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Manchester City Council

Blackley Crematorium and Chapel | Decarbonisation Scheme

Mechanical, Electrical & Public Health Services Particular Specification

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1.0 Introduction

1.1 Description of the Project

This specification details the Mechanical, Electrical and Public health project specific requirements associated with the decarbonisation project at Blackley Cemetery building, owned and operated by Manchester City Council.

Key features of the project brief include meeting the Client overall brief to decarbonise their corporate estate with the target of achieving Net Zero Carbon status by 2038.

The scope of works generally comprise:

- The removal of gas fired boilers and associated plant to be replaced with new Air Source Heat Pumps (ASHPs) along with new buffer vessel(s) and controls
- New Primary heating infrastructure will be required to serve the primary side of system , this include new ASHP's and point use hot water being installed locally where applicable , this will replace the central hot water system .
- Improvements to the Building Management System (BMS) and controls
- Installation of new switchboard
- Installation of the new lighting within the air source heat pump enclosure

1.2 The Site

Blackley cemetery crematorium is located on Victoria Avenue, Blackley, Manchester M9 8JP. The crematorium is part of a larger site which also includes a cemetery office building. The cemetery office and crematorium are linked electrically, with the office building feeding the crematorium.

The figure below details aerial location of the area for the existing development.

1.4 The Project Team

The Project:
The particulars of the project as a whole are given in main contract preliminaries. Refer to the documentation for overall project details and requirements.

The Client
Equans
Neon
Q10 Quorum Business Park
Benton Lane
Newcastle Upon Tyne
NE12 8BU

Project Manager / Employers Agent (EA)
Drees & Sommer
Jackson House
Sibson Road
Sale
Manchester
M33 7RR

The Architect
TBA

Civil & Structural Engineers:
TBA

Building Services Consultant:
Crookes Walker Consulting (CWC) ltd
The Plaza
Old Hall Street
Liverpool
L3 9QJ
Tel: 0151 600 5409

Principal Designer
Drees & Sommer
Jackson House
Sibson Road
Sale
Manchester
M33 7RR

Quantity Surveyor/PQS:
Drees & Sommer
Jackson House
Sibson Road
Sale
Manchester
M33 7RR

1.5 MEP Services Tender Documentation Overview

The following CWC Documentation is provided as part of the M&E Services package of works:

M&E Services Particular specification (this specification document)
The M&E Services particular specification describing the specific works for the project. The specification comprises the following sections:

- Sections 1, 2 & 3 of this specification details the general conditions and general design information for this project by which the Contractor(s) (both Main, Electrical and Mechanical) shall adhere too
- Section 4 of this specification conveys the requirements relating to testing and commissioning and handover of the building services
- Section 5 of this specification conveys the requirements relating to the strip out of any existing redundant building services
- Section 6 & 7 of this specification of this specification conveys the criteria, which the Contractor(s) (both Electrical and Mechanical) shall adhere to in order to complete a fit for purpose detailed M & E services design and installation
- Section 8 of this specification provides the scheme appendices to be completed and returned by all tendering Contractors (both Electrical and Mechanical).

General Conditions / Preliminaries Specification
A separate standard preliminaries and general conditions relating to the provision of the building services generally.

M&E Workmanship & Materials Specification(s)
A separate standard workmanship specification for the Mechanical and Electrical services has been issued as part of the tender package and form part of the scheme requirements.

Tender Drawings

A series of M&E services drawings accompany the tender package detailing the specific content of works to be undertaken by the Contractor(s) and the proposed plant selections.

Refer to the accompanying document issue sheet for the complete list of all documentation forming part of the M&E services scheme.

This documentation shall also be read in conjunction with the following Project Design Information prepared by the Technical Team consisting of:

- Main Contract Documentation.
- Health and Safety advisor reports and risk assessments.
- Specialists Reports
- Survey Drawings
- Architectural Information
- Structural and Civils Information

The Contractor(s) shall be responsible for ensuring they obtain the latest revisions of this information in order to coordinate the works packages. The Contractor(s) shall notify the PM/EA and CE in writing if any discrepancies appear between various sources of information noted above before submitting a Tender.

2.0 Scope of Works and Related Services

2.1 General

The works pertaining to the MEP services generally comprises the strip out of existing and installation of new mechanical and electrical services.

The concise services brief established through discussions with the Client is outlined below:

- Design to ensure a low energy design and operation whilst meeting the peak and continuous heating and hot water demands of the building and internal illumination levels.
- Simple to use and maintain systems that offer innovation and meet the agreed capital budgets whilst offering a high market value.
- Meet all current relevant standards and regulations as well as the stipulated design criteria.

The Contractor(s) together with the Main Contractor shall look to approach the M&E installation works in an innovative and progressive manner. The servicing strategies contained within this documentation outline the proposals that the appointed Contractor shall adhere to as part of the works.

The Contractor(s) is free to offer alternative solutions that meet the high-level Engineering Brief, as well as the specific design parameters contained within each work section, in order that alternative, progressive, energy efficient designs may be considered for incorporation into the scheme. Where alternatives are proposed, these shall be communicated with the Consulting Engineer and Client, who retain the right to refuse any alternative proposals that do not offer a solution of equal quality and performance.

The approach to installation works shall be a holistic one and focus on practicability for maintenance, functionality, and marketability as well as the Client/Employer's and End User/Operator requirements. The Client, EA and CE reserve the right to veto any proposals by the Contractor should they be deemed to unduly affect the operational and/or marketable nature of the building in terms of design, construction, and maintenance liability or where the alternative deviates from the established brief.

2.2 The Programme of Works

The Contractor's attention is drawn to the requirements of the Main Contract Programme. The Contractor shall liaise with the Main Contractor to produce a detailed integrated programme of works that is compliant with the requirements of the Main Contract Programme. This shall include commissioning, soft-landings, handover, and seasonal commissioning.

The Contractor shall also refer to any phasing or sectional handover requirements outlined within the Main Contractor's programme.

2.3 Services Strategy Overview

The summary scope of works includes in the below table.

Services	Notes
Existing services strip out	Primarily to provide safe strip out of existing power supplies, lighting, gas fired heating and hot water generating plant and heating distribution pipework and emitters which will become redundant or to facilitate the new installation works.
Low Voltage Power Distribution	A new switchboard is to be installed to accommodate the additional supplies as part of this project
Small Power and outlets	New supplies to air source heat pumps and associated plant.
General and Emergency Lighting	Provide new emergency lighting within the air source heat pump compound
External Lighting	External lighting to be provided for maintenance of new external ASHP equipment.
Fire Detection and Alarm	Provide amended fire detection systems and interfaces to suit the works and ensure a fully functional fire detection and alarm system that complies with BS 5839-1 and the building fire strategy.
Domestic hot water	Domestic hot water via be electric point of use system where shown on drawings
Heating	ASHP systems to generate heat for use in space heating. New heating pipework distribution and emitters to suit the ASHP operating conditions.
BMS	Provided updated BMS to accommodate the ASHP technology.

General Works:

- Detailed production of coordinated working drawings including accurate setting out.
- Testing and commissioning.
- Training, aftercare, handover including O&M's following a soft landings approach.

2.4 Definitions

The following definitions shall apply throughout this document:

CE The Consulting Engineer acting for the Client (in this case) in preparing this tender documentation on behalf of the Client responsible up to Workstage 4a Services Design Stage. (CE in this case refers to CWC - Refer to information production tracker for full list of responsibilities)

Provide Shall be taken to mean all activities required to complete all or part of the works. The term "provide" shall normally include design, procurement, delivery, unloading, storage, erection, installation, setting to work, testing, commissioning, performance testing, documentation and warranty.

Electrical Contractor the Electrical Contractor instructed to provide the Building Services Installations and the production of the O&M manuals etc

Mechanical Contractor the Mechanical Contractor instructed to provide the Building Services Installations and the production of the O&M manuals etc

Sub-Contractor (s)/Contractor/Contractor(s) A generic term which would apply to both Electrical and Mechanical Contractors as necessary. Clauses with this term are relevant to both Electrical and Mechanical Contractors equally.

Main Contractor the Contractor employed to carry out the total building works. The "Contractor(s)" shall be a sub-Contractor to the "Main Contractor". The Main Contractor shall act as Principal Designer and Contractor as part of the works.

Specialist Sub-Contractor Any Sub-Contractor employed by the Contractor(s) or Main Constrictor to carry out specialist services.

Independent Commissioning Specialist (ICS) A third party specialist contractor appointed by the Main Contractor to manage the MEP Services commissioning in accordance with the specification

EA Employer's Agent or Client Representative

Client the Client team and stakeholder alike.

Landlord/Building Operator(s) The person(s) responsible for building maintenance

End User / Tenant The occupiers of the buildings.

2.5 Health and Safety & CDM 2015 Regulations

The pre-tender health and safety plan:
This section shall be read in conjunction with the Pre-construction Health and Safety Plan.

This project is being undertaken in accordance with the Construction (Design and Management) Regulations 2015. The Mechanical and Electrical Services Sub-Contractor shall be a "Designer" and "Contractor(s)" as defined in these Regulations. The Contractor shall provide both the Design & Construction Phase Health & Safety Risk Assessments.

Details of the Pre-tender health and safety plan are included in the Main Contract Preliminaries.

CDM Regulations 2015
The successful Main Contractor will be appointed by the Employer as the Principal Contractor to undertake the duties and responsibilities as laid down in the Construction (Design and Management) Regulations 2015 (CDM -2015).

The Main Contractor/Contractor shall allow adequate costs and resources within his tender for exercising his statutory duties under the regulations and for adequate liaison with the Client, and their appointed CDM Co-ordinator / Health and Safety advisor as necessary.

The Principal Contractor shall include for the following duties notwithstanding their responsibilities and duty of care under Health and Safety Law and Common Tort.

The Principal Contractor's key duties are as a minimum to include:

1. Develop and implement the Health and Safety Plan.
2. Arrange for a competent and adequately resourced Contractor(s) to carry out the design sub-contract work.

3. Undertake the detailed design in a manner that prioritises the health and safety for operatives / personnel in relation to the safe installation, commissioning, maintenance and removal of building services.
4. Ensure the co-ordination and co-operation of the Contractor(s) and design team members.
5. Obtain from the Contractor the main findings of their risk assessments and details of how they intend to carry out high risk operations.
6. Ensure that the Contractor has information about risks on site.
7. Ensure that workers on site have been given adequate training.
8. Ensure that the Contractor and workers comply with any site rules which may have been set out in the Health and Safety Plan.
9. Monitor health and safety performance.
10. Ensure that all workers are properly informed and consulted.
11. Make sure only authorised people are allowed onto site.
12. Display the notification of the project to the Health and Safety Executive.
13. Pass information to the CDM Co-ordinator for the Health and Safety file.

The Contractor's attention is drawn to the following Regulations, Approved Code of Practice and general guidance notes available from HSE Books.

1. Statutory Instrument Health and Safety.
2. The Construction (Design and Management) Regulations 2015
3. Managing Construction for Health and Safety.

Risks to health and safety & CDM Regulations:
The Contractor(s) shall note the following significant Hazards or Risks identified to date (regarding the works they are specifically involved in) which cannot be avoided or designed out. This information is provided here for ease of reference and is not intended to replace the much more detailed information given in the Health and Safety Plans. Whilst these hazards and works sequences cannot be avoided, they can generally be reduced/controlled by standard and special management and constructional procedures as noted.

Refer to appended CDM M&E Services pack for M&E residual hazards together with the pre-construction Health and safety package for complete CDM requirements and details.

Given the nature of this particular building, the accuracy and sufficiency of this information is not guaranteed at this stage of the design. The Contractor(s) shall ascertain for themselves any information they may require in order to ensure the safety of all persons and the Works as well as CDM Regulations 2015.

The Contractor(s) shall comply with the requirements of the CDM Regulations by:

1. Adhering to the rules of the Pre-Construction Information and Construction Phase Plan.
2. Reporting accidents, injuries or dangerous occurrences to the Main Contractor.
3. Providing the Main Contractor with appropriate input to the Health and Safety Plan, including risk assessments, and to the Health and Safety File.
4. Providing the Main Contractor with information on the subcontract works which might affect the health or safety of any person.

The Contractor shall ensure they are issued with a copy of the relevant sections of the Pre-Design and Construction Phase Health and Safety Plans by the CDM-Coordinator / Principal Contractor prior to commencing the relevant stages of their works. The Contractor(s) shall be deemed to have included for all safety procedures outlined within that document and the CWC CDM M&E pack, noted below and/or required by the scope of works described herein.

Unforeseen eventualities

In the event of any unforeseen eventuality arising which has an effect on health and safety, the Contractor(s) is to immediately cease operations after safe site conditions have been achieved to the best of his ability and simultaneously notify the PM and all other appropriate personnel.

Overlap with statutory undertakings

The site services installations where under the control of the Statutory Bodies require particular care to be exercised by the Contractor(s) to ensure that there are no gaps or overlaps in terms of responsibility for safety as well as the content of the works. The Contractor(s) shall ensure that there is a clear understanding of responsibility for safety prior to carrying out works to or close to services under the Statutory Bodies control.

In order to define the spilt of responsibility the Contractor(s) shall propose a Permit to Work system for works to key electrical, water and gas installations. This Permit to Work system is to be approved by the Main Contractor to its introduction. No works to electrical or gas installations are to commence without the appropriate permit being issued in the agreed manner.

2.6 Access and Maintenance

All plant and equipment shall be installed in accordance with the relevant manufacturers' recommendations and guidance, ensuring safe access/egress during installation, commissioning, maintenance, and life cycle replacement.

The access and maintenance strategy provided by the design team shall be developed by the Contractor in accordance with the Workstage 4b, 4c technical design through Workstage's 5 – 6.

3.0 Design Criteria and Standards

3.1 General Codes and Standards

The complete MEP Services installation shall be designed, supplied, installed, tested, commissioned and set to work by the Contractor. The following associated documents shall be utilised, but shall not be limited to, when carrying out all aspects of the design and installation:

- The Health & Safety at Work Acct 1974
- Construction (Design & Management) Regulations 2015
- IET Regulations for Electrical Installations (BS 7671)
- The COSHH Regulations
- The Clean Air Act
- The Environmental Protection Act
- The Public Health Act
- British Standards Institution Publications and appropriate ISO or CEN/CENELEC Standard
- The Electricity at Work Regulations
- ErP legislation
- The Water Supply (Water Fittings) Regulations 1999
- Pressure Systems Safety Regulations 2000
- Institution of Gas Engineers and Managers (IGEM) technical standards
- Relevant British Standard Specification and Codes of Practice
- Building Regulations and the associated 2nd tier Approved Documents
- Requirements and recommendations of Building Control Body / Approved Inspector / Local Fire Officer
- Requirements of any insurance companies concerned
- Were no specific design, performance or installation standards are quoted the following shall apply.
    - CIBSE Guidebooks
    - Guide A Environmental design
    - Guide B Heating, Ventilating, Air Conditioning and Refrigeration
    - Guide C Reference data
    - CIBSE Code for Lighting.
    - CIBSE Technical Memoranda.
    - Institute of Plumbing - Plumbing Engineering Services Design Guide

In all instances, the latest revision and/or amendments to the above publications / regulations / recommendations shall be utilised.

3.2 General Design Criteria

The general design criteria listed below apply and shall be read in conjunction with the project specific work sections as well as the general conditions specification and accompanying design drawings.

Mechanical & Public Health Services

The mechanical services are designed in accordance with the following key systems design criteria:

External Design Temperature

- Winter -5°C, saturated

Internal Design Temperatures

- Offices / Meeting Rooms 21°C (minimum)
- Chapel areas 21°C (minimum)
- Reception 21°C (minimum)
- Circulation 19°C (minimum)
- WC's 19°C (minimum)
- Kitchens 16°C (minimum)
- Store Rooms 12°C (minimum)

Electrical Services

The electrical services are designed in accordance with the following key systems design criteria:

Plant Area lighting (as per BS EN 12464-1)

- Maintained Ave. Illuminance 100 lux @ FFL
- Uniformity 0.4
- Colour rendering index 40
- Glare Rating (limiting) 45

All electrical services shall be designed in accordance with the latest edition of BS 7671 and the following, but not limited to:

Systems	Standard
Fire alarm	BS EN 54 BS 5839 BS 9999
Emergency Lighting	BS 5266 BS EN 1838
External Lighting	BS 5489 BS 12464-2
Lightning Protection	BS EN 62305
LV Distribution	BS 7671

3.3 Contractor Responsibilities

The Contractor(s) shall be responsible for:

- Workstage 4(ii) through 5, 6 and 7 inclusively, including relevant Contactor detailed design portions, production of coordinated working drawings, setting out and installation of the complete MEP Services and systems.
- Coordination and Liaison with other Contractors and design team members
- Coordination and Liaison with Any Specialist Sub-Contractors
- Liaison with the Architect and Structural Engineer
- Coordination and Liaison with the Client and/or their representatives regarding the final positioning of all Specialist Equipment and any associated Contractor attendances
- Coordination of and liaison with incoming services providers/third parties

The Contractor(s) shall also be responsible for:

- Production of all design drawings and calculations where assigned design responsibility for the relevant works for approval by the Client, their representatives and Consulting Engineer
- Complying with Building Regulations.
- Statutory submissions in order to meet the requirements of Building Regulations, Planning and the Client / Funding stakeholders and insurers
- Detailing / setting out of all builders' work in connection with the services
- Co-ordination with the Architect, Structural Engineer and other sub-contractors
- Testing and commissioning including seasonal commissioning and soft landings
- Training of End user and site maintenance and building operational staff
- Providing the necessary contract warranties
- O&M information including 'as fitted' drawings
- Compiling the asset register of all MEP plant and equipment

A list of specific technical submittals for each system to be submitted by the Contractor is included in the relevant work section.

In addition to the summary provided within this section of the specification, refer to individual work sections and the Main Contract documentation for full details of responsibilities.

Contractor Intrusive Surveys

Prior to undertaking any procurement and installation works, in order to gain a full understanding of the existing relevant systems with respect the proposed works, the

Contractor shall undertake intrusive condition surveys for the key systems and equipment as described below:

- General
  - Review of existing risers and ceiling voids for the relevant areas of works to establish any significant constraints that may affect the proposed installation works (e.g. structural steelwork concealed in voids etc).
  - Review of existing external areas to confirm design proposals.
- Mechanical Systems
  - Verification of the existing LTHW heating system to establish the existing concealed pipework distribution routes and zoning strategy and verify the extent of the proposed strip out works, including the boiler(s) natural gas pipework and flues.
- Electrical Systems
  - Verification of the existing incoming electrical infrastructure to establish and verify the extent of the proposed upgrade works.
  - Verification of existing small power and lighting system(s) to establish and verify the extent of the proposed strip out works.
- Deliverables/Outputs
  - Summary written report of findings for each service listed above including input from the relevant specialists identified. Where services are to be retained and require remedial works budget costs shall also be provided within the report.

Photos of all relevant retained services to demonstrate condition shall be undertaken.

Access Requirements

The Contractor shall include for all access requirements such as cranage and working platforms in order to undertake and complete the works in a safe manner and in accordance with HSE and CDM Regulations. All off-loading to be included.

The Contractor shall provide confirmation that all access requirements have been included within their tender.

Builder's work

The Contractor shall ensure that all builders work penetrations are identified early and accurately by the Mechanical and Electrical Contractor. The Contractor shall be responsible for detailing all builders work requirements associated with the installation as detailed within this specification.

The Mechanical and Electrical Contractor shall produce builders work drawings that show the requirements for building works necessary to facilitate the installation (other than where it is appropriate to mark out on site). This shall include the detailing / setting out of all holes through structural walls / slabs, through brickwork/ blockwork (where a lintel may be necessary) and through roofs. The final location of all builder's work openings shall be agreed with the design team.

The Main Contractor shall be responsible for cutting away and making good of all builder's work required as all providing all necessary fire stopping (including testing/ certification, etc.) in order to maintain all necessary fire compartmentation strategies.

Materials & Workmanship

All materials and equipment shall be new of the best quality, most suitable for the purpose specified and shall comply with all relevant British and European Standards Specifications. They shall be fully capable of withstanding variations of temperature and humidity arising under working conditions without distortion or deterioration or the setting up of undue stress in any part, and without affecting the suitability of the various parts of the works with which they have to perform.

The CE reserves the right to reject any part of the installation which is of inferior quality / standard, and which does not comply with the complete specification, in which case the Contractor shall carry out the necessary remedial work at his own expense, and without delay to the contract.

The complete works shall be carried out with due regard to the needs of inspection, cleaning, repair, replacement and the satisfactory operation under sudden variations of temperature, loading etc., as may be met under working conditions.

Co-ordination with Other Trades

In all areas such as false ceilings, builders work ducts, behind panels, in service corridors, at roof level and any other location where differing services are run in close proximity, the Contractor shall ensure that all services do not in any way impair or prevent the installation of other services.

The Contractor(s) shall also give attention to the requirement for the careful co-ordination of the services installation within the corridor.

Any alterations to the Contractor's installations due to the lack of co-ordination on his part with other trades shall be carried out by the Contractor at no additional cost to the Contract.

M&E Obsolescence

The Contractor shall ensure all M&E equipment supplied for this project shall continue to be supported by the supplier for a minimum of 10 years and shall be the most recent version of the equipment offered. 'Supported' means that spare parts, consumables, software support and technical literature, etc., shall be available for at least 10 years following completion of the project.

