention sums shall not be released.

1.22.1 Installation Report

The automatic controls specialists shall provide detailed trend logging of the operation of the building services plant interfaced to the BMS. The mechanical contractor shall co-ordinate the works of the BMS specialist and all other necessary suppliers to ensure that the complete building services operate in a homogenous state for a minimum of seven days.

During the seven day period the mechanical contractor shall arrange for step changes to be made to the plant to demonstrate that the automatic controls are able to recognise the change and react accordingly.

The mechanical and electrical contractor shall provide a detailed test plan prior to commencing the works. The testing shall include but not be limited to such items as:

- Optimised start;
- Building frost protection;
- Fan coil operation
- DX unit operation
- air handling plant operation
- SER cooling operation
- heating system operation
- domestic hot water system operation
- Power failures to individual remote outstations;
- Failed temperature, pressure and humidity sensors;
- Disconnection of network at individual CEs;

- Manual plant operation from the head end;
- Issuing of emails and SMS text messages during fault conditions;
- Fire cause and effect.

The operation of the plant and its ability to react shall be recorded by the contractors, both as a hand record of the events and a full BMS and VRF log. The logs shall show system set points and the actual values achieved.

The contractors shall review the test results, annotate the reports indicating the faults that occurred, the records obtained by the BMS/VRF and the system reactions. The reports shall be reviewed, by the contractors modified and the systems corrected where incorrect actions are noted. The testing shall continue with full recording for a minimum of seven days and until the works are fault free.

The trend logs shall show plant operation over the entire period with all field and virtual points logged at a minimum of one minute intervals.

1.22.2 Environmental report

The automatic controls specialists shall arrange for a survey of temperatures that are being achieved after the system has been fully adjusted and ready for occupation shall be made in all areas.

The report encompasses all building services environmental control equipment and is not restrictive to the BMS.

The Mechanical and BMS specialist shall submit a record of this survey in the form of a bound report showing plant operating conditions and times, outside and inside temperature and supply systems wet and dry bulb temperatures.

The survey shall monitor air temperature and moisture content (including control tolerance) for all areas for a period of 7 days. The survey shall include the monitoring of plant start / stop times, morning boost operation, heating and cooling systems operation, HWS flow and return temperatures, supply and extract air temperatures, room and floor temperatures, plant operation

The survey shall include the demonstration of plant loading and unloading. Appropriate commissioning attendance shall be provided to manually adjust the system where necessary to simulate load variance and to validate controls calibration for flow measurement.

Include with the survey three sets of control drawings and schedules showing final set points of all controllers required to obtain the above results.

1.22.3 Approvals and acceptance

Services will be tested to show their compliance with this specification and to the requirements of the relevant service authority. Proof of compliance with any service authority requirements will be supplied to the Client Representative. After receipt of the commissioning reports the Client Representative will check that the claimed results are within the allowed tolerances. The automatic controls specialist will give the Client Representative 7 days written notice of his intention to demonstrate and seek an acceptance certificate for any item or system. All tests for acceptance certification of systems or items of equipment will be witnessed by the Client Representative or their appointed representatives. The BMS specialist/package plant control specialist will allow for giving such notice and making adjustments, setting up, and other preparations for testing and for the Client Representative or their representatives attendance in witnessing such tests. The BMS specialist/package plant control specialist will carry out testing and commissioning work using trained, experienced engineers. The supervising commissioning engineers will have a minimum of five years experience in the testing and commissioning of heating, air-conditioning and ventilation controls installations.

The BMS specialist package plant control specialist shall demonstrate the works to the main contractor who shall approve the installation along with the appropriate mechanical and electrical contractor. The main contractor shall initial all test sheets indicating their approval and comments. When satisfied with the works the main contractor shall offer the system for review to the Employer.

1.22.4 Test equipment and instruments

The BMS specialist/package plant control specialist will supply and fix all necessary apparatus and instruments for making tests on the installations. The BMS specialist/package plant control specialist will submit to the Client Representative a list of the equipment that he proposes to use in the testing and commissioning of the services. All instruments that require periodic re-calibration will be properly adjusted before work is commenced. If, in the opinion of the Client Representative instruments should be rechecked for accuracy because of the time that has elapsed since the previous calibration or because of damage or any other reason, this will be carried out at the BMS specialists expense. Data sheets will be submitted for each test instrument to be used, indicating the manufacturer's name, model number, serial number, latest date of calibration and correction factors.

1.22.5 Test certificates

The BMS specialist/package plant control specialist will provide four copies of test certificates to the Client Representative bearing the signatures of the BMS specialist/package plant control specialist. Test certificates will serve as a certified record that the item referred to has been shown under test to meet the requirements of this document, Local Standards, Statutory and Local Authority Regulations and the like, wherever applicable. Test certificates will be dated, numbered and clearly referenced to the item tested by means of serial, chassis, or other manufacturer's reference number permanently marked in a conspicuous position on the item concerned.

If the Client Representative does not attend to witness tests on receipt of correct period of written notice from the BMS specialist/package plant control specialist then the tests will be carried out by the BMS specialist who will sign and submit certified copies of test certificates to the Client Representative. The Client Representative reserves the right to have such sections of the work tested by the BMS specialist but not witnessed by the Client Representative, re-tested. In the event that such a re-test shows the work to be defective the BMS specialist will bear the cost of this and any necessary subsequent tests.

In addition to the above, test certificates will be submitted to Statutory or Local Authorities as may be required.

1.22.6 Control panel tests off site

The BMS specialist/package plant control specialist will test all control and starter panels off site.

1.22.7 Software testing off site

The BMS specialist/package plant control specialist will test all software off site.

1.22.8 Pre-commissioning checks

In order to ensure that the appropriate system is in a satisfactory and safe condition before starting up, checks will be made in accordance with the relevant CIBSE Commissioning Codes.

1.22.9 Electrical wiring

Wiring terminations to all control equipment supplied by the BMS specialist/package plant control specialist will be checked both for compliance with the control wiring diagrams and interlocks with other equipment shown on the electrical and mechanical sub- Contractor's wiring diagrams. All motors will be checked for rotational direction.

1.22.10 Control panel devices

The commissioning of all instrumentation supplied with the control panels will be the responsibility of the BMS and the packaged specialist.

1.22.11 Point to graphic

Every field point (100)%, hardware and software connected shall be verified from field to graphic.

1.22.12 Sensor calibration

Every sensor shall be verified with a certified instrument, to show that the measured value is displayed accurately in the controller and at the head end.

1.22.13 System operation

Each system shall be tested both in a static and dynamic case. Static commissioning includes safety interlocks and general sequence control. Dynamic commissioning includes operation of plant in normal heating and cooling modes and the setting of control loops and final set points.

All plant shall be trend logged for 2 days in which time step inputs shall be applied and the BMS/package plant reactions checked. Systems that do not operate to the satisfaction of the client's representatives shall be re-commissioned and retested by the contractors until the system is fault free.

1.22.14 Commissioning records

The BMS specialist/package plant controls specialist will submit to the Client Representative a complete set of data on all equipment and systems which he commissions.

1.22.15 Drawing register

- 9000 legend
- 9100 Network
- 9101 motor control centre sheet 1
- 9102 motor control centre sheet 2
- 9103 general ventilation sheet 1
- 9104 general ventilation sheet 2
- 9105 heating system sheet 1
- 9106 heating system sheet 2
- 9107 Apartment systems
- 9108 gas systems
- 9109 public health system sheet 1
- 9110 general monitoring sheet 1

MOTORISED DAMPER WITH END SWITCH

MOTORISED DAMPER WITH END SWITCH

MOTORISED SMOKE RATED DAMPER WITH END SWITCH

WEATHER LOUVRE

ELECTRIC HEATER BATTERY

FILTER

AIR TO AIR RECUPORATOR

MECHANICAL NON RETURN DAMPER

FIXED SPEED PUMP

VARIABLE SPEED PUMP

VARIABLE SPEED FAN

TWO SPEED FAN

FIXED SPEED FAN

HEAT RECOVERY FAN UNIT

POSITIVE DISPLACEMENT PUMP

PRESSURISATION UNIT

AIR COOLED CHILLER

WATER COOLED CHILLER

FORCED DRAUGHT BURNER

COOLING TOWER

DIRECT GAS FIRED AIR HEATER

PUMP WITH INBUILT INVERTER

4 PORT CONTROL VALVE

3 PORT CONTROL VALVE

2 PORT CONTROL VALVE

CONSUMER

DX COOLING UNIT

CALORIFIER

TWIN FAN PACKAGED UNIT

SINGLE FAN PACKAGED UNIT

HUMIDIFIER ELECTRIC

HUMIDIFIER SPRAY

HOT WATER COIL

COOLING COIL

RUN-AROUND COIL

FLOW METER

HEAT EXCHANGER

ADIABATIC COOLER

ORIFICE PLATE

FIRE DAMPER

VOLUME CONTROL DAMPER

HEAT METER

THERMAL WHEEL

CONSTANT VOLUME UNIT (with integral controller, velocity sensor and actuator)