Maintenance and Spares

When pricing the Tender, the Contractor is to allow for the first year's maintenance of all systems installed as part of this contract. This maintenance shall include for all routine and preventative maintenance required, on a fully inclusive basis, and allow for all costs including parts and labour.

The period of maintenance shall be 12 months, with a cost option for 5 years, from date of the Practical Completion certificate.

The Mechanical and Public Health services shall be designed with due regard for future maintenance. While sizing plant the Contractor shall consider the replacement and inspection and the application of standardised components wherever possible. All health and safety risks to maintenance operatives shall be mitigated as far as is practicable, and detailed method statements will be included within the O&M manuals for all maintenance activities.

The Contractor shall provide a cost option for all consumables and necessary spares in his tender to affect the requirements of first 12 months' maintenance

Plant Replacement and Maintenance

All heavy parts of plant shall be provided with some convenient means of slinging or handling during erection or overhaul and items requiring extraordinary arrangements for removal, or for maintenance purposes, shall be clearly identifiable. Detailed method statements describing the procedures required to carry out such works shall be included within the O&M manuals.

The Contractor shall allow in his tender for ensuring that all equipment which may require dismantling for normal routine maintenance purposes can be readily undertaken and the Contractor may be required to prove that dismantling and re-assembling can be carried out with a minimum amount of external work.

Where required, the Contractor must be able to demonstrate that all plant and equipment can be removed for replacement / maintenance purposes and subsequently re-installed. The Contractor is to ensure that adequate space around plant and equipment is provided to allow for maintenance undertaken in situ. The

Contractor must ensure that maintenance space is provided in accordance with the manufacturer's instructions.

Defects Liability

The Contractor is responsible for making good any defect in, or damage to, any portion of the works which may develop during a period of twelve months (or as detailed in the Main Contract preliminaries) after practical completion of the Main Contract; and which may arise from defective materials, workmanship, or from any act or omission by the Contractor during the maintenance period. The Contractor shall handle all defects within the time period identified by the EA and as identified in the Main Contract Preliminaries.

Defects of an urgent nature as deemed by the EA, shall be dealt with the same day they are discovered, irrespective of the day or time. Urgent defects shall be those that, in the opinion of the EA, either present a health and safety hazard or that prevent the end-user from using the entire building for its intended usage and purpose.

Manufacturer's Guarantees & Warranties

Provide manufacturers' guarantees and warranties for materials and products.

Ensure that manufacturers' guarantees, and warranties are valid up to the end of the Defects Liability Period following Practical Completion of the Works or as identified below (whichever is the greater). Longer periods contained in the Main Contract however will take precedence.

Type	Commencing from	Duration
Manufacturers' Guarantees & Warranties	Practical Completion	12 months
Extended Guarantees for Repair under Defects Liability Period	Date of repair	12 months
Guarantee of availability of spares	Practical Completion	10 years
Longer term Manufacturers' Guarantees & Warranties	Practical Completion	24 months

Ensure materials and products normally guaranteed by the manufacturers for a period longer than that defined above remains under guarantee for the maximum period. Provide an extended guarantee period from the date of the repair for any system part repaired during the Defects Liability Period as identified in the table above, normal wear and tear excepted.

Ensure any maintenance required by the Supplier is provided before Practical Completion and that records are kept and included in the O&M Manuals.

4.0 Testing and Commissioning

4.1 Testing and Commissioning

The Contractor(s) shall include for testing of all plant and equipment to ensure that the systems are set to work in the appropriate standards and manner once the installation works have been completed.

All testing and commissioning shall be carried out in accordance with BSRIA and CIBSE Commissioning Codes, together with test procedures defined within British Standards and Standard Specification Clauses.

Definitions
The following definitions shall apply:

1. Off-site tests: carried out on items of equipment at manufacturer's works or elsewhere to ensure compliance with relevant British Standards, codes of practice or other indicated performance requirements.
2. Site tests: tests on static plant and systems to ensure correct and safe installation and operation (e.g. inspection and testing of welds, hydraulic pressure testing of pipework, resistance and insulation testing on new low voltage distribution cables, RCD operating times etc.)
3. Commissioning: the advancement of an installation from the stage of static completion to full working order to specified requirements. Commissioning shall include:
    - Preliminary checks to ensure that all systems and systems components are in a satisfactory and safe condition before starting up.
    - Preliminary adjustment and setting of all plant and equipment consistent with eventual design performance.
    - Energising and setting to work all plant.
    - Final regulation and demonstration that the installation delivers the correct rate of flow of fluids at the conditions specified.
4. Setting to work: the process of setting a static system into motion.
5. Regulation: the process of adjusting the rates of fluid flow and heat transfer in a distribution system within specified tolerances as stated in the relevant CIBSE commissioning code or as otherwise indicated.
6. Performance testing: the measuring and recording of the performance of the commissioned installation under varying plant loading utilising artificial loads.

Standards

Preliminary checks, cleaning, setting to work and regulation of the individual systems shall be in accordance with the relevant CIBSE commissioning codes, BSRIA publications and other documents as indicated below:

- CIBSE commissioning codes (series A, B, C, M, R and W)
- BSRIA application guide 1/89 flushing and cleaning of water systems
- BSRIA application 2/89 the commissioning of water systems in buildings
- BSRIA application 3/89 the commissioning of air systems in buildings
- BSRIA BG 44/2013 Seasonal Commissioning
- Government Soft-landings Guidance
- BESA a practical guide to ductwork leakage testing – DW/143
- BS 7671 18th edition
- Building regulations part L and the Domestic & Non-Domestic building services compliance guides

Particular attention shall be given to the permitted design tolerances in the above codes.

The entire commissioning and performance testing of the installation shall be undertaken by an approved commissioning specialist whose name and details shall be provided at tender return. The Contractor(s) shall be responsible for the supervision of the commissioning specialist's work and shall ensure satisfactory completion of commissioning and recording of results. A summary report shall be provided to the CE on the progress of the works and commissioning prior to each progress meeting highlighting any areas that do not meet the specification and proposals for remedying such.

Arrange for the commissioning engineers to survey the installations and submit a commissioning schedule and programme to the CE for comment at least 6 weeks before commencement of commissioning.

The CE and the Client team shall be given the opportunity to witness all tests with advance written notice of tests being given.

Any defects of workmanship, materials, performance, maladjustments, non-compliance with this specification or other irregularities which become apparent during the tests or commissioning shall be rectified by the Contractor, at his own expense, until the whole works is free from defects and in full working order to the complete satisfaction of the CE.

The Contractor(s) shall supply all labour, apparatus and instruments necessary for tests. All instruments shall be provided by the Contractor(s) or his commissioning

specialist, and evidence of the accuracy of the test instruments shall be provided. Test methods shall be demonstrated to the CE on request.

The Contractor(s) shall submit to the CE a schedule detailing the equipment which he or his commissioning specialist proposes to use in the testing and commissioning of the services and the test methods to be employed.

Testing and commissioning of major items of proprietary plant or specialist equipment shall be carried out by the manufacturer's personnel and witnesses by the commissioning specialist. The CE shall be advised of such activities.

Test results shall be recorded on commissioning certificates where layout and content shall be approved by the CE.

Performance testing

A series of performance tests shall also be carried out after completion of all equipment and system commissioning, to demonstrate that the whole of the works performs according to the requirements of the specification. Performance testing shall incorporate the following as a minimum:

- All control devices (local and remote) shall be checked for correct operation.
- All protection and detection devices shall be checked for correct selection, adjustment and operation.
- All indicating and measuring devices (local and remote) shall be checked for correct operation.
- All control and safety interlocks shall be checked for correct operation.

Performance testing of mechanical systems would incorporate the following as a minimum:

- Operational checks
- All control elements, including remote and local, sensors etc, shall be checked for correct operation according to all the control schedules / settings contained in the specifications. This shall include the air and water systems and shall be carried out by altering set point values and monitoring the steady state conditions achieved consequently.
- Operation of the time schedules shall be proved by altering the apparent time to force the system through its cycles.
- The operation of all control and safety interlocks shall be checked.
- The cold water and domestic hot water systems are to be shown to satisfy the maximum demand, as defined by BS 8558 / BS EN 806 and HSE ACOP L8 for the facilities provided.

The failure of any equipment during any tests shall make that test null and void. The necessary remedial works would be carried out and the works re-tested / commissioned and the performance test programme re-started.

System performance testing

The Contractor shall demonstrate by measurement and recording that the installation as noted functions correctly without the need of adjustment and is capable of maintaining internal environmental conditions within specified limits under varying plant loading. All tests shall be witnessed. Performance testing of an installation shall only take place on completion of commissioning.

The Contractor shall ensure that all performance testing requirements are achieved, and the plant is continuously operated for a minimum period of 24 hours before tests are witnessed with the witnessing covering a further 24-hour period.

The Contractor shall be satisfied and confirm to the CE giving a minimum period of 96 hours' notice, that the installation is ready for witness of performance testing.

Where cooling systems are proposed, the Contractor shall be responsible for the supply, fixing, connection and safe operation of enough temporary artificial heat load equipment (to the design load) and any instrumentation necessary to demonstrate system performance, and for subsequent disconnection and removal from site when the CE is satisfied that tests are complete. The Contractor(s) shall submit his proposals for the performance tests to the CE for approval 6 weeks before start of commissioning.

For the duration of performance tests, the Contractor(s) shall ensure that all qualified commissioning and other specialist personnel are always present and available to make any necessary immediate adjustments and repairs.

Measurement and records of performance test results are to be entered on appropriate commissioning certificates.

The Contractor shall subject the entire plant under test to a total continuous run of the duration indicated to ensure that all apparatus, materials and systems are working properly; that all controls, safety devices, operating services and the unit are properly adjusted and operating correctly; that design temperatures in the piping system and throughout the air systems are established; that the systems provide the required internal conditions and to assure himself that the design intent is achieved before demonstration to the CE. The performance shall be evaluated during environmental conditions prevailing at that time.

The tests shall be made at the direction of the CE.

The Contractor shall provide a temporary installation of portable recorders to simultaneously record temperatures and humidity's in each test area. The locations of test instruments shall be approved by the CE. The corresponding external conditions shall also be recorded whilst tests are in progress. The capacity of refrigeration plant, (including components thereof such as condensers, evaporators, cooling towers, etc.), and other air handling plant shall also be demonstrated and recorded.

Individual room temperatures shall be measured 1.5m above floor level at points unaffected by the influence of draughts or direct radiation from hot or cold surfaces.

Offsite testing

Where British Standards stipulate testing of items of equipment to demonstrate compliance, these shall be carried out at a manufacturer's works or elsewhere as appropriate. In all cases, test certificates shall be submitted in duplicate to the CE and be included in the record documents. In certain cases, where appropriate, type test certificates shall be accepted as indicated.

1. Fans: type test certificates showing fan characteristic curves (BS 848 part 1), test method as appropriate, and type test certificates for sound power levels (BS 848 part 2)
2. Electric motors: below 40kw output type test certificates; for motors of 40kw output and above, routine (individual) test certificates; in accordance with BS 4999.
3. Starters and control gear: type test. certificates (BS 587). For control panels, routine (individual) high voltage test in accordance with BS 587.
4. Other electrical equipment, such as air heaters (but excluding thermostatic control equipment): test certificates in accordance with BS 816.

Test certificates shall serve as a record that the item referred to has been shown under test to meet the requirements of this specification and / or British standards as applicable and shall be dated, numbered and clearly referenced to the items tested by means of serial, chassis or other manufacturer's reference number permanently marked in a conspicuous position.

Where an individual inspection or test takes place at the manufacturer's works, a representative of the Contractor(s) shall normally be required to be present.

Tests shall be made at the Contractor's or supplier's premises, on samples of materials and components to be installed in the works in any manner deemed necessary by the CE to ensure conformity with the specification. The results of such tests shall be in no way relieve the Contractor(s) of his responsibilities to ensure that

all materials and components used in the works are entirely suitable for the applications and conditions of operation.

All control panels shall be checked at the manufacturer's works and certified to comply with this specification prior to despatch. Functional checks shall also be carried out at the manufacturer's works to ensure that all interlocking and sequencing is in accordance with the performance requirements. Test jumpers, where fitted, shall be removed at the end of the checking. Documentary evidence of compliance with short circuit ratings shall also be provided.

Commissioning of specialist equipment

The Contractor(s) shall ensure that all commissioning work carried out on specialist equipment by the manufacturer's personnel is completed to his satisfaction, to the satisfaction of the commissioning specialist and to the satisfaction of the CE.

Commissioning results

All equipment data and commissioning results shall be recorded by the Contractor(s) on the commissioning certificates. Each certificate shall be witnessed unless otherwise indicated. The scheduled items and stated commissioning procedures shall be interpreted by using the appropriate clauses of this specification, any supplementary specification and the design requirements of the drawings. All certificates shall be serially numbered for retention in the commissioning data section of the operation and maintenance logbook.

Prior to completion of the commissioning certificates, the Contractor(s) shall obtain written confirmation from specialist manufacturers that their commissioning tasks are complete, and the equipment is operating correctly. A statement recording the level of performance shall be included where appropriate.

A comprehensive final report shall be provided to the CE/ICS confirming satisfactory operation of each element of the works, and the measured performance of all plant. The report shall include all individual equipment commissioning reports as well as the system commissioning reports, in a form suitable for incorporation into the operating and maintenance manuals.

Records and certificates

Inspection and test results shall be recorded on the forms approved by the ICS/CE. Two copies shall be submitted to the ICS/CE within 7 days of each test.

When all inspections and tests results are satisfactory, a completion certificate and an inspection certificate shall be given to the CE not later than the date of completion of the works. The certificates shall be given in the form laid down in the IEE wiring

regulations for electrical installations, BS 5839 for fire alarm systems and BS 5266 for emergency lighting systems.

The values of prospective short-circuit current and earth fault loop impedance at the origin of the installation shall be recorded on the inspection.

Covering up:
Ensure no section of the works are covered, concealed or insulated until completion of a witnessed satisfactory test by EA/CE

Give notice when works which are to be covered or concealed are ready for examination and/or measurement, not less than 3 working days
Give notice to:

- Employers Agent (EA)
- Consulting engineer (CE)

Test notices:
Provide all formalities in connection with test notices, agreement and application for supply forms etc. Ensure all documents requiring the employer's signature are forwarded to the PM/CE in time to meet the building programme for the necessary test and supply arrangements to be made. No additional payments shall be made for expenses incurred due to reconnections, re-visits, etc., by supply authorities or any other officials.

Mechanical services

General
The Contractor(s) shall be responsible for fully commissioning each system. The entire commissioning procedure shall be performed to the satisfaction of the CE and the Contractor(s) shall demonstrate that the installation or any portion thereof, which has been set to work, complies with the requirements of this specification.

All packaged controls systems shall be installed, tested and commissioned in accordance with the manufacturer's recommendations and instructions.

Inspection and testing shall be carried out in accordance with CIBSE guides and BSRIA publications identified above as well as the requirements of this specification and as indicated.

Inspection shall include a physical check that all equipment has been securely fixed, and that all electrical and mechanical connections are mechanically sound.

In addition to the test at the completion of each installation, certain tests shall be done during the progress of the works, as noted below.

For equipment supplied under the contact the Contractor(s) shall obtain from manufacturers declarations of conformity to demonstration ERP compliance complete with 'CE' markings.

Cleanliness

Items / equipment for incorporation in the works are to be kept in protective storage until needed. Tubes and equipment shall be kept effectively plugged, capped or sealed until incorporation.

Before installations are commissioned and subjected to the inspections and tests required, they shall be thoroughly cleaned internally and externally.

Clean equipment using an appropriate combination of effective measures including brushing, vacuuming and wiping clean. Ensure surfaces are not damaged by the cleaning processes used.

Clean all external surfaces of plant, ductwork and pipework.

Clean internal surfaces of air handling plant including all component parts (e.g. ductwork, impeller blades, internal surfaces of fan scrolls, internal surfaces of attenuators, heat transfer surfaces, etc).

Clean casings and air ways of air-cooled motors. Remove motor casing if the airways are sufficiently blocked to possibly affect cooling performance.

Remove and clean internal surfaces under casings used to cover plant.

Open up and clean internal surfaces of control panels, electrical connection boxes, etc.

Remove temporary filters and replace with new, clean filters.

Ensure that all unwanted building materials are cleared from all service voids and plantrooms and that spaces are dust free.

Internal cleaning for hot water heating / chilled water installations shall include flushing, chemical cleaning, passivation and final flushing to a written specification approved prior to starting. Items, which could be damaged by the cleaning processes, shall be isolated and cleaned by approved alternative methods.

Cleaning procedures shall be carried out in compliance with the recommendations contained in CIBSE Commissioning Code W and the code of practice for the use of high-pressure water jetting equipment as relevant.

DHWS and CWS installations shall be flushed, cleaned and disinfected to a written specification approved prior to starting. Cleaning for these systems shall accord with the requirements and recommendations contained in HSE ACOP L8.

Effluent from cleaning processes shall be discharged into the foul-drainage system in compliance with the requirements of the local water undertaking.

Ductwork systems shall be cleaned by 'blowing out' using the supply air fan. No fan shall be started until cleaning is to commence. Cleaning shall be completed before the connection of terminal units and fittings. Duct spigot ends shall be temporarily fitted with securely fixed fine mesh covers to collect air-borne particles for disposal.

Remove waste materials to designated areas on a continual basis.

Ensure that the entire Building Services Works are handed over in a clean state. Allow for progressively cleaning and for maintaining the operational area in a tidy, safe condition.

Remove all temporary supply labels as agreed, thoroughly brush down, wipe and otherwise clean the Building Services Works and any affected area on completion of the Building Services Works.

Site testing

The Contractor(s) shall be responsible for site testing of static systems in order to ensure safe operating conditions consistent with design performance. Site testing shall include inspection and testing of welding and brazing, pressure testing for soundness of hydraulic systems and air leakage testing of ductwork systems.

All main plant including tanks, cylinders, pumps, etc., specified to comply with British standards shall be subject to such tests at works as are provided for in the relevant BS. Where there is no BS, such plant shall be subjected to a hydraulic test at works of 1.5 times the maximum working pressure or of 1.5 bar whichever is the greater, for a period of 60 minutes.

After completion of pipework cleaning operations and before the application of thermal or acoustic insulation, each water distribution system shall be charged with clean water and then subjected to a hydraulic test of 1.5 times the working pressure. There shall be no loss of pressure during a period of not less than 60 minutes. To suit installations, hydraulic test(s) shall be carried out on the complete system or in

sections as directed by or agreed with the CE. Where sectional testing is adopted, a final hydraulic test shall be necessary. Any items of equipment set to operate at or below the test pressure shall be isolated or removed prior to the application of this test. On completion of testing and cleaning operations, systems shall be protected against internal corrosion until water treatment is completed.

Medium and high pressure / velocity ductwork systems shall be tested for air leakage in accordance with BESA specification DW/144 using methods described in BESA guide DW/143. Low pressure / velocity ductwork systems shall be tested for air leakage by the same methods where specified.

All air leakage testing shall be carried out before the application of thermal insulation.

Installations or sections of air or water distribution systems which shall be embedded in the structure or concealed in permanently sealed ducts, trenches, roof spaces, etc., shall, in addition to the above specified tests, be individually tested as they are installed and before being embedded or concealed.

Vibration transmission-break equipment shall be thoroughly checked for correct installation and alignment and shall be statically tested to ensure that suspensions and / or connections operate as intended.

The Mechanical Contractor(s) shall be responsible for correcting any unacceptable vibration apparent during plant operation.

Wiring terminations to control equipment shall be checked for compliance with the wiring diagrams, and for interlocking with other equipment. Any faults shall be rectified unless associated with wiring carried out under a separate contract, in which case they shall be recorded, and the details passed to the CE for action.

Above ground drainage

The complete new above ground drainage system shall be inspected for leaks in accordance with BS EN 12056. Air shall be pumped into the system, one floor at a time, through a branch of a tee until a pressure equal to 38mm water gauge is achieved. The inlet valve shall then be closed, and the system shall maintain the pressure for a minimum of three minutes.

Water distribution systems

Prior to regulation, pipe systems shall be modified as necessary and in accordance with good pipework practice, so that flow rates with all valves fully open are within 50% above the design values.

After all water systems have been regulated, the final settings are to be recorded on the commissioning certificates. Fluid flow rates shall be adjusted to within 95% and 110% of the design flow, following the BSRIA commissioning guide BG 2/2010 template, unless otherwise agreed by the CE.

Air distribution systems

After the air systems have been regulated, all dampers shall be labelled, and quadrants indelibly marked to show the correct setting. Filters shall be checked and where necessary, changed or cleaned. The CE shall decide whether a filter change or cleaning is necessary.

Regulation of a system shall be achieved initially by variation of the inverter (or by change of drive pulleys). Any minor regulation may be obtained by adjusting the fan discharge damper. Additional dampers which may be required for correct air balancing, together with the associated works, shall be provided.

After all systems have been regulated, the final settings are to be recorded on the commissioning certificates.

Heating

The heating systems shall be set to work in accordance with the manufacturers instruction and operated to demonstrate the system performance. Where the CE deems necessary data loggers shall be provided, by the Contractor at their cost, to demonstrate the specified internal design temperatures are achieved.

Sound level measurements

Readings shall be taken to ensure that the required noise ratings are not exceeded. Representative areas shall be selected by the EA / Acoustic Engineer / CE.

The acoustic performance of atmospheric silencers, items of plant where limitations on permitted noise levels are specified and the noise transmission from plant room areas shall be measured, recorded and the results assessed as indicated.

Wherever necessary, when measuring room sound levels, normal continuous background noise from sources other than the installation shall be considered. Measurements relating to overhead terminals shall be taken directly below each terminal at 1.7m above floor level, and for sidewall terminals, 1m horizontally from each terminal and 1.7m above floor level.

Results of octave band analysis shall be submitted on noise rating curve charts for each individual space.

Tests shall be carried out using a sound level meter, with frequency analyser, meeting the requirements for BS EN 61672-2.

All tests shall be undertaken in accordance with the Acoustic Engineers requirements.

Electrical services

General

Inspection and testing shall be carried out in accordance with the IET wiring regulations, the requirements of this specification, and as indicated.

Inspection shall include a physical check that all equipment has been securely fixed and that all electrical connections are mechanically sound.

In addition to the test at the completion of each installation, certain tests shall be done during the progress of the works, as noted below.

For equipment supplied under the Contact the Contractor(s) shall obtain from manufacturers the time / current characteristics of all protective devices for automatic disconnection of supply and provide copies to the CE and to the person or persons carrying out the inspection and testing.

Testing methods general

The EA / CE shall be notified of the method to be used for each type of test.

For testing continuity of protective conductors and equipotential bonding an A.C. source shall be used.

The method used to verify the effectiveness of the protection afforded by a residual current-operated device shall not exceed 100% of the nominal setting of the device. For a fault-voltage operated device the test voltage between the exposed conductive part and earth shall not exceed 50 volts. In addition to the tests simulating an appropriate fault condition any test facility incorporated in the device shall be operated to test its effectiveness.

High voltage tests on HV cables and, where indicated on lv cables, factory-built assemblies and transformers shall comply with the requirements for site testing in the appropriate British standards.

Alternative methods to those set out in the IET wiring regulations may be proposed for the approval of the CE but they shall be not less effective than those in the regulations.

Where necessary to prevent damage to components of equipment the equipment shall be disconnected for the duration of the relevant tests.

Power cables

Tests shall be made immediately on completion of the installation of power cables to demonstrate that the phase sequence is correct at all end connections.

LV cables shall be tested at high voltage as soon as their installation is complete.

LV cables not required to be high voltage tested shall be tested for insulation resistance as soon as their installation is complete. The test voltage shall be 500V D.C. For installation rated up to 500V and 1000V D.C. For installations rated up to 1000V. Tests shall cover all permutations between each conductor, screen, metallic sheath, armour and earth.

The over sheaths of cables laid underground shall be given a voltage withstand test after backfilling of the trenches is complete but before termination.

Alarm, control, communication, and monitoring cables

Cables shall be tested as soon as their installation is complete to ensure that the cores are continuous, that they have not been crossed and that the insulation resistance is satisfactory. Insulation tests shall cover all permutations between each conductor, screen, metallic sheath, armour and earth.

Conduit and trunking

Where conduit is cast in-situ in reinforced concrete it shall be checked for freedom from blockage and steel conduit shall be tested for electrical continuity as soon as the shuttering has been removed.

Steel conduit and trunking systems shall be inspected and tested before any wiring is installed; under floor ducting and flush floor trunking shall be inspected and tested before screeding.

Earth fault loop impedances

The measured earth fault loop impedance for each circuit shall be checked against the maximum value. Where the maximum value is exceeded, the CE shall be informed.

Fire detection and alarm systems

Fire alarm systems shall be inspected, tested and commissioned in accordance with BS 5839. All system interfaces shall be tested including but not limited to mechanical

plant, solenoid valves, BMS, fire dampers etc. Such tests shall need to be undertaken out of hours in order not to unduly affect the building operation.

The Contractor(s) shall measure the sound pressure level in each in each room more than 1m^2 and record the dB(A) results in tabulated format on A4 paper and submit to the CE for approval. Once approved the results page shall be appended to the test and commissioning certificate contained within the O&M manual.

The complete Fire strategy cause and effect shall be reviewed as part of the testing and witnessing requirements prior to handover.

Emergency lighting systems

Emergency lighting systems shall be inspected and tested in accordance with the "three yearly" inspection and test procedure laid down in BS 5266.

Emergency lighting level checks at a minimum of 1 per 5m^2 route or 33m^2 of open plan areas.

General lighting systems

The electrical Contractor shall undertake full lighting illumination level checks of the general lighting systems in areas provided with new or modified lighting systems in order to demonstrate compliance with BS EN 12464 part 1 and other relevant CIBSE guidelines.

The readings shall be taken across a representative area of the occupied zone within each room on the working plane as described below. The results shall be recorded on a suitably scaled drawing and included in the O&M's. The light meter calibration certificate shall be provided along with the results.

A series of performance tests shall also be carried out after completion of all equipment and system commissioning, to demonstrate that the whole of the works performs according to the requirements of the specification. Performance testing shall incorporate the following as a minimum:

All control devices (local and remote) shall be checked for correct operation.
All protection and detection devices shall be checked for correct selection, adjustment and operation.

All indicating and measuring devices (local and remote) shall be checked for correct operation.

All control and safety interlocks shall be checked for correct operation.

Internal lighting level checks at a minimum of 1 per 20m2 at locations to be advised by the CE

External lighting level checks at a minimum of 1 per 50m2 at locations to be advised by the CE

The Contractor(s) shall allow for these tests and those noted at above to be carried out at night with appropriate shielding as necessary to external windows.

The failure of any equipment during any tests shall make that test null and void. The necessary remedial works would be carried out and the works re-tested/commissioned and the performance test programme re-started.

Inspections & Tests Requirements

Allow the EA to witness inspections, tests, commissioning and performance tests. The Contract Administrator will attend these as he/she deems necessary.

Ensure the Building Services Works have been fully inspected, tested, commissioned and checked before offering any equipment or systems to the Contract Administrator so that the Performance Demonstration Tests can reasonably be expected to proceed without delays. Invite the Contract Administrator to Performance Demonstration Tests only when the associated Building Services Works are complete, fully checked and commissioned and have passed the Contractor's acceptance tests and certified records have been submitted.

Submit method statements in advance of any test describing all aspects of the work required. Identify tests required on work before covering up during construction.
Provide at least the minimum notice of inspections and tests identified in the table below.

OEM Site Performance Testing

Allow for major items of equipment to be inspected, tested, commissioned and performance tested by the original equipment manufacturer (OEM).

Electrical Systems

- Client Main LV Switchboard

Mechanical Systems

- N/A

Site Inspection & Performance Testing

Carry out site inspections and tests to demonstrate that the Building Services Works comply with the specification and include the Site Demonstration Tests listed below.

Electrical Systems

Item	Required
LV Switchgear	✓
Transformers	n/a
Cable Distribution	✓
Demonstrate Discrimination & Interlocking	✓
Earthing & Bonding	✓
Lightning Protection	✓
Lighting Control Systems	n/a
Illumination Levels	✓
Emergency Lighting	✓
Fire Alarm System	✓
Specialist Systems (e.g. Refuge/ Fireman's Intercom)	✓
Intercoms	n/a
Control Panels	✓
PV arrays	✓
BS 7671 IET Wiring Regulations	✓

Mechanical Systems

Item	Required
MVHR/Fan	n/a
VRF/DX/ASHP Heat pump systems	✓
Ductwork Pressure & Leakage	n/a
Ductwork Cleanliness	n/a
Air Flow Rates	✓
Water Flow Rates	✓
Fire Dampers	✓
Sprinklers	n/a
Dry Risers	n/a
Smoke Ventilation	n/a
Room/Space Noise NR Levels (All Spaces)	✓
Above Ground Drainage	✓
Rainwater pipework services	✗
External Noise Levels (from All Plant)	✓
Room/Space Temperatures (All Spaces)	✓
BMS & Controls	✓

Piped Services Systems

Item	Required
Pipework Pressure & Leakage	✓
Pipework Cleanliness	✓
Pipework Pressure & Leakage	✓
Pipework Chlorination	✓
Pipework Sterilisation	✓
Sprinkler System Acceptance Tests	n/a

Integrated Systems Test

The integrated systems test (IST/Black Building Test) is to ensure that the operation of all building services installed within the building work as a whole following the successful completion of the individual system commissioning procedures.

Allow adequate time in the construction and commissioning programmes for IST to be carried out.

The test is to prove the many interfaces and interactions with all other systems and their cause and effect. The test is to confirm the building operation under different building failure conditions to ensure that the correct operation and start up procedures occur and that all systems interact correctly with each other. Failure conditions include but are not limited to:

- Complete Power Fail
- Partial Power Fail

All Fire Conditions to test the cause-and-effect strategy for the building / development:

- Correct system returns of all plant following reinstatement / correction of the above scenarios.

Allow for compiling a detailed event procedure for each system detailing the expected reaction under each situation and provide adequate resources to manage and control this testing procedure.

Allow for specialist subcontractors personnel including but not limited to Lighting Control, Fire Alarm, Security to be available on the day to monitor their individual systems.

Main's failure conditions shall encompass the failure of the incoming service and all submain failures. Failures of power supplies to be simulated.

Allow for any special visits to site and provide any necessary attendance during the Defects Liability Period to set up, monitor and remove test and recording equipment.

Acceptance of the system does not absolve the Contractor from their responsibility to provide a fully operational system, even if defects appear during the warranty period, notwithstanding that a defect was not apparent at the time of commissioning. Carry out fine tuning and adjustment of the systems for 12 months from Practical Completion including environmental testing and monitoring.

4.2 Handover

Operation & Maintenance Manuals

The Contractor shall be responsible for the production of all operation and maintenance manuals including 'As Fitted' drawings for the complete mechanical services installations.

The Operation and Maintenance Manuals shall be submitted to the Contract Administrator for comment, not less than 4 weeks prior to practical completion with 3 full and final sets of documentation provided at completion.

The Contractor shall allow for providing the completed Building Regulations Part L logbook.

Provide O&M Manuals and Record Drawings in hard copy and electronically.

Provide O&M Manuals and Record Drawings in accordance with the requirements as defined in the Main Contract Preliminaries and the Health & Safety Plan.

Provide O&M Manuals, Record Drawings and other information necessary to enable the healthy, safe and efficient operation of the building for the entire the Building Services Works.

Include only relevant manufacturers' information. Ensure that manufacturers provide original literature as part of their plant andequipment orders.

Electronically scan any manufacturer's literature not in electronic format.
Modify and update operating details to reflect the agreed commissioning results.

Dedicated Volumes

Provide O&M Manuals in separate dedicated volumes to enable the types of users listed in the table below to easily obtain the information they need.

User Type	Level
Employer's Occupier	Non-Technical
Employer's Facility Manager	General Technical
Employer's Maintenance Staff	Specialist

Standards

O&M Manuals and other Handover Information in accordance with the recommendations of relevant industry standards and guides, including the following publications:

- BSRIA BG1/2007
- BSRIA BG2/2004
- BSRIA BG79/2020
- BSRIA AG 1/87.1
- CIBSE Guide M:2008
- CIBSE TM31
- CIBSE TM39

Additional Information

Provide the additional information identified below in the O&M Manuals and on the Record Drawings.

- Provide O&M information for each and every system.
- Schedules of all equipment settings and actual values maintained during commissioning.
- In a separate section, schedules of all energy and water meters including the particular service description, type, location, identification and method of measurement. Schedule all meters in the building including those provided by Others. Arrange the meter schedules so that they can be incorporated into the Building Logbook.
- Procedures for seasonal changeovers.
- E-mail addresses of manufacturers and suppliers.
- Defects records.
- A list of consumables.
- Provide design information based the Building Services Documents updated to include any agreed changes.

Room & Equipment Referencing

Agree the room reference code system before use including identifiers for:

- Building
- Level
- Room Type
- Room Number. (as applicable)

Agree the equipment reference code system before use including identifiers for:

- Building / Unit
- Level
- System Type
- System Number
- Component Type
- Component Number.
- Confidential Systems

Asset Register

Provide asset registers in the necessary format and content to suit the Management Company / FM team's CAFM systems.

Statutory Examinations

Arrange statutory examinations required. Obtain and issue satisfactory examination report(s).

Familiarisation & Training of Operational & Maintenance Staff

Provide the Handover information in accordance with the Main Contract and standards given prior to Practical Completion. Draft copies to be produced and issued for comment as part of the soft landings procedures for review with the relevant stakeholders. Provide training and assistance to the Employer's staff prior to Practical Completion including the requirements given below.

Explain and demonstrate the Building Services works, O&M Manuals and Record Drawings to the Employer's satisfaction.

Provide training in the form of both classroom sessions and tours of the building systems.

Provide a suitable 'classroom/meeting' environment for at least 10 of the Employer's staff with facilities for PowerPoint or other screen-based presentations for each topic area.

Allow for the minimum contact hours listed below.

Topic Area	Minimum Contact Hours
Mechanical Services	8
Electrical Services	8
BMS/controls	16
Fire Protection Systems	8

Allow for a repeat session for each topic where operating staff are unavailable or cannot be released simultaneously.

Submit copies of the training presentation for the Employer's future reference.
Keep records of the training sessions including any certificates of competence.
Record training sessions on DVD.

Special Tools & Instruments

Provide complete sets of special tools, instruments and keys togetherwith suitable instructions, identification and storage at Practical Completion as listed below.

Item	Quantity
Special tools and instruments (sets per item of equipment)	2
Standard tools e.g., levers, plant, and equipment keys, etc.	3
Plantroom keys (sets per door, cabinet, or panel)	3

Provide a minimum of three robust, lockable toolboxes or tool cabinet in each plant room.

Obtain a signed receipt for all items issued.

Spares & Consumables

Provide spares and consumables for Landlords systems as recommended by the manufacturer of the equipment concerned.

Include the items identified below. All spares to be suitably boxed / stored / protected and labelled / recorded for handover to the Management Company / FM Team.

4.3 Soft landings

The handover process will follow the Government Soft landings procedures and standards, and the Contractor(s) will be expected to support and commit to this standard in full including allowing for the necessary standards as per BS 8536. As part of this requirement the following provides an outline of the envisaged process:

Inception and briefing

Arrange and chair meetings ensuring that the key stakeholders need and required operational outcomes are clearly defined.

Design development and review

Reviewing comparable projects and assessing proposals in relation to facilities management and building users. Providing stakeholders with key information on handover and understanding the handover requirements in terms of CAFM interfaces and similar.

Pre-handover

Review and ensure key stakeholders' operators properly understand systems, interfaces as well as functionality before occupation.

Develop and provide preliminary functional building user guides (following the format from BREEAM) for key interfaces including but not limited to the following key End user experience and interfaces:

- Building services such as controls interfaces and functionality
- Utilities and metering in conjunction
- Telecommunications / off site monitoring
- FM and BMS systems interfaces
- Life Safety Systems /interfaces
- FM maintenance requirements

5.0 Existing Services and Strip out

Performance Objectives

The Contractor(s) shall be responsible for undertaking all necessary mechanical and electrical services isolations and strip-out, as indicated on the drawings and within this specification.

Design Parameters

In accordance with the following parameters:

- CDM Regulations 2015
- Building Asbestos Registers
- BS 6187 Code of practice for full and partial demolition

Proposed System Description

The Contractor(s) shall be responsible for surveying the complete extent of the existing services in situ within the area of works, along with the source of the relevant services, (e.g., plantrooms, LV switch rooms, etc.) and determining the precise isolation points prior to commencing any isolation / strip out works. Prior to commencement of demolition works all means of isolation shall be tested and verified by the contractor as detailed in the RAMS.

All works shall generally follow British Standard 6187, Code of practice for full and partial demolition, and utilise a suitable permit to work system to ensure suitable health and safety measures are in place, particularly in areas to remain live throughout the works and mitigating issues such as dust and noise during the works along with the disruption to occupants. As such the Contractor shall be responsible for determining the specific sequencing of the works.

Reference shall be made to the Client's asbestos register and asbestos R&D reports provided within the overall design package of works prior to commencing any demolition / strip out works.

Reference shall be made to the external services infrastructure drawings for existing constraints, external services isolations / diversions and removals etc.

Reference shall be made to the specific area / zonal works sections found on the relevant drawings and CWC drawings for full details of all strip-out works.

Within retained areas the contractor shall allow for making good of any fire rating of walls / fabric / facades/ flooring / roofs / ground / finishes, etc., as necessary due to the removal of existing services. Any openings shall be weathered / made good by the Contractor as necessary. Where openings are to be reused suitable

temporary measures for weathering / protection (and security if necessary) shall be put in place until the new systems are installed.

The following live services are known to be present and shall be maintained throughout the works:

- Incoming low pressure gas service.
- Incoming mains cold water service.
- Above ground drainage via single stack systems.
- Mains cold water and domestic hot water circulation services serving general appliances throughout the building.
- Decentralised mechanical ventilation generally comprising local extract systems.
- Incoming electricity services
- The main LV switch panel and associated circuit protective devices.
- LV distribution boards and associated submains and busbar systems shall only be locally isolated during out of hours to carry out final circuit wiring.
- Specialist access control, security and CCTV shall only be isolated zonally if deemed necessary.
- Specialist central fire detection and alarm system addressable type inclusive of point detectors, manual break glass units and sounders / sounder beacons shall only be isolated zonally.
- Incoming Telecoms, data services together with structed cabling and comms rooms

The Contractor(s) shall note that the above services are located in and around the site / area of works. The Contractor shall liaise with the End User and Client to obtain a complete full list at the start of the project prior to undertaking any isolations.

Upon appointment the Contractor(s) shall undertake a full detailed survey of the existing MEP services as described in the relevant work sections of this specification, engaging the relevant specialists accordingly to understand detailed service isolations and strip-out / diversions, etc. required in order to maintain the services within the building as required.

Specific areas of works include:

- Low pressure natural gas service in plantroom.
- Mains cold water and domestic.
- Low temperature hot water (LTHW) generation.
- Central controls / BMS system
- Incoming electricity service.
- Mechanical power supplies, including external outlets.

The proposed strip out works is detailed on the accompanying drawings and generally as summarised below:

- Isolations, disconnections and strip-out / removal of existing gas fired LTHW boiler plant, associated pumps, pressurisation unit and expansion vessel(s) and controls (back to the local control panel).
- Isolations, disconnections and strip-out / removal of existing gas fired water heater and recirculating domestic hot water pump, including pipework locally only.
- Isolation, strip out and removal of existing gas pipework branches serving the gas fired boilers and water heater.
- Isolation, strip out and removal of existing flues associated with the gas fired boilers and water heater.
- Isolation, strip out and removal of existing condensate drainage pipework serving the boilers, water heater and flues.
- Isolations, disconnections and strip-out / removal of including all associated LTHW pipework and secondary pumps and controls (back to the local control panel). In plantroom only, existing pipework is to be checked for water condition prior to the installation taking place on the existing system .
- Builders work elements in connection with removal of existing plinths and flue installation as detailed on accompanying layouts.
- Isolation, disconnection and strip out / removal of the BMS control panel along with final circuits to the existing boilers, water heater and pumps along with associated small power equipment. Final circuit to the control panel shall be isolated, retained and coiled up in preparation for re-connecting to a new BMS control panel.
- Isolation, disconnection and strip out / removal of all final circuit wiring and associated small power equipment to the ancillary mechanical apparatus being stripped out.
- The contractor shall make allowance for the gas to capped off once the new ASHP installation is complete, the contractor shall engage with client to ensure that the meter is removed from the system and isolated in safe manor.

Technical Submissions

Provide the following:

- Intrusive survey results of existing systems as detailed in the earlier sections of the specification.
- Marks-ups and / or sketches to show routing of existing systems, where concealed from view, and points of interface to existing relevant systems.

6.0 Mechanical Services

6.1 Above Ground Drainage Services

Performance Objectives

Provide, new condensate drainage for all environmental treatment plant under the scope of works. The drainage systems shall generally be vented to atmosphere and installed in accordance with the requirements of the Building Regulations part G + H and BS EN 12056, connecting to existing foul drainage connections below ground.

Allow for supply and installation of all rainwater pipework c/w suitable vapour sealed insulation, where installed internally within the building as detailed in the Architectural specification.

The works shall consist of the new condensate pipework off the ASHP's to a local floor gulley.

Specific Design Parameters

The installation shall be in accordance with:

1. BS EN 12056-2 Gravity drainage systems inside building: Part 2: 2000 "Sanitary pipework, layout and calculation".
2. BS EN 1329-1:2014+A1:2018 Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure. Unplasticized poly (vinyl chloride) (PVC-U). Specifications for pipes, fittings and the systems
3. The frequency factor used in the flow calculations is taken from BS EN 12056-2, Table 3, but specifically as follows:
    - Usage of appliances frequency factor K
    - frequent use for building = 0.7
4. Building Regulations including but not limited to:
    - Part H (Approved document H "Drainage and Waste disposal".)
5. Refer also to section 3 of this specification for general design criteria

System Description

Suitably sized condensate drainage shall be provided to environmental treatment plant as necessary to convey water to drain. All pipe work serving condensate lines from all necessary items of environmental treatment plant and equipment shall be installed in ABS and shall be installed to discharge upstream of a trap providing connection into a local foul water system via either a trapped floor gulley or a self-sealing trap connection to the local SVP.