VARIABLE VOLUME UNIT (with integral controller, velocity sensor and damper actuator)

PACKAGED HOT WATER GENERATOR WITH ELECTRIC HEATER

PUSH BUTTON

ELECTRIC METER

HEAT METER

WATER METER

GAS METER

ALM - EQUIPMENT MONITORING POINT
BRT - BOILER RESET TEMPERATURE
CBO - COMMAND BOILER ON /OFF
CCO - COMMAND CONTACTOR ON /OFF
CCR - RUN STATUS OF CHILLER
CDM - COMMAND DAMPER MODULATING
CDO - COMMAND DAMPER TWO POSITION
CEO - COMMAND EQUIPMENT ON/OFF
CFO - COMMAND FAN ON/OFF (HS- HIGH SPEED, LS-LOW SPEED)
CFIO - COMMAND FAN INVERTER ON /OFF
CHM - COMMAND HEATER MODULATION
CHUM - COMMAND HUMIDIFIER MODULATION
CHO - COMMAND HEATER ON /OFF
CHUO - COMMAND HUMIDIFIER ON /OFF
CIO - COMMAND INVERTER ON/OFF
CP - CONTROL PANEL
CPO - COMMAND PUMP ON / OFF
CPIO - COMMAND PUMP INVERTER ON / OFF
CVM - CONTROL VALVE MODULATION
CVO - CONTROL VALVE OPEN/CLOSE
DA - DRIVE AVAILABLE
DXCLG - DX COOLING STAGE
EHM - ELECTRIC HEATER MODULATION
EHO - ELECTRIC HEATER ON/OFF
ES - END SWITCH STATUS (D-DAMPER, V-VALVE)
FIR - FIRE ALARM
FIE - FIREMAN'S EXTRACT SWITCH
FIFS - FAN INVERTER FAULT STATUS
FIRS - FAN INVERTER RUN STATUS
FLS - GENERAL FLOW STATUS
FLT - GENERAL FAULT STATUS
FPS - FILTER PRESSURE SWITCH
FSC - INVERTED FAN SPEED CONTROL
FSM - FAN SPEED MODULATION
FRS - FAN RUN STATUS - (HS - HIGH SPEED, LS - LOW SPEED)
HPCO - HIGH PRESSURE CUT OUT
HUM - HUMIDIFIER MODULATION
HUF - HUMIDIFIER FAULT
IRS - INVERTER RUN STATUS
LPCO - LOW PRESSURE CUTOUT
LTCO - LOW TEMPERATURE CUTOUT
PIFS - PUMP INVERTER FAULT STATUS
PRS - PUMP RUN STATUS
PSM - PUMP SPEED MODULATION
PWR - MOTOR POWER KWHR
SAFETY - HARDWIRED SAFETY INTERLOCKS
STS - GENERAL PLANT STATUS
SWT - SWITCH STATUS
SW - SOFTWARE INTERFACE
TWSM - THERMAL WHEEL SPEED MODULATION
TI - FIELD POINT WIRED TO INVERTER TERMINALS
TIX - IMMERSION TEMPERATURE SENSOR
TH - THERMISTOR SENSOR WIRING
TRS - TEMPERATURE ADJUSTMENT
TWX - SPACE TEMPERATURE SENSOR
TZ - FROST STAT TRIP
VOL - VOLUMETRIC FLOW RATE
VOL REST - VOLUMETRIC FLOW RATE RESET

AIR QUALITY SENSOR

AIR QUALITY SENSOR CARBON MONOXIDE

DIFFERENTIAL PRESSURE SWITCH

HIGH TEMPERATURE CUT OUT

PRESSURE DIFFERENTIAL SENSOR

MANUAL SPEED ADJUSTOR

TEMPERATURE SENSOR IN DUCT

TEMPERATURE SENSOR WATER

TEMPERATURE SENSOR FLOOR

TEMPERATURE SENSOR WITH USER ADJUSTABLE KNOB

TEMPERATURE SENSOR ON WALL

VOLUMETRIC FLOW METER MOUNTED IN FAN INLET

RELATIVE HUMIDITY SENSOR

HUMIDITY STAT

VOLUMETRIC FLOW METER

FROST STAT

LEVEL SWITCH

SMOKE DETECTOR

PASSIVE INFRARED SENSOR

STATIC PRESSURE SENSOR

STATIC PRESSURE SWITCH

HIGH PRESSURE CUT OUT

LOW PRESSURE CUT OUT

IMMERSION THERMOSTAT

LEVEL SWITCH LOW

LEVEL SWITCH HIGH

MOISTURE STAT

REFRIGERANT LEAK DETECTION SENSOR

1 ON LOAD LOCKABLE ISOLATOR
2 MCB TYPE C OR D RATED IN ACCORDANCE WITH DRIVE AND STARTING METHOD
3 FUSE PROTECTION
4 3-PHASE HEALTHY LAMPS
5 MID APPROVED - KILOWATT HOUR METER WITH INSTANTANEOUS AND ACCUMULATIVE READ OUT. AMPS AND VOLTS PER PHASE USING SOFT KEYS. (M-BUS/MODBUS/BACNET OUTPUT)
6 DIRECT ON LINE STARTER, WITH HAND RESET THERMAL OVERLOADS
7 STAR DELTA STARTER WITH HAND RESET THERMAL OVERLOADS
8 INVERTER DRIVE
9 CONTACTOR
10 METER AS ITEM 5 BUT CONNECTED TO THE BMS
11 MOTOR PHASE ANGLE SHIFT RELAY
13 DISTRIBUTION BOARD WITH MCBS FOR REMOTE PACKAGED EQUIPMENT
14 RELAY SECTION
15 TERMINAL SECTION FOR DRIVES
16 KWHR METER
17 CONTROLS TRANSFORMER
18 PUMP (FAN) 1/ PUMP (FAN) 2 SELECTOR SWITCH
19 HAND/OFF/AUTO SWITCH - (SYSTEM)
20 HAND/OFF/AUTO SWITCH - (INDIVIDUAL DRIVE)
21 OFF/AUTO SWITCH
22 RUN LAMP 'GREEN' (DRIVEN FROM BMS)
23 TRIP LAMP 'AMBER'
24 SYSTEM RUNNING LAMP 'GREEN'
25 HTCO LAMP
26 CHILLER HAND/OFF/AUTO SWITCH
27 PRESSURISATION UNIT FAULT LAMP 'AMBER'
28 RUN LAMP 'GREEN' derived from DPS OR inverter run signal
29 FAULT LAMP 'RED' driven from BMS
30 THYRISTOR
31 HUMIDIFIER OFF/AUTO SWITCH
32 FAULT
33 GAS VALVE 'CLOSED' LAMP (AMBER)
34 GAS VALVE 'RESET' PUSH BUTTON
35 BOILER FIRING
40 AUTOMATIC POWER TRANSFER SWITCH WITH MANUAL BYPASS
41 MAINS 1 AVAILABLE LAMP 'WHITE'
42 MAINS 2 AVAILABLE 'WHITE'
43 MAINS 1 SELECTED 'WHITE'
44 MAINS 2 SELECTED ' WHITE'
45 CONTROL CIRCUIT HEALTHY 'WHITE'
46 FIRE ACTIVE 'AMBER'
47 BMS (PLC) OUTSTATION
48 BMS (PLC) KEY/DISPLAY PANEL ON PANEL FASCIA
49 ALARM RESET BUTTON
50 LOW PRESSURE
51 SYSTEM COMMON ALARM LAMP 'AMBER'
52 GAS UPS
53 BMS (PLC) UPS
54 CONDENSER UNIT OFF/AUTO SWITCH
55 ANTI CONDENSATION HEATER AND THERMOSTAT
56 PUSH TO START BUTTON
57 PUSH TO STOP BUTTON
58 LAMP GROUP TEST BUTTON
59 INTERNAL PANEL LAMP
60 TANKA/TANKB/COMMON SELECTOR SWITCH
61 HARDWIRED TIMER TO HOLD GAS SYSTEM HEALTHY
62 AUTO/LOW SPEED/HIGH SPEED SWITCH WITH HARDWIRED TIMER FOR HIGH TO LOW SPEED
63 CO HIGH LEVEL INDICATION
64 FIREMANS OVERRIDE KEY SWITCH - AUTO/OFF/HIGH SPEED
65 MAINTENANCE SWITCH ON/OFF
66 FIRE ALARM TEST SWITCH
67 SOFT START
68 METER GATEWAY - MODBUS/M-BUS TO BACNET