Where environmental treatment plant is remote from local SVP's and completely unavoidable, additional condensate traps and pumps shall be provided. Condensate

pumps shall be of the peristaltic type provided complete with tank pump connector, in built tray as and switch level indicator, thermal protection, low noise (47dB(A) @ 1m max), a selector switch for manual flushing, 3-minute over-run timer and be self-priming. The units shall be also provided with a suitable anti-vibration mounting fixing kit. The units shall not be located within noise sensitive areas.

All pipe work drains from AAV's, safety valves, boiler condensate, etc., shall be routed to discharge over floor gullies without any discharge causing splashing or wetting of the floor outside the gully.

All condensates from air moving plant shall drain via local dedicated borosilicate glass traps into an adjacent soil and vent drainage stack system with the necessary fall required. Due regard shall be given to system/plant (e.g. fans etc) static pressure to ensure 50mm min trap seal is always maintained.

Ventilating pipes

Pass ventilating pipes terminating to atmosphere through the roof with a proprietary roof vent connector and purpose made weathering slate to suit the roofing material. Carry this out in accordance with BS EN 12056 and the Building Regulations. Locate the ventilating pipes to avoid ventilation duct inlets and exhausts.

Air admittance valves

Where air admittance valves are to be installed (as a last resort), install in accordance with the Building Regulations and the manufacturer's requirements. The head/end of line drains shall be ventilated to atmosphere. Ensure that all air admittance valves that are to be used have a current British Board of Agreement Certificate (BBA). Locate air admittance valves to allow full access for maintenance and replacement.

Traps

Provide traps to sanitary fittings. Ensure that the deep seal traps are complete with a pipe to wall extension piece and wall cover flange (as necessary). Supply and install the necessary pipe adaptors. The Contractor shall ensure all traps have seal depths and diameters in accordance with BS EN 12056, and that they bear the British Standard Kite Mark.

Anti-siphon and venting pipes (and anti-siphon traps) shall be provided protect the traps on the appliances from loss of water/seal.

Overflows

Provide all overflows to meet the requirements of the Water Supply (Water Fittings) Regulations 1999 and ensure that WC overflows are the internal type within the cistern that allows discharge through the flush pipe into the WC pan.

Expansion

Thermal expansion shall be allowed for within the design calculations and installation PVC-U and polypropylene soil waste and vent pipe work.

Fire protection

Where plastic pipe work passes through fire compartment floors and walls etc as detailed by the Architect and Fire Engineer, intumescent fire sleeves to BS 476 'Fire tests on building materials and structures' shall be fitted. All Pipes which pass through fire rated walls and floors shall be fire protected with intumescent fire protection collars to BS 476 - Fire tests on building materials and structures. Where a pipe passes through a floor or wall, a Class O insulation material shall be used to fill any gap between the pipe and the structure to avoid sound bridging to meet the noise requirements of building. The insulation material shall comprise water resistant / sealed mineral wool type or equal and approved. Intumescent fire collars shall be provided in accordance with the requirements of Building Control. The Mechanical Contractor shall ensure that intumescent fire collars are provided to maintain the fire compartmentation of the building. Fire collars shall be selected to be suitable for the pipe work materials served.

Insulation

All SVP's and stub stacks shall be insulated in accordance with the insulation specification where pipework passes through ground slabs and roofs in order to minimise thermal bridging.

Fittings

Fittings shall be in accordance with the manufacturer's standards and requirements with a double coupler used at all times to connect both pipe and fittings.

Manufacturer's long or short cushioning sections shall be used for changes of direction at the base of stacks: short cushioning sections should be used where the height of the downpipe is less than 10m; long cushioning sections where the height of the downpipe is greater than 10m.

All vertical and horizontal pipe shall be secured using Manufacturer's rubber lined clips only and at spacing distances as recommended by the manufacturer.

System components

The system shall be provided with the following features:

- Free pipework of burrs, rust, scale, throating, flattening rippling and any foreign matter or defects and thoroughly cleaned prior to erection.
- Obtain all components for each type of pipework from the same manufacturer unless otherwise indicated.
- Install discharge pipes and ventilating pipework to gradients strictly in accordance with BS EN 12056 to provide self-cleansing velocities. Agree minor

adjustments of gradient required by practical on-site fixing, size of fittings or through co-ordination with other services with the Engineer prior to installation.

- Provide suitable approved protection to afford protection to pipe, fittings or other equipment whether required on a temporary or permanent nature and where any parts or part are liable to be exposed to damage from other trades or any causes whatsoever.
- Immediately replace, at your own expense, any pipework fittings, valves, sanitary fittings unduly marked by tools or otherwise damaged or distorted and rejected by the Engineer.
- Inspect components carefully before fixing and reject any which are defective. Ensure cut ends of pipes are clean and square with burrs removed.
- At the Engineer's direction on site, and at no extra cost to the Employer, remove, submit for his inspection and re-fix after, any length of pipe, valve or fitting already fixed. If the inspection reveals neglect on Contractors' part, to conform to the requirements of the specification the engineer may direct the removal and replacement without extra cost to the Employer, the whole or any part of the installation.
- Make all branches to horizontal discharge pipework at high level using 45° branches swept in the direction of flow where possible.
- Install all discharge pipework to gradients strictly in accordance with the requirements of BS EN12056, as a minimum.
- Install access doors or caps on sanitary pipework to facilitate rodding and maintenance access to installed pipework. Co-ordinate access through Architectural casings with pipe accessories.
- The Contractor shall be responsible for co-ordinating all connections to below ground with the civil engineer and all stacks, and vent pipes, with the sanitaryware/FF&E.

Testing and commissioning

The complete system shall be inspected for leaks in accordance with BS EN 12056. Air shall be pumped into the system, through a branch of a tee until a pressure equal to 38mm water gauge is achieved. The inlet valve shall then be closed, and the system shall maintain the pressure for a minimum of three minutes.

Controls

Section not used.

Technical submissions

The Contractor shall provide the following information for comment as part of the procurement:

- Coordinated Stage 5 working drawings and setting out of services.
- Technical submittals and details for fire stopping arrangements

- Technical Submittals for proposed pipework including manufacturers details and specifications including jointing proposal, expansion, supports and associated components.

6.2 Heating Installation.

System Objectives

The current system shall remain in

The Services contractor/designer shall be responsible for the issue of fully detailed heat loss calculations identifying the heater selections that have been made for perusal by the client team prior to the final ordering of heaters and installation on site.

Comply with Part L2 (ADL2A and Non-Domestic Building Service Compliance Guide 2013) of the Current Building Regulations and all current standards and codes of practice

Design Parameters
In accordance with:

CIBSE Application Manual 14 'Non-domestic hot water heating systems'
Building Regulations ADL2A 2010
Non-Domestic HVAC Compliance Guide
HVCA TR20/1
Manufacturer's recommendations

Existing System Overview
Heating is provided to scheme as existing by a number of different types of emitters, namely:

- Steel Panel Radiators.
- Underfloor heating

LTHW is provided to the scheme via 2 x modular gas fired boilers located in the plantroom area. The boiler currently feeding 2no heating circuits 1 no CT circuit which feeds the existing underfloor heating and 1no heating circuit which feeds the existing radiators, the heating system currently feeding the existing entrance and memorial area is to be retained and no modifications are required.

Boiler plant is original to the buildings construction and has exceeded economic life expectancy. The boiler systems is provided c/w primary and secondary heating circuits and ancillaries such as flues, horizontal low loss headers, pumps, valves expansion vessels etc.

Maintenance issues have recently occurred from existing boiler operation. The complete system is to be isolated, decommissioning and strip-out and indicated int the strip-out works section of this specification.

Proposed System Overview

The proposal is to replace existing boiler plant with electric heating and 3 no ASHP's to feed the existing heating system via plate heat exchangers , prior to installation taking place the contractor shall provide a water quality test to confirm the water in current is satisfactory to commence the works .

The proposed works generally comprise the following:

- Installation of primary side heating system including ASHP's, pumps and any associated plate heat exchangers .

WATER PIPEWORK

Due to the diverse application of hydraulic systems, it is the contractor's responsibility to comply with all national and local regulation, good practices and manufactures compliance, including water fixing and fixtures regulation.

The water pipe work will not have a static resistance greater than the operational limit of the water pump.

At all times the system shall maintain the minimum circulating water volume as specified in the product installation manuals

The distribution pipe work shall be designed to allow the nominal flow rates as specified in the product installation manuals, either by incorporating an open loop or by the inclusion of a pressure regulated automatic bypass valve between the flow and return water pipe work to allow for the minimum water volume.

PIPEWORK

Pipework shall be supported at adequate centres with the minimum of bends and offsets at intervals not less than those detailed in CIBSE Guide B Table B16.3. The pipe support system shall be installed in a neat and tidy fashion to the satisfaction of the PM.

All supports, brackets, hangars, etc. shall be securely fixed with approved fixings suitable for the building materials used. The Mechanical Contractor shall include for cutting, pinning or building in all supports, brackets, hangars, etc. as required, and for making good any damage to finishes.

The pipe support system shall be installed to prevent any movement of the installation other than longitudinal movement due to expansion and contraction. This shall be achieved by allowing a marginal clearance between the pipes and the supports as recommended by the support system manufacturer.

The Mechanical Contractor shall ensure that the load on any hangar or support does not exceed the manufacturer's recommended maximum load.

The pipework installation shall be installed fully in accordance with all manufacturers' recommendations and utilizing the manufacturer's recommended tools, lubricants etc. Support sleeves within the pipework are an integral part of the system and shall never be omitted when using the system.

The Pipework shall be suitable for operating temperatures at 90°C with a safe maximum working pressure of 10Bar.

All pipe bends shall utilise the cold forming bend fixtures for the specific diameter of pipe used to ensure that the maximum bending radius is not exceeded at any point in the continuous pipe system.

The pipework system shall be manufactured in accordance with BS 7291 – 3: 2010: Parts 1&2, class S all fittings shall be fully compatible with copper pipe to BS EN 1057, 12449 and 12451.

The Contractor shall give care and attention to location of pipework dropper positions and the protection of them to maintain low surface temperature integrity.

The Contractor shall fully co-ordinate all heating pipework with the hot and cold-water pipework, electrical trunking/tray and conduit, light fittings, electrical switchgear, ventilation ductwork and all building fixtures and fittings.

All pipework valves and fittings etc. shall be fully accessible within voids and boxings/risers for future maintenance.

The Contractor's attention is drawn to the areas where the Electrical Contractor will be installing trunking for power, data and telephones specifically in office areas and multi-purpose type areas.

Pipework drops shall generally be concealed within partitions/voids, skirting or dedicated service risers/boxings provided by the Main Contractor. Exposed pipework shall be avoided but where specifically required and agreed with the Project Architect the drops shall generally be discreetly sited within corners of rooms and fully co-ordinated to minimise the number of drops in any one area. Any distribution pipework shall be clipped to the building fabric with brass or equal clips. Under no circumstances will plastic pipework clips be accepted on metal pipework.

The Contractor shall obtain approval of all proposed pipework routes and any dropper positions from the Project Architect prior to commencement of the work.

The Mechanical Contractor shall give care and attention to the routing and location of all pipework drops throughout the building.

Pipework drops shall be within dedicated service risers/boxings/trenches and insulated. Any exposed pipework drops shall generally be discreetly sited within corners of rooms and boxed in as well as fully coordinated to minimize the number of drops in any one area.

All distribution pipework shall be clipped to the building fabric with brass clips. Under no circumstances will plastic pipework clips be accepted on metal pipework.

The Contractor shall ensure all valves and joints are able to sustain a working pressure of up to 3bar (45psi). Particular care should be exercised when fitting radiator valves and only those of high quality to BS 2767:10 should be used. All other valves and fittings should comply with BS 1010. This is due to loss of water pressure from a sealed system will require continuous recharging with fresh water and consequential introduction of air. Air is highly corrosive and will considerably reduce life-expectancy of radiators, pumps etc.

ADDITIONAL VALVES

The contractor is to allow for the installation of additional self-balancing valves were required on the existing system to accommodate new radiator installation and alteration of mean water temperature to ensure optimum performance of the system.

As general pipework routes are assumed the contractor is to allow for relevant surveys and investigation to determine the performance and operation of existing system to determine level of additional valves and mains distribution pipework upgrade works required.

The contractor is to also allow for investigations into workings of TRV's on existing radiators and allow for installation of new were deemed in-operational.
A schedule of rates it to be provided with tender return which details extent of upgrade works required as well and a cost to provide and install valve sets deemed necessary.

The Contractor shall supply and install all isolation/regulating valves, commissioning sets, drain cocks, automatic and manual air vents as necessary for the recommended control/isolation of the system and all the zones and sub-circuits etc.

Commissioning valve sets shall be installed, fully in accordance with the valve manufacturers' recommendations and instructions, on each main sub-circuit as shown on the tender drawings.

The provision of isolating valves shall be such to permit the removal of an item whilst maintaining service from the remaining items.

PICV's/3-port valve and where necessary (generally as indicated on the accompanying drawings) Commissioning stations shall be provided to the return pipe of all mains and main branches in LTHW systems.
Commissioning Stations shall include a DRV and OV. A double regulating valve shall be provided in the bypass pipe to all 3- port valves.

All commissioning stations, double regulating valves, orifice valves, control valves shall be installed at a size to suit the system requirements.

The Mechanical Contractor shall give care and attention to the routing and location of all pipework drops throughout the building.

The Mechanical Contractor shall fully co-ordinate all heating pipework with the hot and cold-water pipework, electrical trunking/tray and conduit, light fittings, electrical switchgear, ventilation ductwork and all building fixtures and fittings.

All pipework valves and fittings etc. shall be fully accessible within voids and boxing/risers for future maintenance.

The Contractor shall give care and attention to the routing and location of all pipework routes throughout the building.

The Contractor shall fully co-ordinate all heating pipework with the hot and cold-water pipework, electrical trunking/tray and conduit, light fittings, electrical switchgear, ventilation ductwork and all building fixtures and fittings.

All pipework valves and fittings etc. shall be fully accessible within voids and boxings/risers for future maintenance.

COMMISIONING VALVES

The commissioning valves shall comprise of a close-coupled double regulating valve and flow measurement device (fixed orifice) conforming to BS 7350.

The regulating hand wheels shall incorporate a means of indicating the number of hand wheel turns from fully closed to the fully open position.

Pressure test pots shall have extended stems to allow valves to be fully insulated without the test valves being covered. Test points shall have coloured cap ties, red to high and blue for low pressure tappings.

Valves up to and including 50mm shall be screwed, above 50mm flanged.

Prior to ordering any commissioning valves, the Contractor shall submit to the Engineer, for comment, a schedule indicating pressure drops across valves when 25% open and maximum pressure drop when 100% open.

The Contractor shall supply and install all isolation/regulating valves, commissioning sets, drain cocks, automatic and manual air vents as necessary for the recommended control/isolation of the system and all the zones and sub-circuits etc.

Commissioning valve sets shall be installed, fully in accordance with the valve manufacturers' recommendations and instructions, on each main sub-circuit as shown on the tender drawings.

THERMAL INSULATION

Thermal pipework insulation shall be installed fully in accordance with the Standard Specification and generally to comprise:

Distribution Pipework
(Ceiling voids/ducts/floor voids/boxings etc)

Thermal insulation shall be installed in strict accordance with the manufacturer's recommendations, thickness of insulation being in accordance with Section 3 of the standard Specification.

VALVES FOR AIR RELEASE

All high points on heating and hot water systems shall be provided with one of the following means of venting: -

Automatic Air Valve of aluminium bronze construction with nickel alloy valve and seat and stainless-steel float (as Winn type A). A lock shield pattern gate valve shall be fitted immediately before each A.A.V. and a 10mm copper drip pipe shall be run from the eliminator outlet to discharge in an approved position.
Up to and including 50mm nom bore, a full bore air bottle shall be formed by means of an equal square tee with an 80mm long space nipple terminating in a cap with a 10mm vent pipe taken from the top of the cap in terminate in an agreed position 1.5m above floor level in a 10mm bronze needle valve (as Hattersley 5N) fitted with a square headed bronze plug into the open end.

MAINS WATER FILL CONNECTION

To comply with the Water Authority requirements, the ASHP systems should be filled via a temporary hose connection to the mains cold water supply (disconnected prior to handover), with a RPZ valve assembly and test point fitted to the mains/boosted water side of a temporary circuit.

The contractor is to allow for investigations into the water hardness on site and allow for the installation of a water softener located within the plantroom is deemed a requirement.

INSTALLATION:

Pipework shall be supported at adequate centres with the minimum of bends and offsets at intervals not less than those detailed in CIBSE Guide B Table B16.3. The pipe support system shall be installed in a neat and tidy fashion to the satisfaction of the PM.

All supports, brackets, hangars, etc. shall be securely fixed with approved fixings suitable for the building materials used. The Mechanical Contractor shall include for cutting, pinning or building in all supports, brackets, hangars, etc. as required, and for making good any damage to finishes.

The pipe support system shall be installed to prevent any movement of the installation other than longitudinal movement due to expansion and contraction. This shall be achieved by allowing a marginal clearance between the pipes and the supports as recommended by the support system manufacturer.

The Mechanical Contractor shall ensure that the load on any hangar or support does not exceed the manufacturer's recommended maximum load.

SLEEVES:
All pipes passing through walls or floors shall pass through a sleeve cut from a length of mild steel pipe and butt into wall or floor. The sleeves shall finish not less than 2 mm proud of the finished surface of the plaster.

The annular space between the pipes and sleeves shall be adequately filled with rockwool or similar to reduce noise penetration, maintain fire integrity, whilst allowing free movement of the pipe. Sleeves for steel pipe shall be from galvanised material. Sleeves for copper pipes shall be in copper.

Sleeves shall be fixed in such a manner that shall prevent them becoming detached from the building fabric and it shall be the Contractor's responsibility to ensure that they are so fixed, and they do not project beyond the finished surface.

Where pipes pass through external walls of the building or trenches the Mechanical Contractor shall install 'puddle pipes' of the same size and material as the pipework in which they are to be installed. Each 'puddle pipes' shall consist of a length of pipe, flanged at each end and with an undrilled flange midway between the two ends.

Pipe sleeves where exposed to view in occupied areas shall be fitted with wall or floor plates.

THERMAL EXPANSION & CONTRACTION:
Where expansion and contraction of pipe work cannot be accommodated by natural offsets and changes in direction expansion loops, bellows, guides and anchors shall be designed and provided by Contractor.

TEST POINTS:
The Mechanical Contractor shall select, supply and fix within the pipework installations mechanical seal type test points in the following locations to facilitate the measuring of pressure and temperatures during commissioning and future maintenance.

Across all strainers.
At each port of each motorised valve
Each circuit.

LABELLING AND IDENTIFICATION:
All new pipework shall be identified with PVC adhesive tape or similar in accordance with the recommendations of BS 1710. All identification tapes shall be colour coded and shall provide the following information:

Name of service
Flow or return
Arrow indicating the direction of flow

Labels shall be clearly legible against the background colour and shall be provided with lettering not less than 6mm high. The identification tapes shall be placed at all pipework junctions, at both sides of valves and items of plant, at floor, ceiling and wall penetrations, and at intervals of not less than 5m on all straight pipe runs.

All plant shall be installed complete with traffolite style labels with lettering not less than 15mm high.

PRESSURE/TEMPERATURE GAUGES:
The Mechanical Contractor shall supply and install the following gauges:

All gauges shall be 80mm diameter with brass case and brass bezel complete with 3/8" BSP connector and gauge cocks.
Temperature gauges shall be calibrated in degrees Celsius and be complete with brass pocket for pipework installation.
The Mechanical Contractor shall make provision, if necessary, with special tee fittings to accommodate the pockets and ensure that:
The temperature gauge is positioned such that the pocket is fully immersed. The pockets and length are suitable for each individual application before ordering any specified instruments.
Pressure gauges shall be calibrated in metres and feet and be complete with gunmetal cocks and syphon tubes.
Each gauge shall be selected so that where possible, the normal operating condition is indicated by a mid-point deflection.
Each gauge shall be complete with an adjustable red pointer set to indicate normal operating conditions.
Gauges shall be located as follows:
Pressure Gauges - Constant temperature heating pumps, suction and delivery

Temperature Gauges - Constant temperature heating pumps, suction and delivery

Ensure that the base of the mating flanges match the base of the flexible connector.

DRAIN PIPEWORK

All pipework drains from safety valves, etc shall be routed to discharge over floor gullies without any discharge causing splashing or wetting of the floor outside the gully. Refer to Foul Drainage Above Ground.

PRESSURE TESTING

All pipework shall be pressure tested as per B&ES Guide TR/BMS

PRE-COMMISSION CLEANING:

Following satisfactorily completion of the pipework pressure testing the pipework installation shall be thoroughly flushed out and treated as follows:
The system shall be dosed with a passive cleaning/flushing chemical.
All system strainers are to be cleaned
The system shall be treated with an inhibitor, suitably selected for the components of system.
The treatment shall be as recommended by a water treatment specialist (with the above being the minimum acceptable). Following treatment appropriate tests shall be carried out and results forwarded to the CE.

The Mechanical Contractor shall employ a Water Treatment Specialist Contractor to carry out the above treatment works that shall use a suitable non-toxic industrial cleaning agent that is compatible with all materials installed throughout the installation. Method statements and chemical COSHH sheets shall be provided by the Contractor prior to carrying out the works.

The Mechanical Contractor shall provide a detailed pre-commission clean certificate upon completion of the works clearly stating all equipment, chemicals, methods etc. used.

Locations for necessary system flushing and drain points are to be determined by the Contractor following consultations with the Specialist Water Treatment Contractor.

CORROSION INHIBITOR:

The Mechanical Contractor shall treat the LTHW installation with a suitable non-toxic corrosion inhibitor to concentration levels as recommended by the inhibitor and boiler manufacturer.
The Mechanical Contractor shall ensure that the corrosion inhibitor used shall be in accordance with the boiler manufacturer's requirements.

Provide identification labels/tags at each boiler and at the sealed system device advising the presence of the inhibitor, type used and concentration.

The Mechanical Contractor shall produce a method statement for the above works together with details of all chemicals to be used and their associated COSHH sheets.

Upon completion of the flushing and water treatment, the Specialist shall take samples and obtain laboratory tests to check the water quality; further testing shall be carried out after 6 and 12 months. All results shall be issued to the Engineer and included in the Operating & Maintenance Manuals.

The Mechanical Contractor shall provide all necessary inhibitor certification for inclusion within the Operating & Maintenance Manuals.

TESTING AND COMMISSIONING:
The Mechanical Contractor shall allow for the testing and commissioning of the whole LTHW heating system fully in accordance with the CIBSE Commissioning Code W for Water Distribution Systems and the standard Specification.

The commissioning process shall ensure that all equipment is programmed, tested and security sealed with the appropriate commissioning data recorded and reported to the client including opening meter readings for billing purposes.

Contractor is to allow for obtaining water samples:
Prior to commencing works to verify existing pipework condition
Upon Project completion to prove cleaning and dosing.

6.3 Hot and Cold-Water Services

General
To provide, install, test, commission and set to work a complete system to provide domestic hot water utilising point of use hot water heaters. The system shall convey hot water to all water fittings within the premises, without waste, misuse, undue consumption or contamination (including degradation of the 'fluid category' as defined by the Water Regulations Guide) of the water supply or the cold-water system all in accordance with applicable regulations and standards and other design parameters. The water system shall be designed and installed to meet any specific requirements of the statutory body as well as the Water Regulations.

Allow for the necessary modifications and adaptions / extension / reconfiguration of the existing hot water system to accommodate works.

Specific Design Parameters

Works to be in accordance with the following publications that are current at the time this Specification has been drafted. Any later publications issued shall apply:

- Health and Safety Executive (Approved Code of Practice) Legionnaires' disease, The control of legionella bacteria in water systems, HSE ACOP L8
- The Water Supply (Water Quality) Regulations
- The Water Supply (Water Fittings) Regulations
- CIBSE Guide G: Public health and plumbing engineering
- Building Regulations Approved Document G
- Building Regulations Approved Document L2
- BS 8558 Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages – Complementary guidance to BS EN 806
- BS 8580 Water quality. Risk assessments for Legionella control. Code of practice
- BS 10175 Investigation of potentially contaminated sites. Code of practice
- BS EN 805 Water supply – requirements for systems and components outside buildings
- BSRIA BG 57/2015 Legionnaires' Disease - Risk Assessment
- BSRIA BG 58/2015 Legionnaires' Disease - Operation and Maintenance Log Book
- CIBSE TM13 Minimising the risk of Legionnaires' disease
- CIBSE Design Guides
- IOP / CIPHE Plumbing engineering services design guide
- WRAS Water Fittings and Materials Directory
- NJUG Vol 1-6 National Joint Utilities Group Guidelines
- Refer to the Standard Specification and section 3 of this specification for general design criteria

All water services supplied in addition to complying with the above stated British Standards and Byelaws shall be installed to comply with the latest publications for prevention against Legionellosis including Legionnaires Disease. The Mechanical Contractor shall provide upon completion a full site logbook, written schemes and risk assessment for the entire air, A/C, ventilation and water systems in accordance with the Health and Safety Executive Series Booklet HS (G) 70 The control of Legionellosis including Legionnaires Disease and ACOP L8.

Water temperatures shall be maintained within the requirements for domestic consumption and Health and Safety Requirements. No dead ends, blanks fitted to tees, stop ends, etc. shall be permitted whatsoever.

Design pressure at sanitaryware to be a minimum 1.0 bar to ensure correct operation of appliances without wasting water

The Hot Water services installation shall be designed and installed so that:

- Hot water outflow temperature - 60°C minimum
- Hot water return temperature - 55°C minimum
- Blended hot water outlet temperature - 41°C generally, 48°C maximum
- The system(s) shall be readily capable of pasteurisation in accordance with HSE ACOP L8

Mains/Boosted water systems shall be installed such that the following design water velocities are not exceeded:

- Less than 15mm dia. — less than 1m/s
- 15 to 50mm dia. — 0.75 to 1.15m/s
- More than 50mm dia. — 1.25 to 3.0m/s

Generally, the Mechanical Contractor shall ensure the following in addition to the above:

- The system shall be easily accessed for routine chlorination
- Dead legs shall be minimised and shall be maintained within the maximum lengths stated within BS EN 806/HSE ACOP L8.
- Hot water temperature of 50° shall be achieved at all outlets within 1 minute (or 41°C at "blended" outlets).

System Description

The extent of the proposed system shall generally comprise:

- Strip out and removal of the existing hot water generation plant.
- New point of use water heaters where shown.
- Associated controls (both packaged and central)
- Thermal insulation to all distribution pipework shall be provided to meet the standard insulation specification
- All associated builders work in connection with the services (BWIC) including plinths

Local water authority

Consult the local water supply company / authority to determine suitable materials, laying techniques and pipe diameter, prior to laying / connection to any mains.

Notify the local water supply company / authority, using the form in the water industry Approved Installation Method (AIM) 08 01, of any proposed reduced pressure zone valves and comply with any conditions imposed.

Ensure the local water supply company / authority is given at least seven days' written notice in advance of connecting to their supply main.

Arrange for the local water supply company /authority to inspect (and sign off as compliant) the completed installation prior to the handover and occupation.

Backflow protection

Ensure all pipework systems and associated appliances are protected against backflow or back syphonage in accordance with the requirements of The Water Supply (Water Fittings) Regulations, WRAS guidance and applicable standards.

Control of legionella bacteria/ environmental precautions

Ensure all water services are fully in compliance with HSE ACoP L8, associated guidance HSE HSG274 Part 2 and CIBSE TM13.

Avoid long runs of pipework to points with very little or infrequent usage. Install a check valve on any branch likely to be infrequently used.

Protect pipework from hot sources and freezing conditions.

Provide cisterns with close fitting covers. Fit insect screens to all overflows, warning pipes and vents. Install inlet and outlet connections at opposite ends of the cistern to prevent areas of stale/stagnant water. Protect cisterns from hot sources and freezing conditions.

Ensure that connections from cisterns dedicated to serving hot water apparatus are located 25mm above connections serving cold apparatus.

For cisterns with a capacity greater than 1000 litres and no delayed action float valve, fit a circulation pump apparatus to minimise occurrences of thermal column formation which can allow the cold inlet to track directly to the outlet so causing stagnation elsewhere in the cistern.

To maximise turnover in variable occupancy or phased occupancy buildings install a variable height float valve in each cistern.

Install a cistern washout valve as close as possible to the cistern and ensure that the inlet is as close as possible to the bottom. Cap/flange the open end. Terminate over a drain but achieving appropriate air gap.

Do not install spray taps or aerators where there is the likelihood of heavy fouling by grease and dirt.

Ensure that potable water points are not installed at the end of long pipe runs from which the draw off is infrequent or low in volume.

Obtain written authorisation from the local water supply company/authority prior to filling the system for bringing it into operation.

Upon filling and following sterilisation, ensure that the system is flushed using chlorinated mains water in accordance with BS 8558 and that suitable records are kept. Maintain the system at design conditions until handover to the Employer.

Carry out temperature recording in accordance with BSRIA Application Guide AG 4/94.

Sterilisation

Flush out the system using drinking water with a maximum particle size of 150micron. Ensure that at least 20 system volume changes are used in flushing. The minimum flush velocity is 2m/s.

Cleanse and disinfect the complete system, including incoming mains, break and storage cisterns and all distribution piping.

Carry out purity tests from water samples and obtain laboratory analysis to ensure compliance with Water Supply (Water Quality) Regulations.

Repeat disinfection and purity analysis until appropriate quality is achieved. Carry out disinfection on a date agreed with the client/contract conditions, with an allowance of at least two weeks prior to the building being occupied, to enable results from the tests to be processed.

Maintain system in a disinfected condition until handover to the employer and notify the Operator of any interim flushing maintenance requirement etc prior to handover.

Upon the domestic hot and cold-water systems being disinfected, the Main Contractor shall open all draw off points in sequence once a week until the systems are handed over. Record each of these operations, witnessed by the clerk of works or engineer.

Pipework

Install hot and cold water distribution pipework in Copper to BS EN 1057 R 250, with lead free integral solder ring joints and fittings to match.

No flexible hoses to be utilised in final connections.

Pipework, fittings and ancillaries

Fully co-ordinate and set-out all domestic water services pipework with electrical trunking / tray, conduit, light fittings, electrical switchgear, ventilation ductwork and all building fixtures and fittings. The existing installation shall be surveyed in detail for final coordination of the new installation works.

Fit check valves to both hot and cold supplies where a shut off valve is fitted to the outlet nozzle of a mixing appliance.

Provide drain-off cocks at all low points.

Pipe routing is to be installed to ensure that heat gain to the potable water system by hot water pipe work, heating equipment etc. is minimised to inhibit the possible growth of Legionella.

All exposed pipework within the building feeding sanitary appliances shall be chromium plated with matching fittings and brackets. No pipework shall be fixed to skirting or coving. Any paint shall be suitable to withstand condensation effects of the cool pipe.

Do not use copper and galvanized steel together in a drinking water installation.

Install flow limiting devices in hot and cold-water feeds to basins where wash basins are not provided with watertight and readily accessible plugs, or spray or self-closing taps.

Where modifying an existing system, ensure that any cut off ends (dead legs) do not exceed 1x pipe diameters in length. If necessary, reconfigure the system to achieve this limit.

Agree the installation of RPZ valves in advance with the local water supply company / authority. Do not use flexible hose connections.

Pipework shall be supported at adequate centres, with the minimum of bends and offsets, at intervals not less than those detailed within the Mechanical Standard Specification. The pipe support system shall be installed in a neat and tidy fashion to the satisfaction of the EA/CE

All supports, brackets, hangars, etc. shall be securely fixed with approved fixings suitable for the building materials used. The Mechanical Contractor shall include for cutting, pinning or building in all supports, brackets, hangars, etc. as required, and for making good any damage to finishes.

The pipe support system shall be installed to prevent any movement of the installation other than longitudinal movement due to expansion and contraction. This shall be achieved by allowing a marginal clearance between the pipes and the supports as recommended by the support system manufacturer.

Ensure that the load on any hangar or support does not exceed the manufacturer's recommended maximum load.

Only metal pipe clips shall be accepted and under no circumstances shall plastic clips be used anywhere within the installation.

Generally, all pipe work and associated supports etc shall be installed concealed being run in ceiling / roof voids, in service ducts /boxings and behind panelling systems to eliminate pipe work on view. No dead ends, blanks fitted to tees, stop ends, etc. shall be permitted whatsoever.

No mechanical type joints shall be used within service voids, boxings, ceilings etc that cannot easily be accessed. No push-fittings shall be used on domestic services pipe work.

No valves shall be located within service voids, boxings, ceilings etc that cannot easily be accessed.

Pipes shall not be supported from each other, or from any item of equipment.

The valves indicated on the accompanying drawings are the minimum provision required. Additional valves shall be provided as noted in this and the general specification and elsewhere as necessary to complete the installation.

Isolating valves shall be provided to all branches (on both the flow and, where applicable return legs at the point of take-off) and to each side of all pumps and plant, at all building entries, at all plant room exits / entries, to each side of all meters, etc., to enable their removal without draining other pipe sections. All isolating valves shall be line size.

Isolation valves for all MCWS shall generally be Stopcocks. All valves designated stopcocks shall be bronze gate valves unless for final isolation which shall be ball type.

Sleeves

All pipes passing through walls or floors shall pass through a sleeve cut from a length of mild steel pipe and butt into wall or floor. The sleeves shall finish not less than 2 mm proud of the finished surface of the plaster.

The annular space between the pipes and sleeves shall be adequately filled with rockwool or similar to reduce noise penetration, maintain fire integrity, whilst allowing free movement of the pipe. Sleeves for steel pipe shall be from galvanised material. Sleeves for copper pipes shall be in copper.

Sleeves shall be fixed in such a manner that shall prevent them becoming detached from the building fabric and it shall be the Mechanical Contractor's responsibility to ensure that they are so fixed that they do not project beyond the finished surface.

Where pipes pass through external walls of the building or trenches the Mechanical Contractor shall install 'puddle pipes' of the same size and material as the pipework in which they are to be installed. Each 'puddle pipe' shall consist of a length of pipe, flanged at each end and with an undrilled flange midway between the two ends.

Pipe sleeves where exposed to view in occupied areas shall be fitted with wall or floor plates.

Thermal expansion & contraction

Pipework expansion and contraction of pipe work shall be accommodated by natural offsets and changes in direction. Where this is not viable and where suitable for the pipework materials; expansion loops, bellows, guides and anchors shall be designed and provided by the Mechanical Contractor.

Water treatment

The whole of the domestic water system shall be flushed out; the installation shall then be chemically cleaned and chlorinated in accordance with HS G (70), BS EN 806 & HSE ACOP L8.

Allow for the taking of two sets of water samples from the sterilised system, one set immediately after sterilisation and one set immediately prior to handover. The method of obtaining samples, sampling point etc., shall be recorded by the Mechanical Contractor and witnessed and certified by the Engineer. The Mechanical Contractor shall allow for the samples to have tests carried out an independent certified testing laboratory to confirm that water from the installation is suitable for human consumption and free from harmful Legionellae, bacteria, coliforms, pseudomonas or chemicals. Two copies of the test reports shall be forwarded to the Engineer. The methods used to test the samples shall be in accordance with those laid down in 'Analysis of raw, potable and waste waters' published by the

Department of the Environment, HMSO 1972 or any method approved and employed by the Environmental Health Department at the time of the tests. Test results shall be forwarded to the CE and if found unsatisfactory the cleaning and testing procedure repeated.

Inhibiting chemicals shall be of proprietary manufacture and used in accordance with the manufacturer's safety instructions.

The sterilisation process shall be carried out by specialists in this field of work who shall submit signed certificates to warrant that the systems have been properly disinfected in accordance with the stated standards.

On completion of sterilisation of the systems all shall be thoroughly and totally flushed out twice with clean water before any water is used for domestic purposes.

The Mechanical Contractor shall chlorinate the whole of the system(s) and provide copies of all test certificates to the CE and UU

A 'clean water' certificate is to be issued by the Mechanical Contractor prior to Practical Completion.

Thermal Insulation

Thermal pipework insulation shall be installed fully in accordance with the Standard Specification and generally to comprise:

- Plantroom pipework
- Distribution Pipework (Ceiling voids/ducts/floor voids/boxings etc)

Thermal insulation shall be installed in strict accordance with the manufacturer's recommendations, thickness of insulation being in accordance with Section 15 of the Standard Specification.

Labelling And Identification

All new pipework shall be identified with PVC adhesive tape or similar in accordance with the recommendations of BS 1710. All identification tapes shall be colour coded and shall provide the following information:

- Name of service
- Flow or return
- Arrow indicating the direction of flow

Labels shall be clearly legible against the background colour and shall be provided with lettering not less than 6mm high. The identification tapes shall be placed at all

pipework junctions, at both sides of valves and items of plant, at floor, ceiling and wall penetrations, and at intervals of not less than 5m on all straight pipe runs.

All plant shall be installed complete with traffolite style labels with lettering not less than 15mm high.

Testing And Commissioning

Allow for the testing and commissioning of the whole domestic water services installation fully in accordance with the HSE ACOP L8, BS 806 & CIBSE Commissioning Code W for Water Distribution Systems and the Standard Specification.

The commissioning process shall ensure that all equipment is programmed, tested and security sealed with the appropriate commissioning data recorded and reported to the client including opening meter readings for billing purposes.

Contractor is to allow for obtaining water samples:

1. Prior to commencing works to verify existing pipework condition
2. Upon Project completion to prove cleaning and dosing.

Technical submissions

Submit the following for comment:

- Stage 5 coordinated working drawings
- Water services technical submittal for proposed pumps, pipework, water heaters, etc. as well as PRVs, including anticipated criteria ranges (maximum/minimum flow rates, upstream/downstream pressures) and mounting orientations
- Operating and maintenance instructions for all items of equipment including:
    - Pumps
    - Water heaters
    - PRVs
- ASHP controls description of operation pertaining to domestic hot water generation.

6.4 Low Temperature Hot Water Heating Services

General

Provide, install, test, commissioning and set to work a complete system to provide space heating to all areas, as detailed in the scope of works and drawings, using air to water heat pumps as the principal means of heat generation. The heating system shall also serve the domestic hot water production requirements.

In addition to controls requirements detailed elsewhere in the specification, provide the minimum controls package for compliance with Building Regulations Part L and to provide an energy efficient, low carbon means of generating heating for the purposes of maintaining the building's internal temperature requirements and secondary hot water requirements.

To provide a piped low temperature hot water (LTHW) heating distribution system from the heat generation plant to the heat emitting equipment and provide all heat emitting items related specifically to the heating system.

Specific Design Parameters

The design and installation shall comply with the following:

- Building Regulations and Approved Documents including Part L
- Non-Domestic HVAC Compliance Guide
- Manufacturer's recommendations
- CIBSE Application Manual 14 'Non-domestic hot water heating systems'
- HVCA TR20/1
- CIBSE AM:17 Heat pumps for large non-domestic buildings

All components of the refrigeration system to be designed installed tested commissioned and decommissioned to the requirements of the following:

- BS EN ISO 12100 and BS EN 378 Parts 1-4 - Refrigeration systems and heat pumps – Safety and Environmental requirements
- BS EN 15450 – Heating systems in buildings, Design of Heat Pump heating systems
- BS EN 14511 – Air conditioners, liquid chilling packages & heat pumps with electrically driven compressors for space heating and cooling.
- BS 6880 Low temperature hot water heating systems of output greater than 45kW
- The Pressure Systems Safety Regulations 2000
- The Approved code of practice to the Pressure Systems Safety Regulations (ACOP) L 122 "Safety of Pressure Systems" – Provide a "Written Scheme of

Examination" for the vapour compression refrigeration system as required by the regulations.

- HSE Approved Code of Practice L8 Legionnaires Disease.
- CIBSE TM 13:2000 - Minimising the risk of Legionnaires' disease
- Refrigeration codes (Institute of Refrigeration), including:
    - Safety code for Compression Refrigerating Systems Utilising Groups A1 and A2 Refrigerants (1999)
    - Safety Codes for Compression Refrigerating Systems Utilising Ammonia
    - Code for Compression Refrigerating Systems Utilising Groups A3 Refrigerants (2001)
    - Code of Practice for the Minimisation of Refrigerant Emissions from Refrigerating Systems.

The heating system shall have the following features:

- Quiet in operation, efficient and provide the effective heating output within the desired warm-up period.
- Be energy efficient and thermostatically controlled to regulate the temperature within the space.
- Be visually pleasing, robust and tamper proof.
- Comply with Part L of the Current Building Regulations and all current standards and codes of practice.
- Meet the internal/external noise criteria for plant.
- Provide storage of heating energy.
- Provide secondary circulation circuits to emitters with duty / standby circulating pumps.

System Description

The extent of the proposed system shall generally comprise:

- Strip out and removal of the existing LTHW generation plant, pumps, pressurisation and expansion plant, distribution pipework and emitters.
- Air source heat pumps and appropriately sized buffer vessel(s) located within a new external plant enclosure.
- New primary and secondary pumping and system pressurisation and expansion provision.
- New pipework distribution in plantroom only
- Associated controls (both packaged and central)
- Thermal insulation to all distribution pipework shall be provided to meet the standard insulation specification
- All associated builders work in connection with the services (BWIC) including plinths for internal plant and concrete bases for external plant.

The air-to-water heat pump system, utilising multiple heat pumps, shall generate low temperature hot water (LTHW) to serve the building's heating and production demands.

The system shall incorporate all ancillary components, including primary and secondary circulation pumps, heat exchangers, thermal stores, pressurisation equipment, water conditioning, chemical treatment plant and controls to provide a fully functional and efficient heating system.

The central heat pump system shall generate:

- LTHW at 70^{0}C flow / 60^{0}C return (weather compensated) to serve:
    - Space heating loads, via:
        - Underfloor heating
        - Steel panel radiators

Air Source Heat Pumps

Provide a cascade system of 3 no Ideal R290HT 50 KW high temperature air source heat pumps c/w packaged controls and all necessary ancillaries as detailed on accompanying drawings and schematics. The equipment shall be as manufactured by Samsung and as per schedule on accompanying drawings. The installation shall be undertaken by a recognised Mitsubishi specialist installer and fully eligible for a full 5-year warranty.