LOCKABLE ON LOAD ISOLATOR
KEY RELEASE LOCK STOP BUTTON
TWIST TO RELEASE LOCK STOP BUTTON
INVERTER WITH ISOLATOR
PACKAGED STARTER PANEL WITH INTEGRAL AUTOCHANGE OVER
PACKAGED STARTER PANEL WITH INTEGRAL MOTOR PROTECTION

Important:

plotted: alan date: 10 May 2018 11:40:17

Notes:

Client

Project

Apartment

Production software

Autocad 2016

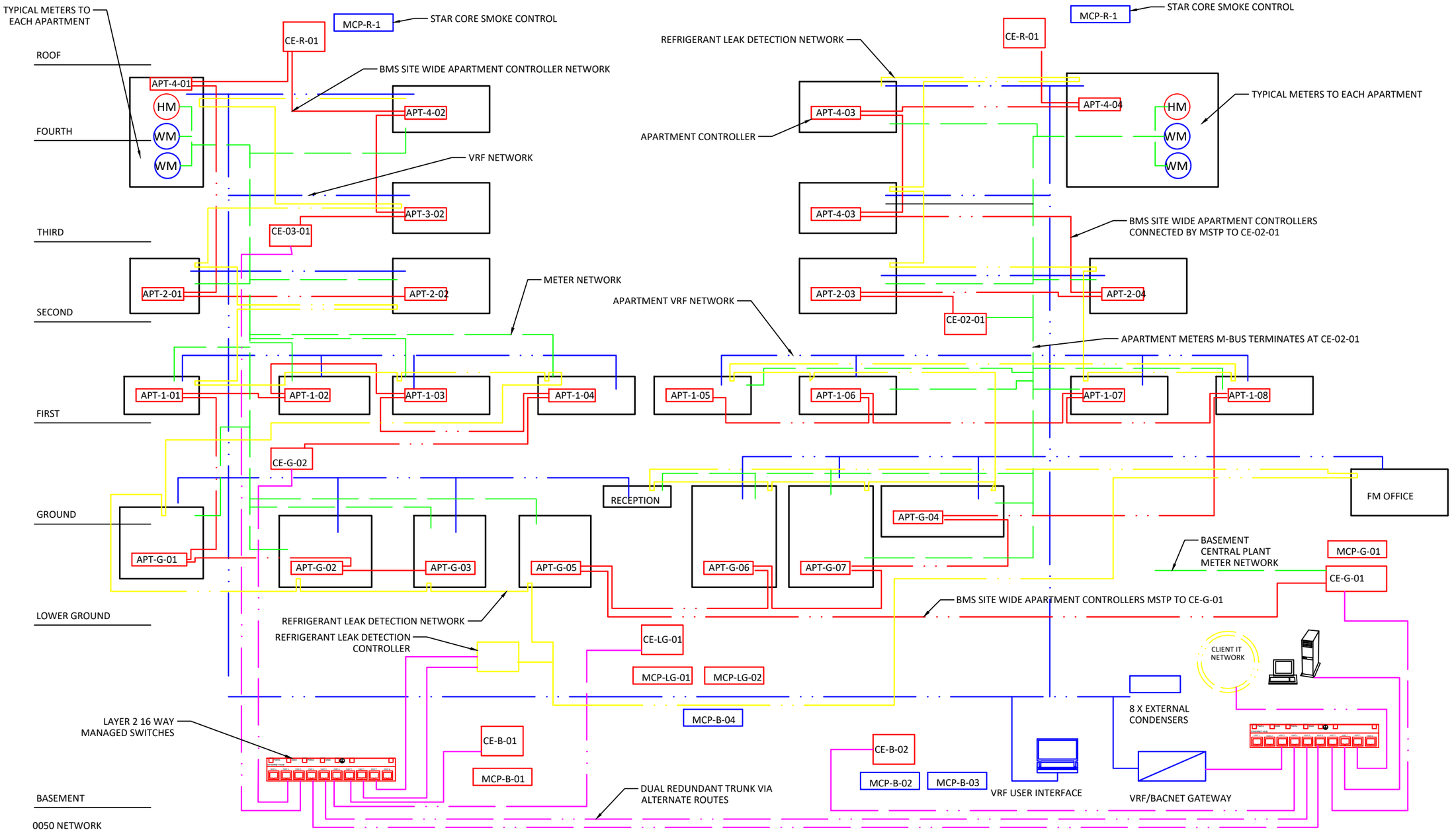
Status

Drawing title

Drawn Engineer Approved Date origin

Scale @ A3 File/BIM ref

Drawing number Revision



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Client

Project

Apartment

Production software

Autocad 2016

Status

Drawing title

Drawn Engineer Approved Date origin

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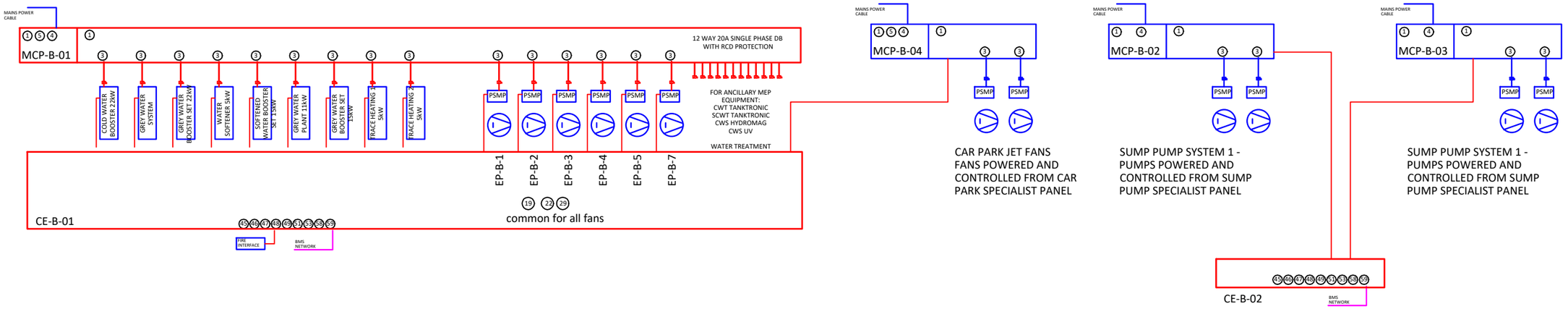

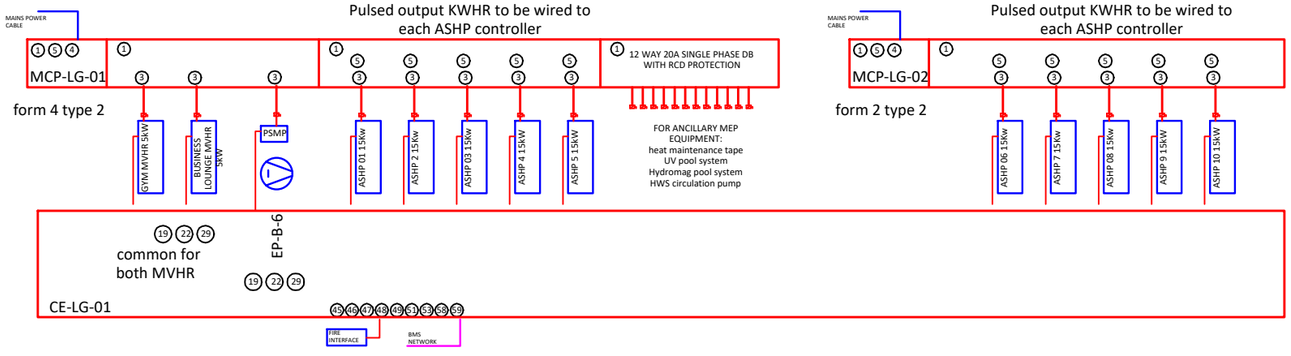

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Notes:

Client

Project

Apartment

Production software

Autocad 2016

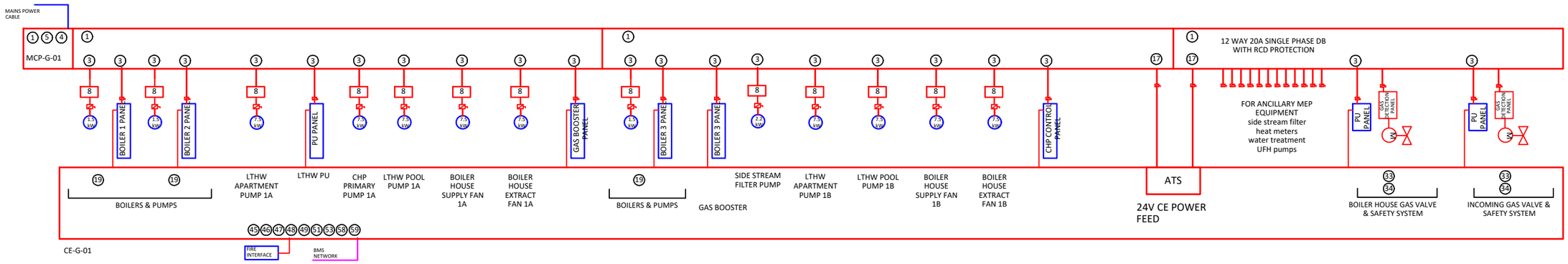
Status

Drawing title

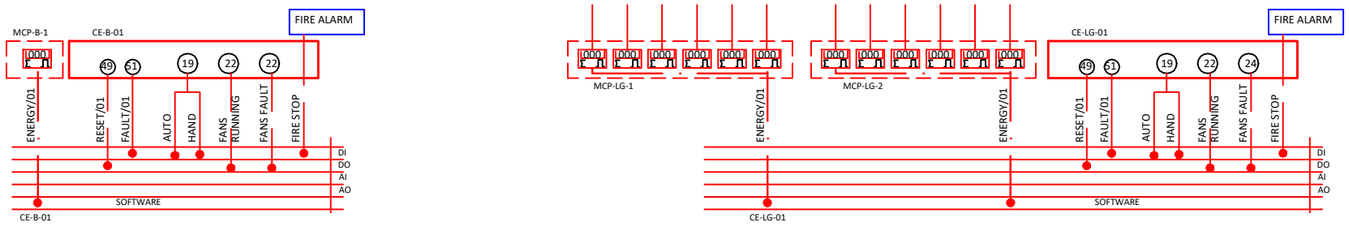
Drawn Engineer Approved Date origin

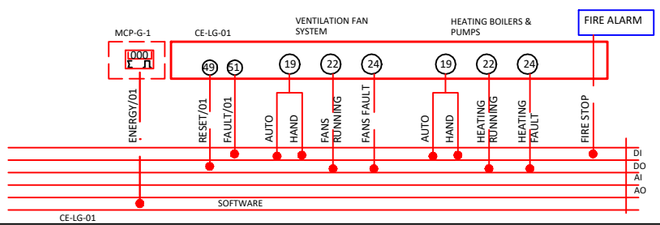
Scale @ A3 File/BIM ref

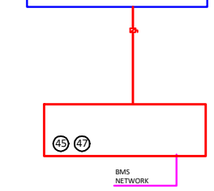
Drawing number Revision



PULSED OUTPUT WIRED TO EACH CONDENSER CONTROLLER



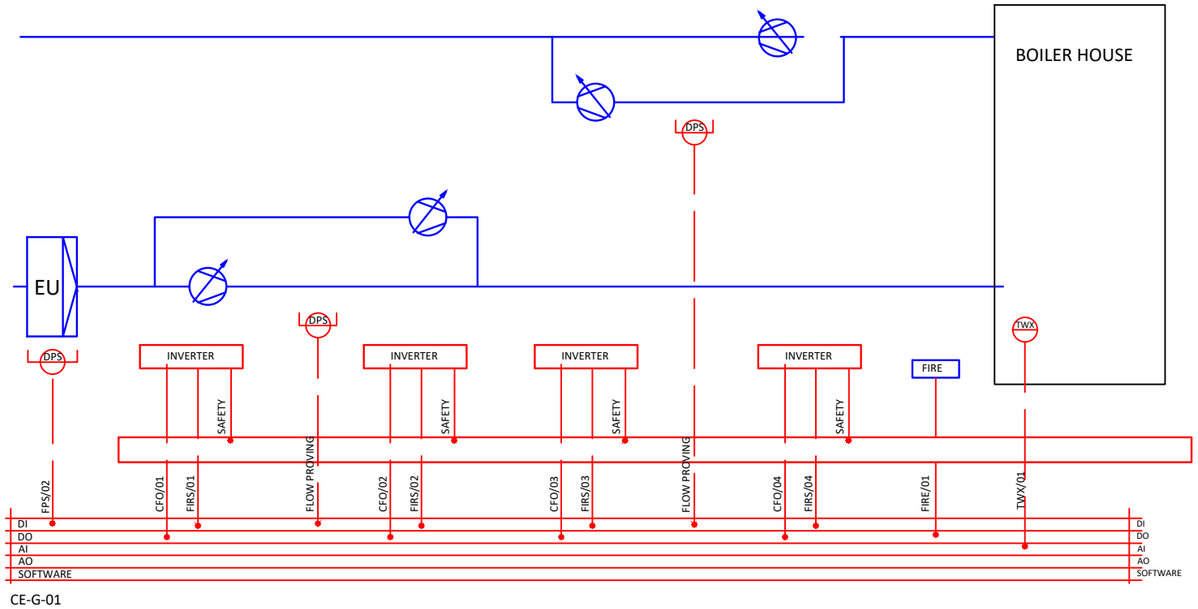




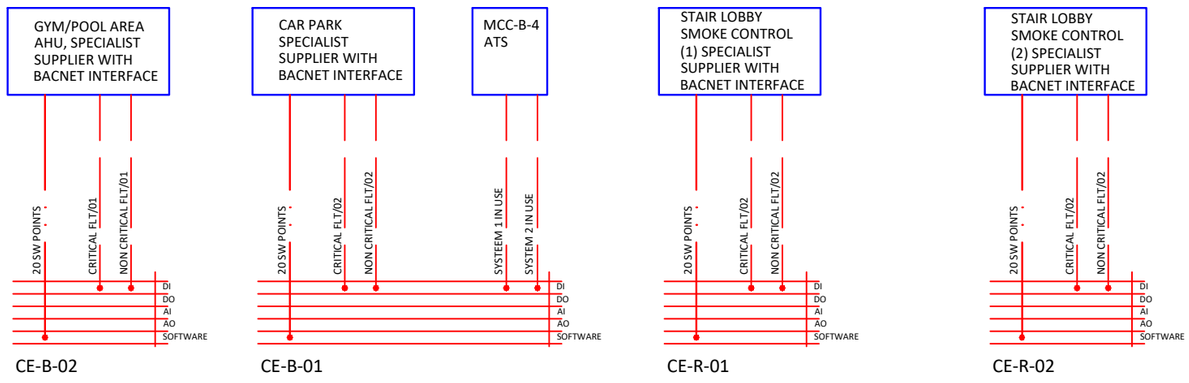
CE-04-01
CE-04-02
CE-03-01
CE-02-01
CE-B-02

0110 MCC

Important: plotted: alan date: 10 May 2018 11:40:30	Notes:		Client Project Apartment Production software Autocad 2016		Drawing title Drawn Engineer Approved Date origin Scale @ A3 File/BIM ref Drawing number Revision



CE-G-01



CE-B-02 CE-B-01 CE-R-01 CE-R-02

1110 - GENERAL VENTILATION

Important:

plotted: alan date: 10 May 2018 11:40:35

Notes:

Client

Project

Apartment

Production software

Autocad 2016

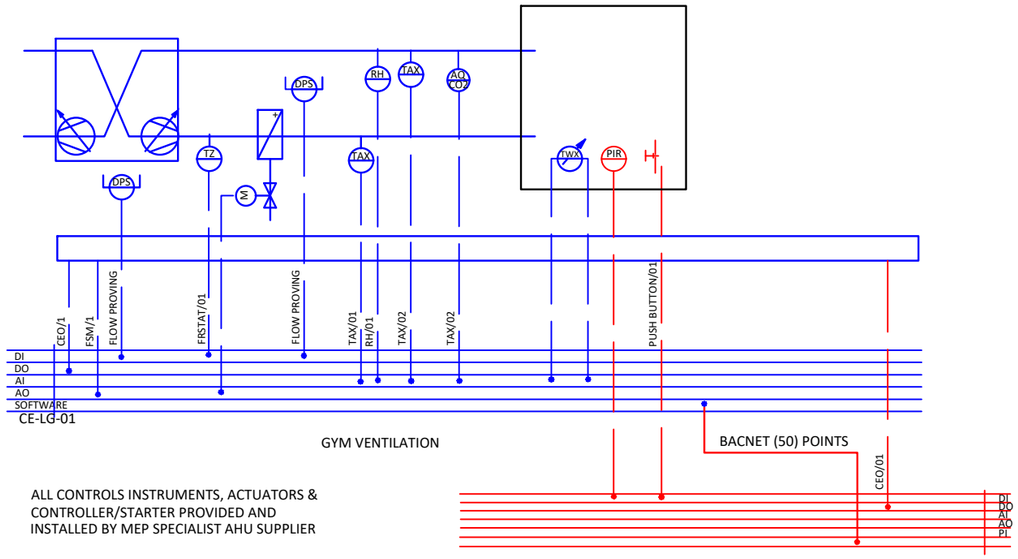
Status

Drawing title

Drawn Engineer Approved Date origin

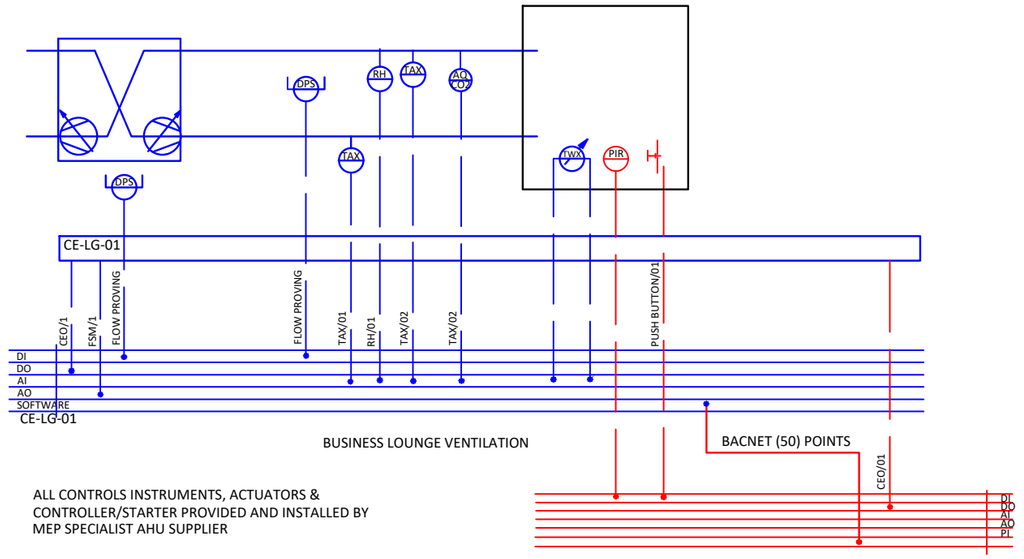
Scale @ A3 File/BIM ref

Drawing number Revision



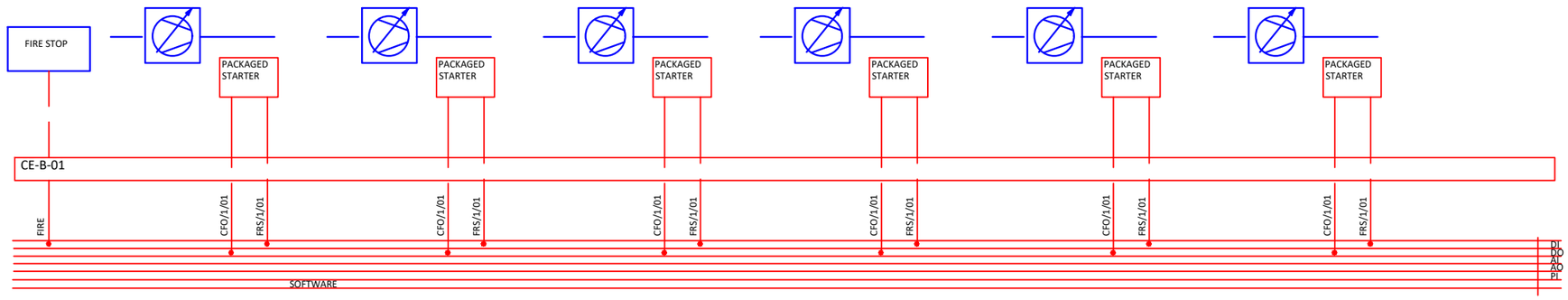
GYM VENTILATION

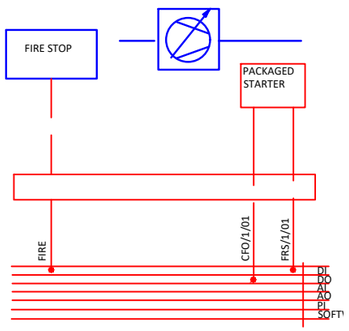
ALL CONTROLS INSTRUMENTS, ACTUATORS & CONTROLLER/STARTER PROVIDED AND INSTALLED BY MEP SPECIALIST AHU SUPPLIER



BUSINESS LOUNGE VENTILATION

ALL CONTROLS INSTRUMENTS, ACTUATORS & CONTROLLER/STARTER PROVIDED AND INSTALLED BY MEP SPECIALIST AHU SUPPLIER





1120 - GENERAL VENTILATION 2

Important:

plotted: alan date: 10 May 2018 11:40:40

Notes:

Client

Project

Apartment

Production software

Autocad 2016

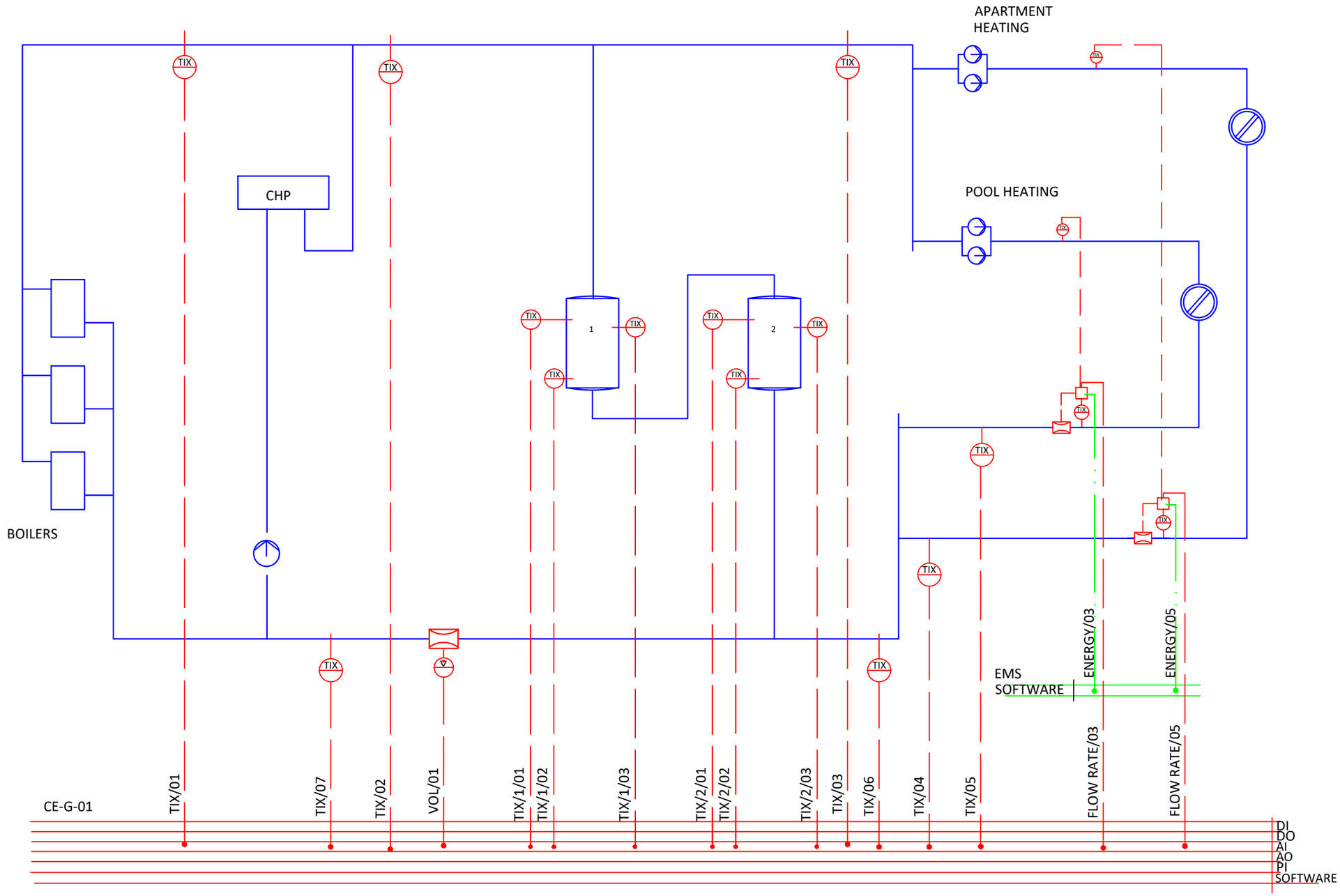
Status

Drawing title

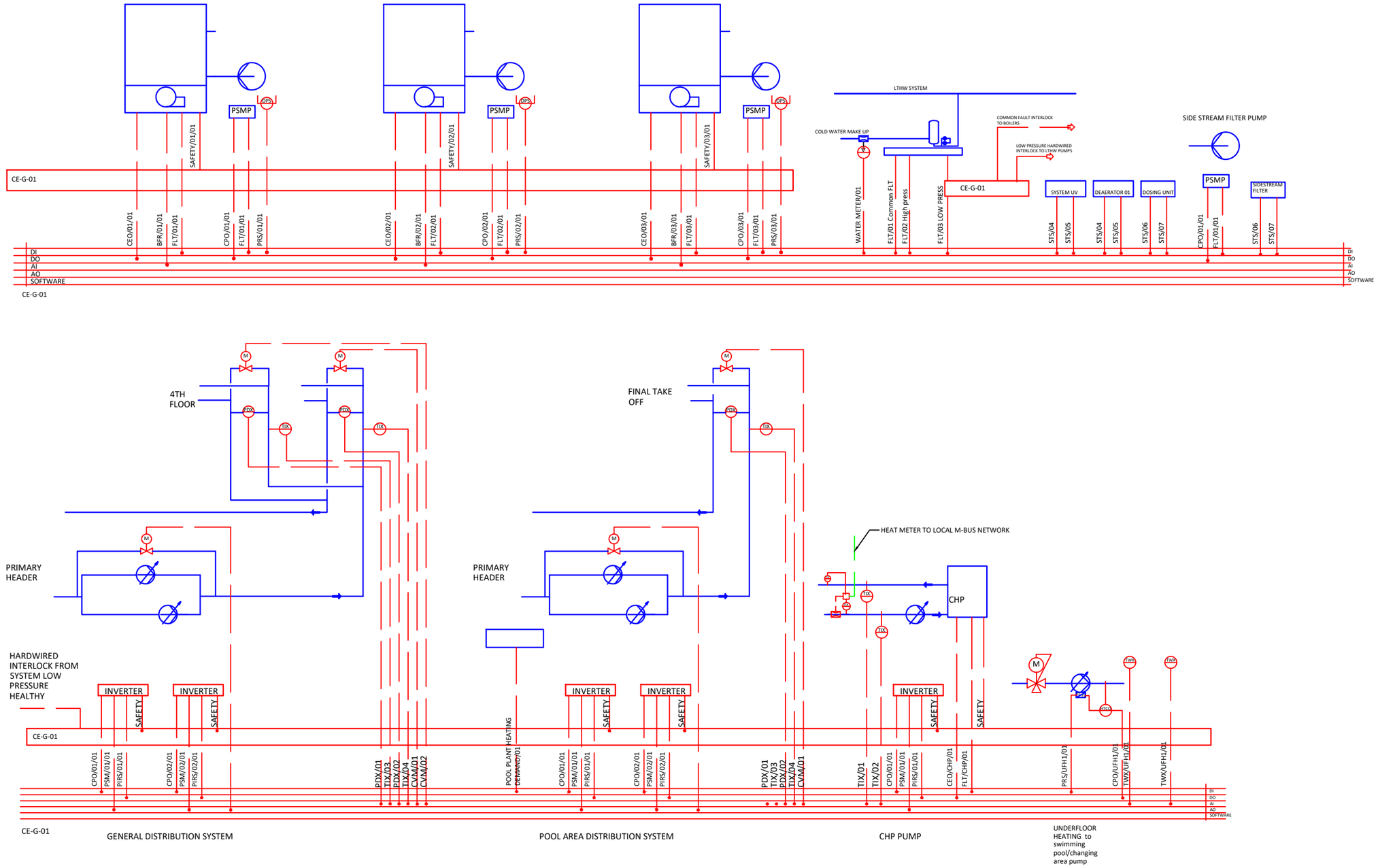
Drawn Engineer Approved Date origin

Scale @ A3 File/BIM ref

Drawing number Revision



Important: plotted: alan date: 10 May 2018 11:40:45	Notes:		Client Project Apartment Production software Autocad 2016	Status	Drawing title Drawn / Engineer / Approved / Date origin Scale @ A3 / File/BIM ref Drawing number / Revision



Important:

plotted: alan date: 10 May 2018 11:40:50

Notes:

Client

Project

Apartment

Production software

Autocad 2016

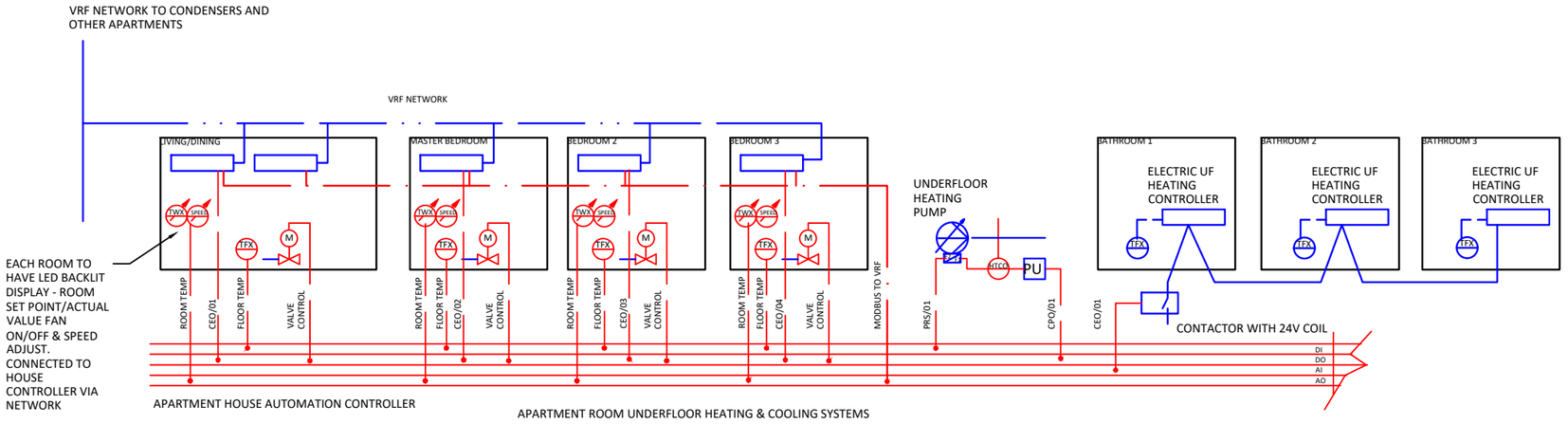
Status

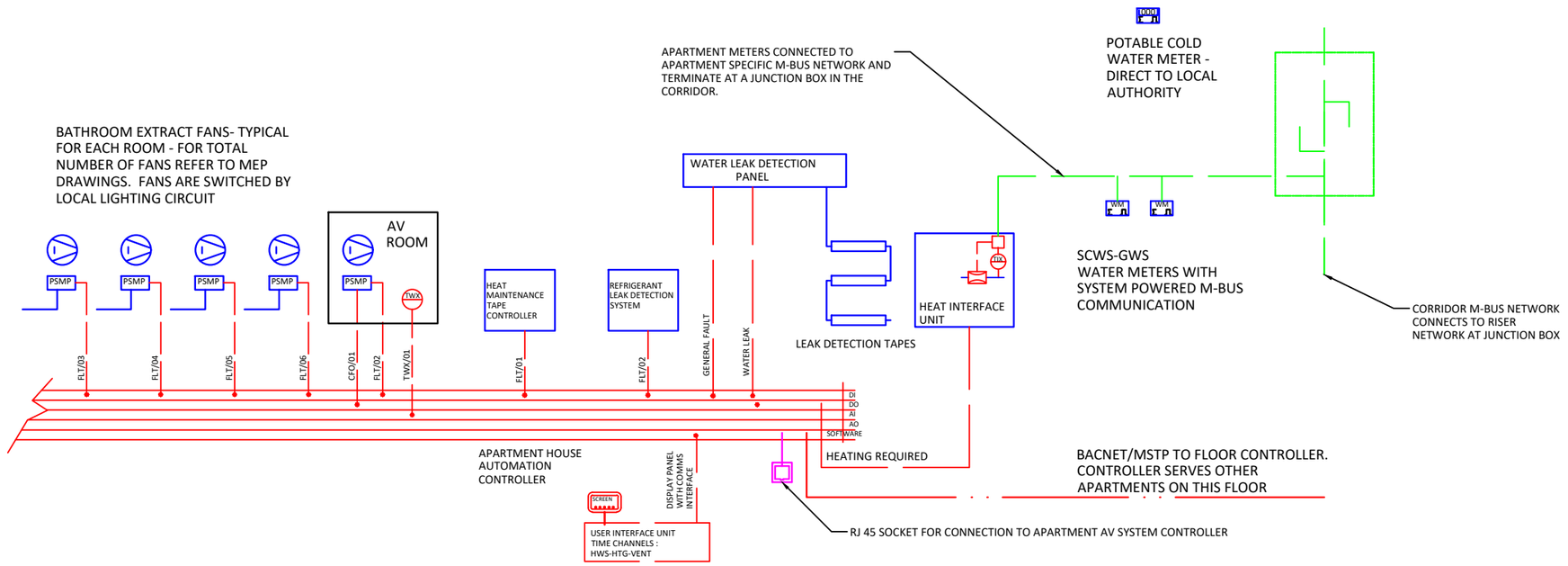
Drawing title

Drawn Engineer Approved Date origin

Scale @ A3 File/BIM ref

Drawing number Revision





Important:

plotted: alan date: 10 May 2018 11:40:55

Notes:

Client

Project

Apartment

Production software

Autocad 2016

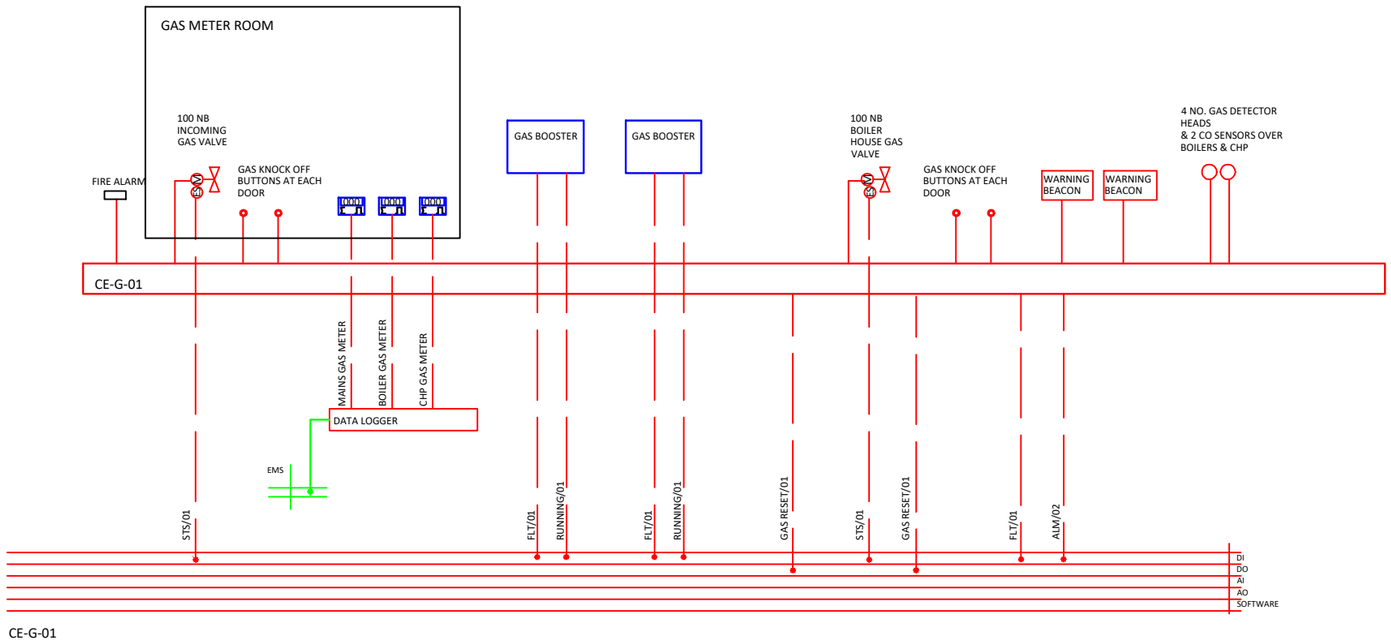
Status

Drawing title

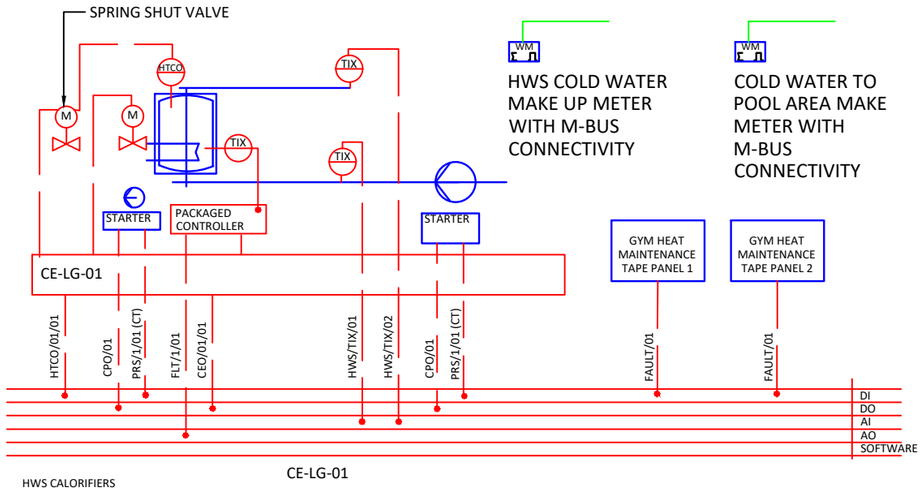
Drawn | Engineer | Approved | Date origin