Buffer Tank(s)

Buffer Tank(s) shall be sized to buffer heat from the air source heat pump installation to minimise number of compressor starts per hour and increase over-all efficiency.

The tank(s) shall be provided in accordance with PD 5500 category 3, or BS EN 13445; BS EN ISO 16433, BS EN 10028; BS EN 1011.

The vessel(s) shall be insulated in accordance with this specification and to meet the requirements of Building Regulation AD Part F. The insulation shall be finished with hammer clad aluminium complete with vapor sealing. External vessel(s) shall additionally be provided with electrical trace heating.

Buffer vessels shall be fitted with temperature gauges, pressure gauges and drain cocks, as well as temperature sensors linked back to the BMS to allow for control of the air source heat pump system.

Buffer Vessels shall be as manufactured by Ormandy Rycroft or equal and approved.

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Circulating Pumps

The LTHW pumps shall generally be of the centrifugal type, in-line glanded pipeline mounted, twin headed with variable speed drive, differential pressure controlled, complete with flanges, counter flanges and pressure tapings.

The pump bodies shall be of cast iron having cast iron impellers, stainless steel shaft BS970, mechanical seal suitable for a temperature up to 110^{0}C and shall be complete with one pair of flexible connections for each pump or pump set and also complete with isolating valves, non-return valve, strainer (with pressure gauges on the inlet and outlet) and pressure gauges on the suction side and discharge side of the pump set. Flexible connections shall have matching flanges.

The pumps shall be quiet in operation.

Isolating valves and gauge cocks are to be provided on the suction and delivery lines to each pump set and each strainer on the heating pumps.

150mm dial pressure gauges each graduated to suit application are to be provided complete with syphons, suitable for fixing into the gauge cocks either side of pump sets, strainers, etc.

The pumps shall be inverter driven. These drives shall be complete with the pump and installed as part of the pump or adjacent the same and supported and wired accordingly.

The circulating pumps shall be installed such that it does not impart any mechanical vibration to either the fabric of the building or to the relevant pipework systems.

The pipeline mounted pumps shall be supported on purpose-made steel brackets incorporating suitable anti-vibration material or mountings to all manufacturers' recommendations.

Where the pump connections differ from the specified pipework sizes, purpose made taper pieces shall be provided at the pump connection. All surrounding valves, strainers etc. shall be to pipeline, not connections size.

The pumps shall be fitted with either flanged or union joints to enable individual removal and replacement. Drain valves shall be provided between pump isolation valves to enable pump replacement without system draining.

Secondary circulators shall employ variable speed pumping techniques to maximise energy savings. To this end each pump set shall be provided complete with the necessary remote differential pressure sensors / pressure transducers installed as necessary to automatically adjust pump speed / volume in line with building demands.

Pressurisation and expansion units

A pressurisation unit, and appropriately sized expansion vessels, shall be provided to maintain the system design fill-pressure in the sealed heating system, replacing water lost through system leakage, and to provide safety circuits locking out the heating plant in the event of extreme pressures.

The pressurisation unit shall be provided fully enclosed in a factory-made frame and casing. The pressurisation unit shall be a fully automatic sealed system filling device, suitable for the water management the heating system. The unit shall be supplied fully commissioned by the manufacturer.

The pressurisation unit shall include integral packaged controls and be provided with the facility to display the system and pump pressure. The pressurisation unit shall provide for remote alarm and status indication to the BMS.

Pressurisation unit shall provide the necessary back flow protection. A quick fill connection shall be provided complete with an RPZ valve.

Install pressurisation unit (PU) and ancillary equipment, including safety valve in distribution pipework (if not part of PU), in accordance with BS 7074 part 2 for LTHW system.

Mains Water Fill Connection

To comply with the Water Authority requirements, the LTHW systems may be filled via a temporary hose connection to the mains / boosted cold water supply, (to be disconnected prior to handover), with an RPZ valve assembly and test point fitted to the mains / boosted water side of the temporary circuit.

Dosing Pot

The Mechanical Contractor shall supply dosing pot facilities at points denoted to adequately dose the systems with inhibitor. Dosing Pots are to be as manufactured by XPOT or equal and approved.

Air & Dirt Separator

The Mechanical Contractor shall supply and install air / dirt separators as indicated on the drawings. The air & dirt separators shall be installed in accordance with the manufacturer's recommendations. Each air and dirt separator shall be as per detailed on the accompanying schedules.

Phex

The Mechanical Contractor shall supply and install 2 no PHEX as indicated on the drawings. The PHEX's shall be installed in accordance with the manufacturer's recommendations.

PHEX shall be as manufactured by Ormandy Rycroft or equal and approved.

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The plate heat exchangers shall have no more than 25kpa resistance through the plate heat exchanger, where resistance is higher the plate heat exchanger details shall be technically submitted to CWC to approve prior to ordering of equipment.

Pipework

Fully co-ordinate and set-out all heating services pipework with electrical trunking / tray, conduit, light fittings, electrical switchgear, ventilation ductwork and all building fixtures and fittings. The existing installation shall be surveyed in detail for final coordination of the new installation works.

Heating pipe routing is to be installed to ensure that heat gain to the potable water system is minimised to inhibit the possible growth of Legionella.

LTHW pipework shall be Carbon Steel to BS EN 10255 or BS EN 10217-1 (Heavy) up to 150mm and to BS EN 10216-1 (Seamless) or BS EN 10217-1 (Welded) 200mm and above. Joints shall be screwed or grooved up to 50mm, with malleable cast iron

fittings, and welded and flanged or grooved at 65mm and above, with carbon steel fittings to BS EN 10253.

Ensure that there are flanges adjacent to all items of equipment to allow removal and maintenance.

Pipework shall be supported at adequate centres, with the minimum of bends and offsets, at intervals not less than those detailed within the Mechanical Standard Specification. The pipe support system shall be installed in a neat and tidy fashion to the satisfaction of the PM.

All supports, brackets, hangars, etc. shall be securely fixed with approved fixings suitable for the building materials used. The Mechanical Contractor shall include for cutting, pinning or building in all supports, brackets, hangars, etc. as required, and for making good any damage to finishes.

The pipe support system shall be installed to prevent any movement of the installation other than longitudinal movement due to expansion and contraction. This shall be achieved by allowing a marginal clearance between the pipes and the supports as recommended by the support system manufacturer.

The Mechanical Contractor shall ensure that the load on any hangar or support does not exceed the manufacturer's recommended maximum load.

The pipework installation shall be installed fully in accordance with all manufacturers' recommendations and utilising the manufacturer's recommended tools, lubricants, etc.

All pipework valves and fittings etc. shall be fully accessible within voids and boxings / risers for future maintenance.

The Contractor shall give care and attention to location of pipework dropper positions and the protection of them to maintain low surface temperature integrity. Pipework drops shall generally be concealed within partitions / voids, skirting or dedicated service risers / boxings. Exposed pipework shall be avoided but, where specifically required and agreed with the Project Architect, the drops shall generally be discreetly sited within corners of rooms and fully co-ordinated to minimise the number of drops in any one area.

Any distribution pipework shall be clipped to the building fabric with brass or equal clips. Under no circumstances will plastic pipework clips be accepted on metal pipework.

Obtain approval of all proposed pipework routes and any dropper positions from the Project Architect prior to commencement of the work.

Pipework Expansion Devices.

Where expansion and contraction of pipe work cannot be accommodated by natural offsets and changes in direction, the Mechanical Contractor shall, design, select, supply and install suitably sized expansion bellows or loops complete with guides and anchors were necessary.

The Mechanical Contractor shall be responsible for determining where expansion will take place and to ensure the correct measures are provided by providing expansion bellows and loops. Any equipment required shall be supplied from Pipe Solutions Ltd, or equal and approved.

Valves

The Contractor shall supply and install all isolation / regulating valves, commissioning sets, drain cocks, automatic and manual air vents as necessary for the recommended control / isolation of the system and all zones and sub-circuits etc.

The valves indicated on the accompanying drawings are the minimum provision required. Additional valves shall be provided as noted in this and the standard specification and elsewhere as necessary to complete the installation.

Isolating valves shall be provided to all branches (on both the flow and, where applicable return legs at the point of take-off) and to each side of all pumps, coils and plant, at all building entries, at all plantroom exits / entries, to each side of all meters, motorised valves / strainers, etc., to enable their removal without draining other pipe sections All isolating valves shall be line size.

The provision of isolating valves shall be such to permit the removal of an item whilst maintaining service from the remaining items.

Commissioning valve sets shall be installed, fully in accordance with the valve manufacturers' recommendations and instructions.

The commissioning valves shall comprise of a close-coupled double regulating valve and flow measurement device (fixed orifice) conforming to BS 7350.

The regulating hand wheels shall incorporate a means of indicating the number of hand wheel turns from fully closed to the fully open position.

Pressure test pots shall have extended stems to allow valves to be fully insulated without the test valves being covered. Test points shall have coloured cap ties, red to high and blue for low pressure tapping's.

Valves up to and including 50mm shall be screwed, above 50mm flanged.

Prior to ordering any commissioning valves, the Contractor shall submit to the Engineer, for comment, a schedule indicating pressure drops across valves when 25% open and maximum pressure drop when 100% open.

Pressure independent balancing and control valves shall be installed where necessary (generally as indicated on the accompanying drawings). Measuring stations shall be installed alongside all automatic balancing valves in order to prove the flow rate through them. Unless indicated otherwise, commissioning stations shall be provided to the return pipe of all mains and main branches. A double regulating valve shall be provided in the bypass pipe to all 3-port valves.

All commissioning stations, double regulating valves, orifice valves, control valves shall be installed at a size to suit the system requirements.

All Differential Pressure Control Valves (DPCVs) to be tested in accordance with the BSRIA guidance standard BS EN 12266-1 and shall provide pressure protection for specific areas or circuits within buildings, via constant pressure control irrespective of design flow rates.

DPCVs to be inline direct acting type to maintain a constant differential pressure downstream of the valve across a specific zone and mounted in the return pipeline.

The valves to consist of control spring and actuator with valve body and bellows. Valves to have cast iron, malleable iron body, brass or bronze body with stainless steel seat, cone and return spring and phosphor bronze bellows.

Connections to be threaded to BS 21 and BS EN 10226-1 or flanged to BS EN 1092 parts 1,2 or as appropriate

Valves For Air Release

All high points on heating systems shall be provided with one of the following means of venting:

a) Automatic Air Valve of aluminium bronze construction with nickel alloy valve and seat and stainless-steel float. A lock shield pattern gate valve shall be fitted immediately before each A.A.V. and a 10mm copper drip pipe shall be run from the eliminator outlet to discharge in an approved position.

b) Up to and including 50mm nom bore, a full-bore air bottle shall be formed by means of an equal square tee with an 80mm long space nipple terminating in a cap with a 10mm vent pipe taken from the top of the cap in terminate in an agreed position 1.5m above floor level in a 10mm bronze needle valve fitted with a square headed bronze plug into the open end.

Pressure/Temperature Gauges

The Mechanical Contractor shall supply and install the following gauges:

- All gauges shall be 80mm diameter with brass case and brass bezel complete with 3/8" BSP connector and gauge cocks.
- Temperature gauges shall be calibrated in degrees Celsius and be complete with brass pocket for pipework installation.
- The Mechanical Contractor shall make provision, if necessary, with special tee fittings to accommodate the pockets and ensure that:
    - The temperature gauge is positioned such that the pocket is fully immersed.
    - The pockets and length are suitable for each individual application before ordering any specified instruments.
- Pressure gauges shall be calibrated in metres and bar and be complete with gunmetal cocks and syphon tubes.
- Each gauge shall be selected so that where possible, the normal operating condition is indicated by a mid-point deflection.
- Each gauge shall be complete with an adjustable red pointer set to indicate normal operating conditions.
- Gauges shall be located as follows:
    - Pressure Gauges - Pumps, suction and delivery
    - Temperature Gauges - Pumps, suction and delivery
- Ensure that the base of the mating flanges match the base of the flexible connector.

Test Points

The Mechanical Contractor shall select, supply and fix within the pipework installations mechanical seal type test points in the following locations to facilitate the measuring of pressure and temperatures during commissioning and future maintenance.

- Across all strainers.
- At each port of each motorised valve
- On each circuit.

Drain Pipework

All pipework drains from safety valves, etc shall be routed to discharge over floor gullies without any discharge causing splashing or wetting of the floor outside the gully. Refer to Foul Drainage Above Ground.

Sleeves

All pipes passing through walls or floors shall pass through a sleeve cut from a length of mild steel pipe and butt into wall or floor. The sleeves shall finish not less than 2 mm proud of the finished surface of the plaster.

The annular space between the pipes and sleeves shall be adequately filled with rockwool or similar to reduce noise penetration, maintain fire integrity, whilst allowing free movement of the pipe. Sleeves for steel pipe shall be from galvanised material. Sleeves for copper pipes shall be in copper.

Sleeves shall be fixed in such a manner that shall prevent them becoming detached from the building fabric and it shall be the Contractor's responsibility to ensure that they are so fixed, and they do not project beyond the finished surface.

Where pipes pass through external walls of the building or trenches the Mechanical Contractor shall install 'puddle pipes' of the same size and material as the pipework in which they are to be installed. Each 'puddle pipe' shall consist of a length of pipe, flanged at each end and with an undrilled flange midway between the two ends.

Pipe sleeves where exposed to view in occupied areas shall be fitted with wall or floor plates.

Pressure Testing

All pipework shall be pressure tested as per BESA Guide TR/6.

Pre-Commissioning Cleaning

Following successful pipework pressure testing the pipework installation shall be thoroughly flushed by the Contractor, following which system strainers are to be cleaned. Following flushing works the Contractor shall pre-commission clean the whole of the LTHW pipework installation.

The Contractor shall employ a Water Treatment Specialist Contractor to carry out the above treatment works who shall use a suitable non-toxic industrial cleaning agent that is compatible with all materials installed throughout the installation. Method statements and chemical COSHH sheets shall be provided by the Contractor prior to carrying out the works.

The Contractor shall provide a detailed pre-commission clean certificate upon completion of the works clearly stating all equipment, chemicals, methods etc., used.

Locations for necessary system flushing and drain points are to be determined by the Contractor following consultations with the Specialist Water Treatment Contractor.

The Contractor shall ensure the pre-commission cleaning process is compliant with BSRIA BG29/2021.

Corrosion Inhibitor

The Mechanical Contractor shall treat the LTHW installation with a suitable non-toxic corrosion inhibitor to concentration levels as recommended by the inhibitor manufacturer.

The Mechanical Contractor shall ensure that the corrosion inhibitor used shall be in accordance with the heat pump manufacturer's requirements.

Provide identification labels/tags at the sealed system device advising the presence of the inhibitor, type used and concentration.

The Mechanical Contractor shall produce a method statement for the above works together with details of all chemicals to be used and their associated COSHH sheets.

The Mechanical Contractor shall allow, prior to the works commencing, samples to be taken and obtain laboratory results to check the quality of the water. Upon completion of the flushing and water treatment of the entire system, the Specialist shall take samples and obtain laboratory tests to check the water quality; further test shall be carried out after 6 and 12 months. All results shall be issued to the Engineer and included in the Operating & Maintenance Manuals.

The Mechanical Contractor shall provide all necessary inhibitor certification for inclusion within the Operating & Maintenance Manuals.

Testing And Commissioning

The Mechanical Contractor shall allow for the testing and commissioning of the whole LTHW system fully in accordance with the CIBSE Commissioning Code W for Water Distribution Systems, BSRIA BG 2/2010 Commissioning Water Systems and the Standard Specification.

The commissioning process shall ensure that all equipment is programmed, tested and security sealed with the appropriate commissioning data recorded and reported to the Client including opening meter readings for billing purposes.

Thermal Insulation

Thermal pipework insulation shall be installed fully in accordance with the Standard Specification and generally to comprise:

- External pipework
- Plantroom pipework
- Distribution Pipework (Ceiling voids/ducts/floor voids/boxings etc)

Thermal insulation shall be installed in strict accordance with the manufacturer's recommendations, thickness of insulation being in accordance with Section 15 of the Standard Specification.

Oversize insulation to be provided to the adjacent pipework where required to maintain the surface when insulating the fittings.

Trace Heating

Heating pipework at risk of freezing shall be provided with suitable frost protection mitigation measures via utilisation of trace heating systems. The system shall generally comprise a network of self-regulating cables (sized to suit the specified external ambient temperatures), cable connections and controls c./w with all necessary fixings. The controls system shall be monitored via the BMS.

The contractor is to allow for all external pipework from the air source heat pumps into the building, including ancillary apparatus (e.g., buffer vessel) to be suitably trace heated to negate the possibility of water within the pipework system freezing. The system is to be designed in line with the extreme design external temperature.

Labelling And Identification

All new pipework shall be identified with PVC adhesive tape or similar in accordance with the recommendations of BS 1710. All identification tapes shall be colour coded and shall provide the following information:

- Name of service
- Flow or return
- Arrow indicating the direction of flow

Labels shall be clearly legible against the background colour and shall be provided with lettering not less than 6mm high. The identification tapes shall be placed at all pipework junctions, at both sides of valves and items of plant, at floor, ceiling and wall penetrations, and at intervals of not less than 5m on all straight pipe runs.

All plant shall be installed complete with traffolite style labels with lettering not less than 15mm high.

Technical submissions

Submit the following for comment:

- Coordinated Stage 5 working drawings and setting out of services.
- Technical submittals for all items of equipment including:
    - ASHP plant
    - Buffer vessel(s)
    - Heat exchangers
    - Pumps
    - Heat emitters
    - Valve schedules
    - Phex
    - Ancillaries plant such as air / dirt separators, pressurisation units, expansion vessels, anchors / guides, etc.
    - Pipework
- Technical submittals and details for fire stopping arrangements

6.5 Controls

Performance Objectives

Engage a BMS Specialist Sub-Contractor to design, engineer, configure/set to work etc and commission install a simple, OPEN PROTOCOL Building Management System (BMS). The general philosophy and strategy for the controls and relevant associated systems. Project specific details shall be defined within the DFE output specification and SSB.

The purpose and requirements of the control system are as follows:

- Occupant comfort - to maintain the environmental internal conditions that are appropriate to the activity within the space.
- Energy and carbon emissions - to reduce energy consumption and carbon emissions through efficient use of installed Building Services systems.
- Space flexibility - the environmental conditions of the internal spaces shall be flexible where required.
- Safe and simple operation - The Building Services systems shall be safe and simple to operate and maintain.
- Information - to inform the end users about the environmental conditions that affect their thermal comfort. This also extends to informing the end users about the actual energy consumption and carbon emissions of the building.

The system shall be set to work such that it controls and monitors landlords' key systems including heating, water, ventilation plant and energy monitoring in an efficient and intrinsically safe manner whilst maintaining prescribed environmental parameters as detailed in various work sections.

In completing the works, the BMS specialist Sub-Contractor shall comply in all aspects with the criteria as defined by the control's manufacturer, relating to the skills of the engineers employed, methods, standards of workmanship and quality. The system shall be able to monitor record and log all key features so that the End User can undertake interrogation.

Specific Design Parameters

The BMS Specialist Sub-Contractor should note that the whole of the Contract installation works shall be carried out strictly in accordance with British Standards and the latest Edition of the I.E.T Regulations for the Electrical Equipment to Buildings issued by the Institution of Electrical Engineers and the Standards laid down by the National Inspection council for the Electrical Contracting Industry. The central control/building management installation shall comply fully with the edition (including amendments) of each of the following, current at the time of tender: -

- BS 5839 Fire detection and fire alarm systems for buildings
- BS 7671 Requirements for electrical installations (IEE wiring regulations) BS 7799 Parts 1 & 2 Code of Practice for Information Security Management
- BS EN 14154 Water meters
- BS EN 50174 Information technology – cabling installation
- BS EN 61439 Low-voltage switchgear and control gear assemblies
- BS EN 50174 Information technology – cabling installation
- BS EN 61439 Low-voltage switchgear and control gear assemblies
- BS EN 60529 Degrees of protection provided by enclosures
- BS EN 61000 Electromagnetic compatibility (EMC)
- BS EN ISO 4064 Water meters for cold potable and hot water BSRIA Application Guide AG2/94 'BEMS Performance Testing'.
- BSRIA Application Handbook AH2/92 'Commissioning of BEMS - A Code of Practice'. BSRIA BEMS Centre Application Handbook AH1/90 Volume 1 Standard Specification.
- BSRIA BEMS Centre Application Handbook AH1/90 Volume 2 Standard Specification for BEMS Version 3.1.
- BSRIA Application Guide AG 7 Library of Control Strategies BSRIA Application Guide AG 9 Standard Specifications for BMS
- CIBSE guide HBuilding Control Systems CIBSE Commissioning Code C Automatic Control
- EC Directives: Low Voltage Directive 73/23/EEC and amendment 93/68/EEC Construction Products Directive 89/106/EEC
- General Product Safety Directive 92/59/EEC Electromagnetic Compatibility (EMC) Directive 89/336/EEC
- ISO 11801 Information technology. Generic cabling for customer premises
- EN ISO 16484-5 Building automation and control systems - Part 5: Data communication protocol

System Description

Appoint a controls specialist to carry out the design, supply, installation, testing and commissioning of the complete automatic control system to provide control and monitoring of all the mechanical engineering systems and plant installed within the new building, along with monitoring of the status of certain items of electrical and other plant and equipment.

The Building Management System (BMS) must be based on the principle of direct digital communication (DDC) controllers in a communications network mode with all the necessary outstations, cabling, interfaces etc., to provide a fully addressable control system.
The controls system supplied shall use the latest product line.

The system will consist of a Mechanical Control Centre Panel (MCCP) located within the GF Plantroom.

The BMS network is to pick up inputs and outputs from field devices such as temperature sensors, air quality sensors, PIR sensors, control valve actuators, common fault signals and the like. Power to the panel shall be derived from local distribution boards.

The system descriptions provided, mode of operation, control is to assist the Mechanical /BMS Specialist Contractor in determining and understanding the design philosophy for a simple BMS and automatic controls required for the building. It is by no means exhaustive in every instance and the points identified both in this section, the remaining section of the specification and on the tender drawings shall require amplification by the Mechanical /BMS Specialist Contractor to meet the performance objectives of each system specified.

No claims shall be considered for additional control requirements, interfaces, monitoring and metering of the individual systems specified that are not suggested below. The Mechanical /BMS Specialist Contractor is responsible for providing a complete system that is fit for purpose and setting it to work.

A display panel shall be provided at the control panel/MCCP by the specialist. The interface shall allow the user networked access to all controllers and allow access to modules, time controls, set points, graphs, meters etc via a touch screen LCD display.

The system shall use the OPEN PROTOCOL for communication to the operator workstation or web server and for communication between control modules. Schedules, set points, trends, and alarms specified in the Sequences of Operation shall all be OPEN PROTOCOL CONTROLS objects.

The BMS specialist Sub-Contractor shall allow for 4No. return visits/building to site through the year post practical completion for fine tuning of controls loops and systems strategies to validate all system are operating and to ensure building energy consumption is minimised.

All controls (except where specifically noted otherwise) shall be located in a within the plant room. The controls shall be designed, arranged and labelled for ease of use by non-technical staff. In order to extend a time schedule (one-off), modify time schedules or set points or correct time setting it should not be necessary to use any tools or require any specialist knowledge.

The Mechanical Contractor shall employ the BMS specialist sub-Contractor to:

- Supply and install all necessary loose controls, sensors, sensor pockets, pressure switches, control switches, alarm lamps, indicator lamps, control valves and actuators (excl. DPCV's/PICV's), damper actuators, filter pressure switches, panels, controller and network as required to provide a fully functioning system
- Provide all wiring to sensors, stats, control valves etc including wiring of all packaged control systems and loose controls (including Sensors, PIR's etc in order to enable full operation of the system) as necessary by the Mechanical Contractor as well as any wiring/setting to work of packaged control systems not set to work by the manufacturers or specialists. Generally power outside of the plantroom shall be via the Electrical Contractor, power within the plantroom to be provided by the BMS specialist.
- Provide fully detailed control panel drawings to the satisfaction of the CE.
- Provide fully detailed control sequence drawings to the satisfaction of the CE.
- Provide all secondary sub-meters as indicated within the tender specification and drawings highlighted for data collection on the energy management system described below.
- Test and commission the entire controls installation
- Provide operator training and operating and maintenance manuals.
- Provide attendances on commissioning engineers
- Provide additional 2No. days attendance/building for additional demonstrations/performance testing or each building
- Provide attendances for seasonal commissioning visits throughout the 12 months defect lability period
- Provide inverter drives to each motor where inverter drives are required to that plant
- BMS shall be IP addressable, and the End User site interface shall be capable of accessing the entirety of the BMS system of controls from off-site via suitable graphic web pages (to be approved and agreed with the Client and End Users.
- A BMS/central control system common alarm panel shall be provided together with local mute button and alarm acknowledgement button shall also be provided within the management suite. The panel shall provide a visual and audible alarm and distinguish between general alarm and critical alarms (i.e. faults/issues on life safety and building water systems).

Where room mounted controllers/sensors are required these shall be flush mounted and to the approval of the Architect and CE. THE FINAL POSITIONS OF ROOM CONTROLLERS AND SENSORS SHALL BE APPROVED BY THE CE/PM.

The BMS specialist shall look to review the specific requirements of the local packaged controlled where specified for a particular system in order to ensure complete integration and coordination with the BMS provision and scope.

The Mechanical Control Panel shall have screw-on-front, rear, top and bottom panels, and shall be protected to IP54 minimum and shall have a polyester powder finish. All ingoing and outgoing cabling shall be from above and shall be front access. The panel shall be constructed to FORM 2 to BS EN 61439-2:2011. All controls shall be in a separate section to the 240/415V power feeds. The 240/415V section shall be complete with door-interlocked isolator. Short-circuit protection for outgoing motor main circuits shall be provided by suitably sized MCCBs. Overload and single-phasing protection shall be provided by overload relays. Short-circuit and overload protection for control panel control circuits and outgoing circuits other than motor circuits, shall be provided by Merlin Gerin MCB's, Type 3 M9.

Inverter drives where provided may be located local to plant or within the Mechanical Control Panel.

Each BMS controls panel/outstation shall have space for extending the controllers therein by 25%.

Each inverter or motor drive supplied from our control panel shall generally be provided with a HAND/OFF/AUTO selector switch. Where duty / standby motors are provided, an addition No. 1 / No. 2 switch shall be provided.

The control panels shall be interlocked with the fire system to disable the plant in the event of an alarm. The fire specialist shall install adjacent to each control panel an addressable fire relay that the BMS specialist shall make the final connect to.

Each control panel shall be provided with a door interlocked isolator, power on lamp, 24Vac controls transformer, relays, contactors, MCB supplies, H/O/A door switches & LED lamps on traffolite labels. All cabling shall be wired from its respective controllers, relays, MCB's to prewired terminal rail.

Drawings

Control panel external layout and wiring drawings shall be produced using AutoCAD on A3 sized paper. All control panel equipment shall be labelled with a dedicated reference. All wire and terminal numbers are to be shown. The control panel drawings shall be issued with drawing numbers that refer to the particular contract. A full set of ‘as manufactured’ drawings shall be provided with the panel housed in an internal drawing pocket.

Safety

Panels shall be constructed with components that meet IP20 standards to allow safe live testing with the door open. All control circuits shall be 24VAC. All phases, including incoming isolator terminals, must be fully shrouded. Terminals having live feeds from external equipment shall be shrouded and carry a warning label.

Enclosure

Control panel enclosures shall be designed to meet IP54 protection standards. Control panels shall be manufactured to Form 2 or 'wardrobe' type construction with separate starter and controls sections. Each individual starter shall be covered by transparent plastic and fitted with an interlockable isolator.

Panel body and doors shall be of sufficient thickness (1.5 - 2.0mm) and braced to form a rigid structure. Doors shall be braced as necessary to prevent flexing. The equipment mounting plates shall be of 2.5mm galvanised sheet steel and equipment mounting shall be by screws into tapped holes to enable replacements to be made from the front only.

Wall mounting panels shall not exceed 1200mm in height. Panels exceeding 1200mm in height shall be of the floor standing type.

Floor standing panels shall be manufactured and delivered to site as a single item. Panels can be split into sections if required for site access.

Floor standing panels shall have provision for lifting eyes and for fixing to a concrete plinth.

All panel doors shall be lockable in the closed position and all locks shall use the same key.

The controls section door shall not be interlocked.

Natural or forced ventilation shall be provided to prevent the internal temperature exceeding a maximum of 40°C.

Finishes and labelling

Panels shall be finished in RAL 9005 black. Internal mounting plates shall be galvanised steel. Panel fascia labels for plant control and indication shall be white traffolite with black lettering. Standard sizes for labels shall be 100mm wide by 200mm high or 200mm wide by 200mm high and shall cover the entire area taken up by the relevant equipment (e.g. switches and associated lamps). All fascia labels shall be fixed with bright finish pan head screws. Warning labels shall be yellow

self-adhesive type with black lettering. Internal labels shall be clear self-adhesive type with black lettering fitted to the grey trunking lids.

Wiring, identification and labelling

All internal panel wiring shall be in accordance with IEE wiring regulations. Power wiring shall be tri-rated (stranded) in phase colours with a minimum size of 2.5mm^2 and a maximum size of up to 6.0mm^2.

Power wiring 10.0mm^2 and above shall be black cables with terminal sleeves in phase colours.

Control circuit wiring shall be kept physically separated from other circuits within the panel and shall be tri-rated cable (stranded), with a minimum size of 1.0mm^2.

The cable colour coding shall be as follows:

- 400VAC Brown/black/grey/blue
- 230VAC Brown/blue
- 24VAC Red/orange
- 12/24VDC Violet
- Controls cables (ELV) White

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

Wiring shall be carried on the front surface of the mounting plate neatly strapped in suitably sized, ventilated, plastic cable trunking.

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

Wiring to movable doors shall be loomed and protected with spiral wrap.

Wiring outside the trunking or loom shall be neatly set for connection to terminals or equipment.

All control wires shall carry numbered ferrules at both ends.
Each incoming and outgoing cable shall be separately terminated with an approved crimped terminal to suit the terminal use.

Terminals for control wiring shall be of the Entrelec type and sized depending on rating.

Terminals for power wiring shall be of the Entrelec type and sized depending on rating.

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

No more than two wires shall be connected to any one terminal.

Insulating barriers shall be fixed between adjacent terminals for power wiring to give adequate protection while allowing easy access to terminals.

Cable entries

Removable gland plates shall be provided for terminating incoming cabling. All plates shall be sealed against the ingress of dirt, dust and moisture.
All entries for cables shall be easily accessible and marked to correspond with the panel-wiring diagram of external connections.

Controls section

The controls section shall house the DDC (Direct Digital Control) controllers and any power supplies, interface relays and terminals as detailed on the drawings. An internal, shrouded on/off switch shall be provided to allow isolation of the controls section. The power supply to the controls section should be taken from the live side of the main incoming isolator. Controller input cables shall be screened, and a terminal shall be provided for each cable's screen. The cable from the incoming terminals to the controller shall continue screened with the screens grounded to clean earth bars adjacent to the controllers. A 13A socket shall be provided within the controls section for supplying test equipment. The socket shall be labelled "For computer use only".

Isolators

Main isolating switches and fuse switches shall be capable of opening and closing on-load and shall be suitable for 50Hz, three phase, four wire operation.

Miniature circuit breakers

All protective devices shall be miniature circuit breakers (MCBs). MCBs shall be selected in accordance with manufacturer's recommendations to suit the application. The circuit breaker mechanism shall be of the current limiting type to ensure interruption of a fault current during the 'rise' of the first half cycle, thus limiting the let-through energy. The operating mechanism shall be completely trip-

free, and it shall not be possible to prevent the breaker tripping by holding or wedging the handle in the 'ON' position.

Contactors

Contactors shall be suitable for use on three phase, four wire 400/230V, 50Hz supplies and fitted with 24VAC coils, unless otherwise detailed.

Motor overload protection

Motor protection shall be provided by breakers with combined magnetic (short circuit) and thermal overload releases. Also, protection against phase loss shall be provided by a differential trip. The device shall be suitable for providing isolation and shall accept a padlock. Motor protection devices above 37.5kw shall be of the electronic type. All motor protection devices shall be arranged for hand resetting.
Interlocking relays

Plug-in type relays shall be interchangeable with equal numbers of 'N/O' and 'N/C' contacts. Relays operating on different control voltages shall be grouped and labelled with coil voltage.

All relays shall have an integral status indication and manual override.

Switches

Control switches shall be of the rotary type, comprising a switch handle fixed to the panel fascia and the required number of contacts fitted to the rear of the bezel. Control switches shall have black handles unless specified as key-operated and shall have a protection index of IP54.

Indicator lamps

Indicator lamps shall be multi-cluster LED type and generally operate on 24vAC. 230vAC lamps shall only be used for mains supply status indication. A lamp test button shall be fitted to each panel. Colours of lamp lenses shall be as detailed in BS4099.

- Green Motor running
- Red Motor tripped, alarm
- White Power on, control circuit live
- Amber Flow fail, filter dirty

All lamps shall be long life LED type

The BMS Specialist Sub-Contractor shall provide a common alarm output from the panel that shall illuminate an orange warning light to be provided within the ground floor reception area. The lamp shall remain illuminated until reset at the

relevant panel. The alarm shall act as a prompt for the maintenance team to interrogate the BEMS, determine and rectify the system fault as necessary.

Inspection and Testing

All control panels shall undergo a final inspection and test procedure.

Each control panel shall have its own unique test certificate and serial number.

Despatch

Control panels shall be despatched with a set of 'as manufactured' drawings.
Control panels shall be despatched with a copy of the test certificate.

Electrical power and control wiring:

All field controls wiring emanating from the control panel shall be carried out by the Automatic Controls Specialist under the electrical section of the works.

The controls specialist shall allow to provide:

- Primary & secondary containment within the plant room for all Mechanical Plant and BMS power & control wiring associated with the mechanical installation. (Power to BMS panel by Electrical Contractor)
- Secondary containment outside of the plant room to field devices.
- BMS wiring of all mechanical systems as required in order to provide complete operational controls. Extra—low voltage power supplies to items such as solenoid valves etc shall be derived from the MCCP.
- Final power connections to all plant from local isolators to plant by the Electrical Contractor based upon wiring diagrams provided by the BMS Contractor.
- Wiring of all loose controls and systems in order to ensure a full controls system is provided.

The Electrical Contractor shall provide:

- Primary containment outside of the plant room for all Mechanical Plant and BMS power & control wiring associated with the mechanical installation. This shall include containment for all power and controls (ELV etc) as required. Secondary containment to power mechanical plant shall also be provided.
- Electrical distribution wiring to power all mechanical plant and equipment up to local isolators as well as final connections to the plant and allow for the complete testing in accordance with BS 7671.

The BMS Controls Specialist shall then allow for final distribution from the isolator and connection, as necessary. The BMS Controls Specialist shall also be responsible for the supervision of the electrical works associated with all equipment supplied, liaison with the other parties responsible for wiring associated with interlocks and connection of the control panel, to ensure that complete connection and termination details are supplied to the Electricians, therefore eliminating any problems which could arise during all periods of the installation and commissioning of the works. The mains supply feed to the control panel and fire alarm specialist wiring shall be supplied by the main electrical Contractor.

The containment (primary) and secondary within the plant room shall be installed by the BMS specialist and the containment (Primary) external to the plant room shall be installed by the main electrical Contractor. The BMS specialist is allowed to run network cabling and sensor cabling that runs outside the plant room on this containment provided by the main electrical Contractor. Secondary containment by the BMS specialist. Power supplies for all mechanical services equipment shall be derived from dedicated local mechanical distribution boards.

Control Panels

Provide each panel fascia with phase healthy lamps, LED lamp test button and control circuit failure lamps. All lamps shall be of the LED type.

Provide each panel fascia with an LCD controller / display to allow interrogation of the BMS at a number of levels. Provide as a minimum, password protected operator access for the following levels:

- Level 1: Ability to display monitored data
- Level 2: As level 1 with the ability to initiate data logging
- Level 3: As level 2 with the ability to change user-adjustable set points and time schedules
- Level 4: As level 3 with the ability to change control strategies, schematic/graphic functions and password assignment.

Ensure that password protected operator access is set up for both operator workstations and field controllers which have an operator interface. Ensure the passwords permit at least eight alpha numeric characters. Ensure that the BMS software is protected from unauthorized entry. Ensure that the BMS complies with ISO/IEC 27001 and BS ISO/IEC 17799.

Space shall be afforded in each motor control panel for the installation of additional outstations to accommodate a 20% increase in the number of points for each point type without compromising the system functionality or speed of operation.

The following tables schedule out a summary of fascia mounted controls and indicators required.

Summary of controls for MCCP (for each building)	
Plant	Comments
ASHP's	Packaged controls by manufacturer interfaced via Modbus or BACnet to BMS with full read/write interface: General Heating ASHP's TV Studio reversible ASHP's
Primary Heating Circuits pumpset	Duty and standby with auto changeover rotation for heating. Each pump to have hand/auto/off local control for heating Indication of pump failure at BMS/boiler panel/locally. Variable speed control based upon differential pressure controls.
Buffer Vessel	Monitored for temperature high and low level
Secondary Heating Circuits pump set	Duty and standby with auto changeover rotation for heating. Each pump to have hand/auto/off local control for heating Indication of pump failure at BMS/boiler panel/locally. Variable speed control based upon differential pressure controls.
Heating circuits – Weather compensation	Centralised control from heat source/boiler control panel either optimiser or time clock control with automatic daylight-saving correction (BST/GMT changeover). ASHP control should be weather compensated as well as based on spaces served e.g., if all AHUs or thermostats indicate no heat required then heating boiler and pumps should turn off.
Pressurization unit(s)	Pressurization set fault. System high/low pressure alarm

Summary of controls for MCCP (for each building)	
Plant	Comments
Trace Heating System(s)	Fault monitoring (packaged controls)
Temperature monitoring	External air temperature. Domestic hot water flows and return via BMS. Heating flow and return via BMS.
Metering	Main water meter Water sub-meters (1No./building) PV energy generation ASHP power consumption (HH) ASHP heat generation (HH) LTHW heat generation (HH
General	Panel mounted fascia interface / display screen Head End PC interface for data recording and logging for M&T.
Fire	Fire alarm interface and automatic shut down
Emergency shutdown	Emergency shutdown facility

Items with Independent Control Panels

All plant with independent controls shall be provided with a volt free contract to provide common alarm status to the BMS. Additional levels of BMS interface with remote plant are required as set out in each specification section. Relevant systems include, but are not limited to:

- ASHP systems
- Pressurisation units
- Pumps

Main Water Meter

An incoming main water meter shall be provided on the cold-water service entering the site. The meter shall be supplied complete with pulse counter for connection to the DDC system within the control panel to monitor building water consumption.

Water Sub Meters

Water sub-meters shall be provided where indicated on the metering schematic.
Electrical Metering/Monitoring

Provide hours run monitoring to every motor and item of plat that is electrically served from the respective MCC to achieve compliance with Part L.

- Provide kWhr monitoring for each mechanical plant DB with indication to the BMS. Provide kWhr monitoring for each lighting distribution board with indication to the BMS.
- Provide kWhr and max demand monitoring at the main LV switchboard with indication to the BMS. Monitor lift alarms.
- Monitor status of on/Off/Auto selector switches for external lighting. Monitor photocell for external lighting.
- Ensure that all water, gas and electricity power consumption meters are provided with pulsed output units and are monitored by the BMS.

Hardwired Interlocks

Provide hardwired interlocks for the following system plant groups:

- Dedicated high- and low-pressure switches & pumps
- Fan flow proving switches & motorised valve end switches.

Fire alarm inputs from interface units to each motor control panel for plant shut down

Alarms

Ensure that alarm data provides:

- condition identity
- condition value
- alarm source
- alarm time and date
- acknowledgement status.

Ensure that the operator can acknowledge alarms, including muting of audible or flashing annunciators. Provide the facility to acknowledge alarms individually or on a group basis.

Ensure that alarms can be configured to ignore start-up and shut-down delays. Provide a facility for the operator to adjust the triggering limits of alarms.

Ensure that alarms can be prioritised (including a high priority that shall be enunciated regardless of other activity) and a low priority or information status that is only enunciated on demand.

Ensure that visual, audible and printed annunciation of alarms, or any combination of these, can be selected by the operator.

Field Controllers

Use field controllers that meet the requirements of BSRIA AG9.

Fit field controllers with battery back-up (minimum backup capacity of 72 hours). Ensure field controllers can perform all control actions independently of the operator workstation.

Ensure field controllers can operate with the loss of shared data, through the use of either default values or final data reading before the loss of network communications.

Construct field controller enclosures to IP45 in accordance with BS EN 60529. (Where the field controller is fitted inside a control panel that is protected to IP54 then the field controller protection can be reduced to IP41.). Ensure field controller enclosures are lockable.

Ensure that the interfaces for the field controllers are appropriate for gathering data from sensors and devices.

Ensure that the interfaces for the field controllers are capable of providing control signals to actuators and switching devices.

Data Monitoring and Logging

Log the hard and soft points of each field controller.
Provide the facility for the operator to set / stop times and logging frequency at the operator workstation.

Ensure each log can be defined in terms of:

- Log identification
- Units
- Date / time stamp

Control Valves and Actuators

Provide control valves and actuators to meet the requirements of BSRIA AG9.
Unless otherwise instructed by the Engineer, only use modulating type control

Use valve bodies that are fit for purpose and comply with the following:

- Sizes 15-50mm - screwed connections.
- Sizes 65mm and above - flanged.

Control Damper Actuators

Provide damper actuators to meet the requirements of BSRIA AG9. Co-ordinate with the Mechanical Installer to ensure that the damper and its linkages match the control requirements, and the actuator matches the damper.

Use either modulating or on/Off damper actuators. Ensure modulating actuators are supplied with 24V AC and are positioned by an analogue signal from the BMS. Ensure On/Off actuators are supplied with 24V AC Open/Close signals from digital outputs on the BMS.

Fit dampers with position indication, actuator feedback position indication and a direction reversing switch. Fit auxiliary switches as an indication to remote devices. If damper assemblies are greater than 1m2, electrically connect the damper motors as master / slave units.

Alarms shall be raised on the BMS on an individual damper basis should the position feedback signal differ significantly from the damper control signal.
If damper motors are required to fail open or closed or provide an instantaneous open to closed or closed to open reaction, use a spring return mechanism, activated by a break in the electrical supply, connected to the motor.