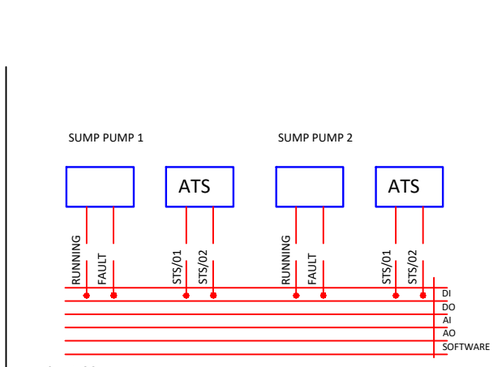
Scale @ A3 | File/BIM ref

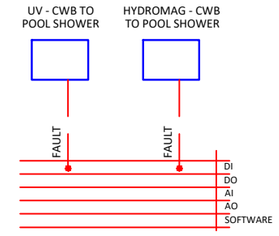
Drawing number | Revision

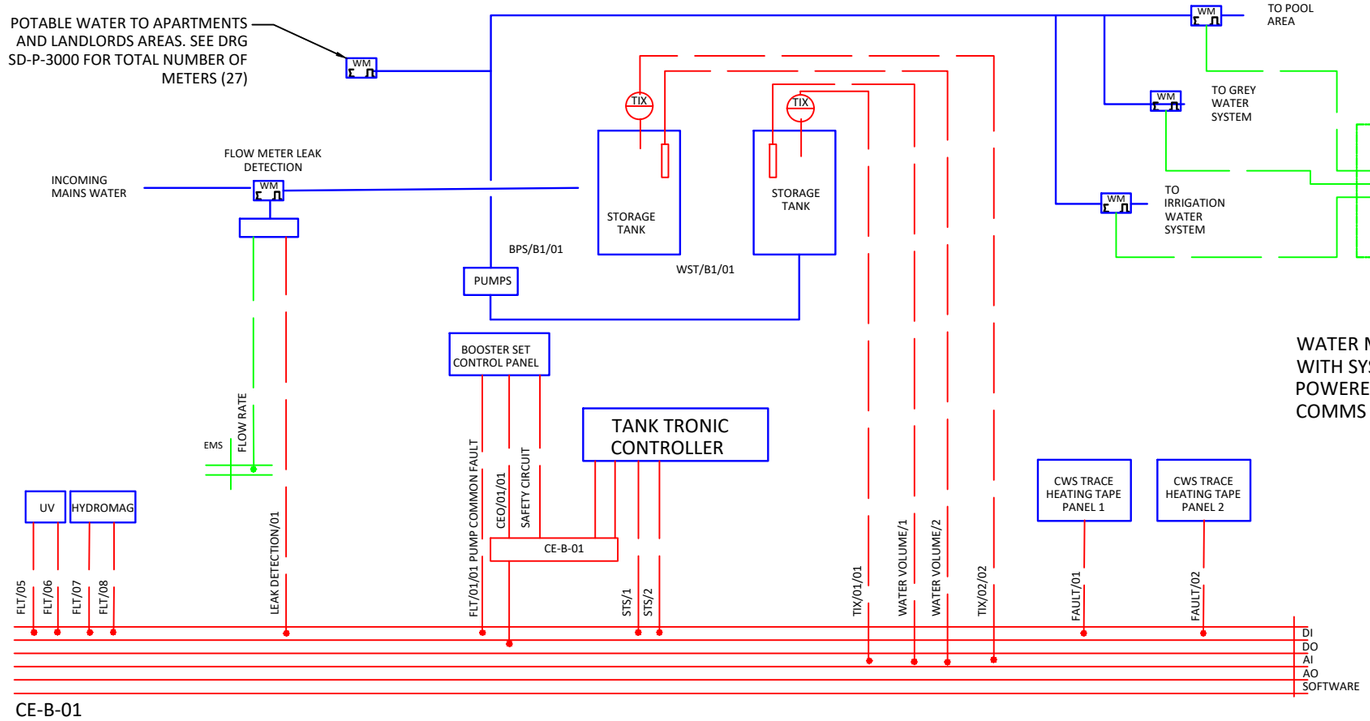


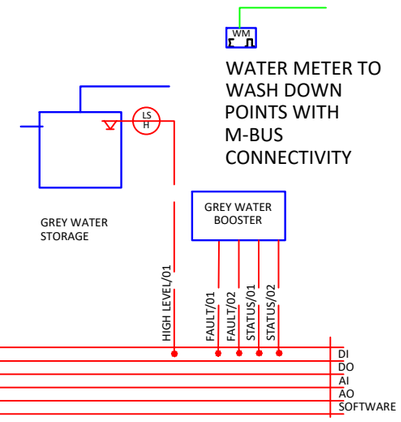
Important: plotted: alan date: 10 May 2018 11:41:00	Notes:		Client Project Apartment Production software Autocad 2016	Status	Drawing title Drawn Engineer Approved Date origin Scale @ A3 File/BIM ref Drawing number Revision

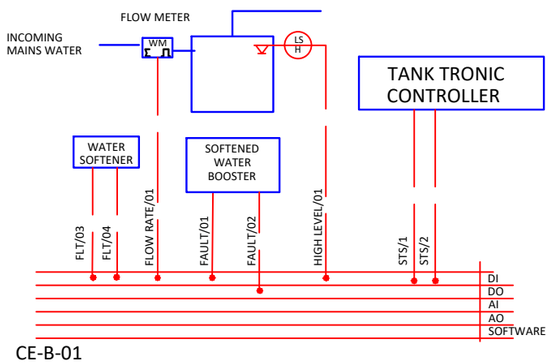












Important:

plotted: alan date: 10 May 2018 11:41:05

Notes:

Client

Project

Apartment

Production software

Autocad 2016

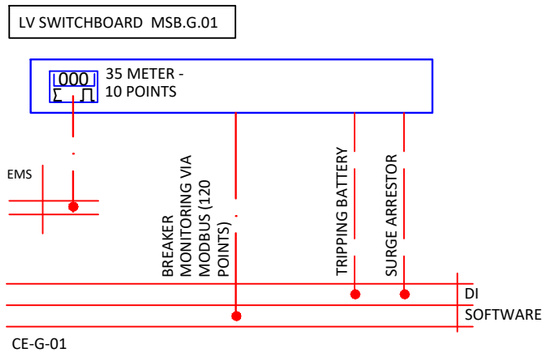
Status

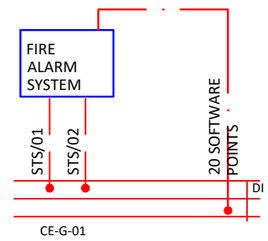
Drawing title

Drawn Engineer Approved Date origin

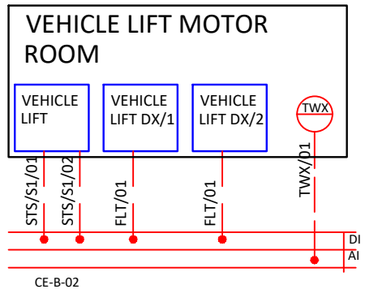
Scale @ A3 File/BIM ref

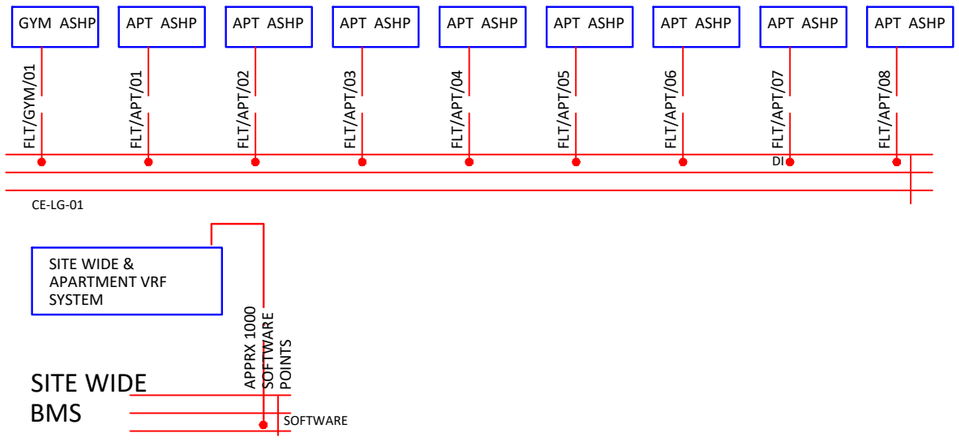
Drawing number Revision

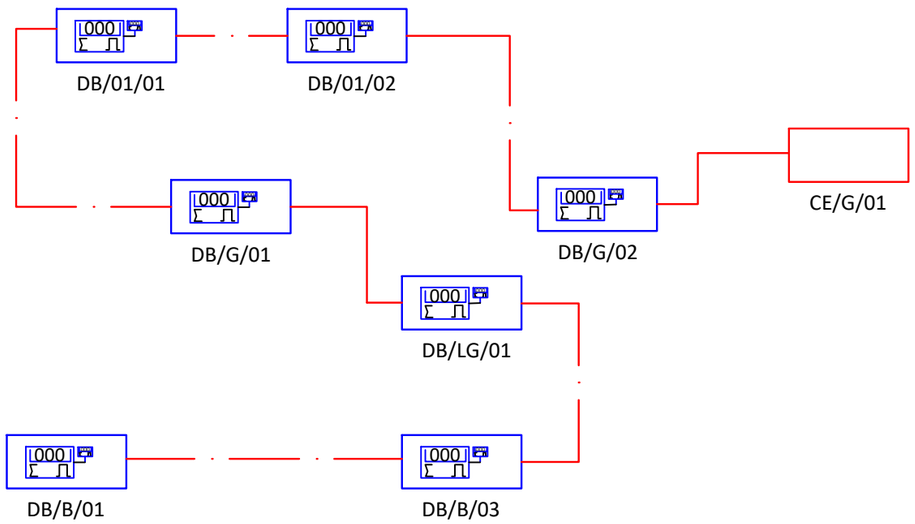


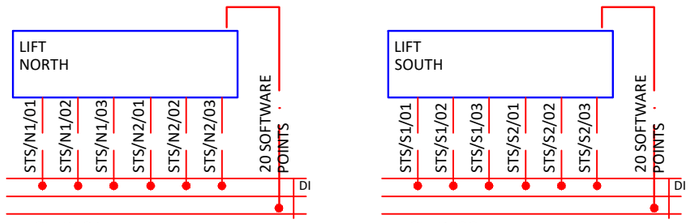


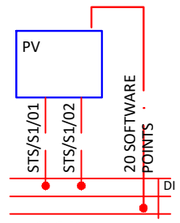
FIRE ALARM SYSTEM INCLUDES:
FIRE DETECTION STATUS (FAULT OR FIRE)
SPRINKLER SYSTEM STATUS
SPRINKLER SYSTEM ALL FLOW SWITCHES

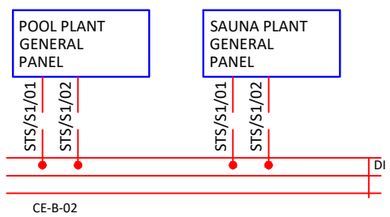




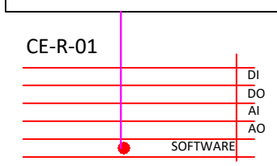








WEATHER STATION:
TEMPERATURE
HUMIDITY
WIND SPEED & DIRECTION
RAIN SENSOR
UV INDEX
BAROMETRIC PRESSURE
SOLAR RADIATION MEASUREMENT



Important:

plotted: alan date: 10 May 2018 11:41:10

Notes:

Client

Project

Apartment

Production software

Autocad 2016

54785

Status

Drawing title

Drawn Engineer Approved Date origin

Scale @ A3 File/BIM ref

Drawing number Revision