Temperature Sensors
Provide temperature sensors to meet the requirements of BSRIA AG9.

Humidity Sensors
Provide humidity sensors to meet the requirements of BSRIA AG9.

Tank Level Switches
Fit horizontally mounted magnetic level switches, which are fit for purpose, to cisterns, oil tanks etc.

Use flange mounted units of glandless construction. Use a material which is fit for purpose for float assemblies.

Manufacture the switch housing to protection class IP45 or better, use electrical contacts for changeover action.

Differential Pressure Switches
Use industrial quality pressure switches. Use a nominal setting of 5.5 bar and a differential not exceeding 0.6 bar for compressed air measurement. Use a nominal setting of 200 Torr and a differential not exceeding 20 Torr for vacuum switches.

For pressure switches at roof plant level, construct enclosures to protection class IP65. For all other pressure switches construct enclosures to protection class IP54. Use electrical quick break contacts with a minimum rating of 250V AC, 10A resistive. Configure contacts for a changeover action

Screw pressure connections to accept standard compression type couplings of a type suitable for the duty.

Frost Protection
Ensure that when the outside temperature falls to the operator set minimum frost-protection temperature, the selected pumps start, and circulation is established through pipework systems and their components. Allow the operator to pre-select which plant is to be started. The automatic standby plant is to operate on failure of the duty plant.

Ensure that when the return temperature falls below the operator pre-set minimum, the full frost- protection facility is initiated. Ensure that for heating systems, the heat

Operated to maintain the return flow temperature above the pre-set minimum. Ensure that specified protective devices activate for other liquid systems.

Protect air handling unit pre-heat coils with a capillary type of thermostat (mounted in a serpentine configuration on the downstream face of the coil with suitable support clips). Set the thermostat to operate at an air temperature of +5°C. Use automatic reset type air frost protection thermostats. Ensure maximum switching differential of the thermostat is 2°C. Ensure auto reset frost thermostats operate in conjunction with the frost coil return water immersion temperature sensor.

Provide a facility to allow frost protection to be logged together with data and time.

Water Flow/Heat meters

Provide water flow meters to meet the requirements of BSRIA AG9.

Ensure each device can measure the flow down to 10% of the rated flow of the device and is capable of a pulsed output to the BMS to signify the quantity of water/energy used.

Software equipment

Provide operating and supervisory software as necessary to meet the requirements of this specification and the BMS.

Use IT industry standard operating systems verify that licences to use software applications are owned by the client.

Take all necessary steps to prevent unauthorised access to the software.

Graphics

Prepare interactive web-based graphical diagrams, to display real-time data of any PC with the IP address and system passwords. These diagrams shall represent, on a system-by-system basis, the inter- relationship between system and plants both in overview and in detail.

Initially, provide each diagram on purpose-prepared sheets, which shall enable the diagram to be mapped to the screen pixels.

Prepare overview diagrams for each major system or group of systems (e.g. Heating, cooling, ventilation, electrical utilities etc). Ensure these diagrams show overall distribution and function in a clear concise manner. Provide all overview diagrams with corresponding terminal unit controller diagrams.

Ensure overview diagrams are detailed diagrams relating to one or more groups of plants (e.g. All fan coil units,) served by the system. These diagrams shall

Ensure all diagrams are inter-related, enabling the user to page from a system overview diagram to a detail diagram of a plant served by the system, and then to a different overview diagram of another system serving the same plant (e.g. Heating system to air handling unit to chilled water system).

Use only codes and designations employed within the system when annotating each diagram.

Ensure each graphical page starts to display within 2 seconds and is complete (with all analogue set pints, actual values, alarm values and status displays) within 7 seconds. Update all variable data on the display every 10 seconds. Provide the ability to change this update rate.

The speed of response, displays and action, quoted within this Specification are based on the following criteria:

- That the test graphic is dynamically updating on the screen
- A minimum of 20 analogue values
- A minimum of 10 digital values

Details of test procedures are contained at the end of this section - "Test Requirements".

Provide a software library of plant schematics and symbols. Provide a facility to allow the operator to modify plant schematics and to generate new ones.

Integration with Fire Alarm Systems

Obtain approval from the relevant Fire Prevention Officer or Building Control Officer. Comply with the requirements of BS 5839.

Ensure the fire alarm system can run autonomously and shall not be affected by failure to the BMS. Ensure the BMS shall not be affected by failure to the fire alarm system.

Provide the display of fire alarm detector status information on the BMS operator workstation.

Provide any specified building graphics/schematics on the BMS operator workstation indicating the location of fire detector heads or zones.

Ensure that a fire alarm condition automatically displays the appropriate building graphic/schematic along with relevant detector head status or zone status.

Ensure that any specified building services control actions operate correctly in response to the status of the fire detection system.

Identification of electrical services

Comply with 18th Edition BS 7671.

Identify and label all system components in accordance with, BSRIA AG 9 (Clauses B3.1.3 and B3.6.3).

General Testing and Commissioning

Test and commission the system in accordance with Specification sections A32/8000 Y53 and Y81, BSRIA AG 9 Part C2 and CIBSE Commissioning Code C – Automatic Controls.

Undertake tuning of control loops as necessary in accordance with CIBSE Commissioning Code C.

Work Tests

Fully test and demonstrate all control panels/motor control centres at the manufacturer's works prior to delivery to site.
Demonstrate operation of the complete system including process and

Provide a programme and submit a method statement for each test.
Where external signals are required, provide these using physical connections to a test rig facility (i.e. Potentiometers/switches/lamps etc.).

Performance and Acceptance Tests & Handover Requirements

The detailed requirements for handover are set out in the DfE's EIR.

A full 7-day period of 'soak testing' shall follow on from the successful commissioning and testing activities. This shall be repeated seasonally across the defect's liability period. i.e. winter and summer occupation.

Soak Testing

A soak test of all the controls in their normal/auto operation mode shall be carried out, prior to Completion, as if the building were occupied and in use.

The soak test shall be programmed to occur after completion of all setting to work, commissioning and testing of the mechanical and electrical services. This is to prove their reliability and correct calibrations over a continuous period of 7 days.

Practical Completion shall not be granted until a successful soak test as described here has been achieved and documented.

It is not necessary to install additional dummy loads into rooms to prove system performance at the maximum design.

All control systems shall be fully energised and placed in their normal/auto operation mode with all normal occupied time settings applying to:

- Control systems
- Energy metering and monitoring systems

The soak test shall meet the following requirements:

- The test shall be included in the programme for the Works and shall continue until seven continuous days of plant operation have occurred without fault or failure of any component/function.
- Monitor all functions (plant operating times/starts per hour/energy and water use) which shall be trend logged using the microprocessor controls equipment where installed. [Ac_05_50_54]
- Each type of space served by the plant and equipment shall be monitored using data loggers (supplied by the Mechanical or Electrical Contractor) or the BMS system to verify the performance.
- Specified noise performance surveys shall be carried out during this period.
- All data and monitoring results shall be provided to the Employer in Excel spreadsheet format (electronic and hard copy) along with details of any faults arising and corrective action taken.
- Should the soak test fail for any reason, then the results shall be null and void and the test period shall re-commence upon rectification of the problem/failure.
- All costs associated with the soak test, such as test equipment, attendance and supervision shall be at the Contractor's expense.
- Costs incurred as a result of or a consequence of having to restart the soak test shall be at the Contractor's expense.
- The soak test results shall be included in the Health and Safety File.

Documentation

A detailed description of the controls systems and operating instructions shall be included in the operation and maintenance manuals.

All testing and commissioning certificates shall be submitted prior to Practical Completion and that the certificates include the test equipment identity and certificates of calibration.

A hard copy and an electronic copy of the testing and commissioning certificates of the controls systems shall be submitted with each copy of the Operating and Maintenance Manuals and 'As Installed' (record) drawings.

The controls documentation shall include the optimum settings for all controls systems as well as product description, date of purchase, performance characteristics, application (suitability for use), method of operation and control, and cleaning and maintenance requirements.

'As Installed' (record) drawings and information for the Operating and Maintenance Manual and Building Logbook relating to the controls system shall be submitted which include all controls cabling, the cable origin, circuit designation, route, conductor material and insulation type and colour, number of cores per cable, number of cables in ducts, on tray or ladder and location of control panels, equipment and repeater panels.

A hard copy and an electronic copy of the cable schedules relating to the controls system shall be submitted with each copy of the Operating and Maintenance Manual.

A Building User Guide shall be provided which includes a user-friendly description of all controls and an overview of the control's philosophy. It shall include a short, illustrated guide for each type of space e.g., classroom, hall, practical space, describing how to control the ventilation, lighting and heating for the user(s) of the space(s).

The Building User Guide shall be provided in hard copy and electronic format as detailed in the DfE's EIR.

Commissioning and Building Performance Evaluation

The controls systems shall be fully commissioned throughout prior to handover. The building services systems shall be commissioned such that where control systems interact with each other they are commissioned at the same time in order to simulate this interaction as accurately as possible.

The Building Services control systems shall be commissioned in accordance with CIBSE Commissioning Code C: Automatic controls (refer to Technical Annex 2F for details of seasonal commissioning required).

A commissioning programme shall be provided prior to construction. The programme shall capture a two week notice period prior to witness testing.

Inspection and testing shall be undertaken in line with BS 7671 'Requirements for electrical installations. IET Wiring Regulations'.

The controls system shall be commissioned in accordance with BSRIA AG 9/2001 'Standard specifications for BMS'.

Building Performance Evaluation and Seasonal Commissioning shall be carried out in accordance with section 8 of the GDB. Performance testing/proving shall be carried out during the 12-month defects period. Seasonal commissioning of the control systems shall be carried out during the 12 months after handover (during the defects liability period) to fine tune control settings.

The Contractor shall also run, monitor and maintain the systems for a minimum period of 1 week before handover. During this period, the required demonstration of the system and controls shall be undertaken in line with the requirements set out in the DfE's EIR.

Demonstration and Training

The detailed requirement for training and familiarisation is set out in the EIR. The Contractor shall provide dedicated training to the Employer's and any nominated representatives.

In the event that a facilities management team has not been appointed prior to Practical Completion, the Employer shall be responsible for selecting an appropriate
representative for the training procedure.

The Employer shall then be responsible for ensuring that the training is passed on accordingly.

Demonstrating Compliance

The Contractor shall demonstrate compliance with the Employer's Requirements by use of protocols detailed in the Contractor's Quality Assurance procedures capturing evidence of both coordinated design and its implementation into the construction of the building(s) with photographic evidence and / or third-party accreditation

Demonstration & Handover

Following satisfactory commissioning, validation and testing, demonstrate and handover the system in accordance with BSRIA AG 9 Part C3.

Provide Operation and Maintenance Manuals and all software and associated licences in accordance with specification section A37 and the requirements of BSRIA AG 9 Part C3.

Operator Training

Provide operator training for up to four personnel to Intermediate Operator (or Basic Operator or Advanced Operator) level as defined in Part C4 of BSRIA AG 9.

Systems handover

The Controls Specialist shall ensure the following are completed prior to practical completion:

- Any snagging to be documented and an agreed date determined for clearance
- All password/PIN numbers, levels and operators recorded
- Electronic copies of all system and data files supplied
- Proprietary software manuals and disks supplied
- All equipment access keys supplied
- Complete set of O & M manuals with any agreed amendments/ additions required to be documented and a target date for the completion agreed
- Training/instruction of Engineers and operators.
- Controls system description of operation, user guide for inclusion in Operations and Maintenance manuals plus one copy affixed to inside of control panel door.

Graphics and software

The BMS specialist shall provide all necessary licenses and software for a new interface to be installed the existing site central supervisor dedicated PC provided by the BEM Specialist suitable specification for storing and managing the logged data.

Software graphics

The BMS specialist shall allow for production web-based graphics. Graphics are to be offered to the Client for approval prior to commissioning. A dedicated Server by the BMS specialist shall be provided to the Client requirements and located in the new Laboratory comms room.

Post-handover attendance

The Controls Specialist shall include in their tender an allowance for system tuning via autodial and visit to check correct operation of all plant which may exhibit changes in stability due to settling in or seasonal conditions. This shall be based on 2 No. visits to site and shall be used at the discretion of the Client during the warranty period. This shall be in addition to the defect liability responsibilities under the contract. The purpose of these visits is to allow for fine tuning/adjustments due to differences in dynamic thermal performance due to:

- Occupation of people and equipment
- Seasonal variations from those at initial commissioning stage

Maintenance Contract

With the tender return, provide quotations for one- and five-year maintenance contracts in accordance with BSRIA AG 9, Part C (5).

Technical submissions

The Installer shall submit for the Engineer's comment:

- Wiring diagrams
- Descriptions of operations
- Control panel fascia proposals
- Points Schedules
- Sample Graphics
- Layout Drawings
- Software Licenses
- Commissioning/witnessing method statement and programme
- Operating and maintenance instructions for all items of equipment
- With the tender return provide a summary Contractor's Proposals for control system including BMS specialist details/qualifications and experience, proposed open protocol controls system, design, installation, commissioning, validation and maintenance. This should include details of the proposed communication protocols.

Controllers & Points

The Trend Controls BMS controllers and associated expansion modules shall be sized to meet the analogue and digital, inputs and outputs of the system, with approximately 25% spare capacity. All plant shall be controlled from digital & analogue outputs from the BMS controller.

Point Name	AI	DI	AO	DO	Network
Water Metering					
Site Meter					M Bus
Landlord BCWS Meter					M Bus
Heat Meters	2	2	2	2	M Bus
Temperature Monitoring					
Temperature Sensors	4				
External Weather Sensor	2				
Space Temperature Sensors	3				Via Mitsubishi AE200
Building Monitoring					
Smoke Vent System Fault		1			
Door Access System Fault		1			
CCTV System Fault		1			
ASHP's					
Common Fault	1	1	1	1	Common Fault
Common Enable	1	1	1	1	Common Enable
Buffer vessels temperature sensors	4	4	4	4	
2Ports Valves	3	3	3	3	
3Port Valves	3	3	3	3	
Pump Controls	5	5	5	5	
Solar PV					
Common Fault	1	1	1	1	
Common Enable	1	1	1	1	
Metering					M Bus
Electric Metering					
Main LV Board Meters					Modbus
Landlord Distribution Boards Power/Lighting					Modbus

6.6 Thermal Insulation

Performance Objectives

Engage a specialist sub-Contractor to provide the necessary insulation for the building services as described with the tender package.

Specific Design Parameters

- BS 5422: 2009 Method for specifying thermal insulating materials for pipes, tanks, vessels ductwork and equipment operating within the temperature limits, -40°c to +700°c.

- BS 1710: 1991 Identification of pipelines and services.
- BS 6700: 1997 Specification for design, installation, testing, and maintenance of services supplying water for domestic use within buildings and their curtilages.
- Building Regulations (England & Wales) Approved Documents Parts L2 (Conservation of fuel & power) & Part B - (Fire safety)
- Green Guide to specification (A or A+ rating as necessary)

The Environmental Thickness Tables in BS 5422:2009 are specified as the basis of qualification for Enhanced Capital Allowance for pipe insulation and as a means of compliance with the Building Regulations (England & Wales) and the Scottish Building Standards.

System Description

Thermal insulation materials and their installation when applied to the following mechanical engineering services.

- Hot and Cold-Water Services
- LTHW Heating System
- Above Ground Drainage

Thermal insulation and methods of application shall comply with the requirements of BS: 5422:2009 as well as Part L of the Building Regulations as applicable to the installation to be insulated.

All materials shall be used in accordance with the manufacturer's recommendations.

A specialist thermal insulation sub-Contractor who is a Member of the Thermal Insulation Contractors Association shall carry out all thermal insulation work. The sub-Contractor shall be fully acquainted with all the site conditions and programme of woks and shall execute his works within such confines and programme.

The sub-contractor shall include for the supply, delivery and installation of materials necessary for the thermal insulation of systems described in this specification.

Thermal insulation shall not be applied until the pipework or ductwork installations have been tested and approved by the Engineer.

Thermal insulation materials and finishes shall be inherently proof against rotting, mould and fungal growth and attack by vermin, be non-hygroscopic and in all respects be suitable for continuous use throughout the range of operating temperatures and within the environment indicated.

Any work not of acceptable standard shall be removed and replaced at no additional cost to the contract.

All insulation materials and finishes shall be installed in accordance with the manufacturer's recommendations.
Insulating materials shall have Zero Ozone Depletion Potential and zero Global Warming Potential.

No insulation material containing CFC or HCFC components shall be accepted.

Fire rating of insulation materials

All insulating materials and facings installed within buildings shall be;

- Class O in accordance with the Building Regulations (England & Wales)
- Low Fire Risk in accordance with the Scottish Building Standards.
- Specific Optical Density of Smoke Generated less than 20 In accordance with BS 6401.

Insulation materials, adhesives, sealants and facings installed on pipework, ductwork and equipment external to buildings shall be rated as Class 1 when tested to BS 476: Part 7: 1997.

Pipework systems

Cold water, Rainwater insulated, and vapour sealed.

Hot water services insulated to suit temperatures.

Cold water services insulated, and vapour sealed.

Refrigeration pipework systems insulated with Armstrong Armacheck – class 'B'.

Heat exchangers, hot water cylinders and Water Heaters insulated to suit temperature (using proprietary jackets)

Pipework exposed on roof or other external locations, unless otherwise indicated, insulation shall be as above with weatherproof finish.

Internal and external water storage tanks

All tanks shall be provided pre–insulated and vapour sealed.

Valves, flanges and unions

Unless otherwise indicated, all Valves and flanges/fittings shall have removable covers, Velcro, removable jackets All valve wraps can be easily installed and removed

via Velcro fastenings. Valve wraps to be the same thickness and type as on adjacent pipework and also vapour sealed on services operating below ambient temperature.

Insulating materials

Pipework Systems up to 100°C Insulation shall be, CFC & HCFC free, 35 kg/m^3 nominal density, pre-laminated phenolic foam sections, with an autohesively applied outer facing isogenopak finish.

The aged thermal conductivity of the insulant shall not exceed 0.021 W/mk at 10°C mean temperature.

The insulation shall be Class O rated to the Building Regulations (England & Wales) and Low Fire Risk to the Building Regulations (Scotland).

Insulation thickness is to be determined in accordance with BS 5422:2009, from the tables in of this specification.

All pipe support inserts on pipework operating up to 100°C shall be rigid phenolic insulation or equal and approved.

Internal and external water storage tanks

When supplied to site uninsulated, insulation shall comprise 40 mm thick Zero ODP Duct Insulation, 40 kg/m3 nominal density rigid phenolic insulation boards, reinforced with Isogenopac for internal tanks and venture clad Plus 1577CW for externally mounted tanks. These finishes provide a vapour barrier jacket. All fixed by propriety methods, plastic rivets, sealing tape or adhesive as appropriate to the individual area.

Insulation finishes

- Service Ducts, Ceiling Voids and Floor Voids - Pipe Insulation to be finished with Plastic sheet and elastomer sheet such as Isogenopac cladding to pipe and ductwork operating at temperatures below ambient, to be secured with adhesives and recommended manufacturers fixings with matching seals at 450 mm centres and at circumferential joints which shall be overlapped by a minimum of 40 mm.
- Internal and Exposed to View - Where the Engineer/Architect requires an aesthetic/decorative painted finish, insulation shall be provided.

Internal in Plant Rooms or Boiler Houses

Specification for pipe and duct insulation shall be as detailed above, plus the following mechanical protection:

- Insulation to be finished with Plastic sheet and elastomer sheet such as Isogenopac Cladding to pipe and ductwork operating at temperatures below ambient, to be secured with adhesives and recommended manufacturers fixings with matching seals at 450 mm centres and at circumferential joints which shall be overlapped by a minimum of 40 mm.
- All flanges and valves in plant rooms shall be fitted with removable valve/equipment jackets.
- External (Weather Protection) - Specification for pipe insulation shall be as detailed as above, plus one of the following weather protection systems:
- Ventureclad Plus 1577CW – Water and weatherproof, puncture and tear resistant insulation protection system comprised of 5 layers of polyester film and 4 layers aluminium foil over a 3-layer core of polyethylene fabric.

Standards and workmanship

Pipework services

Insulating materials, adhesives, sealants and coatings shall be utilised in strict accordance with current recommendations of the supplier, particularly in respect of coverage, drying time, service temperature limits and methods of application.

All pipe insulation sections shall be concentric and matched for thickness. No sections having damaged ends or edges shall be used.

Insulation for bends and fittings shall be formed from mitred and trimmed pipe insulation sections, cut to ensure that a good contact with the surface to be insulated is made.

The insulation shall be neatly trimmed with purpose made end caps at pump casings, flange joints, valves and strainers.

The Isogenopac cladding shall be continuous at junctions with insulated pipe support inserts with joints sealed.

Under no circumstances shall pipes be married together with the insulating materials.

Care must be taken to ensure the integrity of the vapour barrier is maintained on cold water, chilled water and refrigeration pipework.

Pipework conveying liquids below 10°C shall be additionally fitted with electrical trace heating for frost protection.

Frost protection

Where pipework services are located at roof level or within unheated areas of a building, insulation thickness is to be determined in accordance with BS 5422: 2009 from the tables given in this specification.

Insulation alone shall not give adequate protection from frost on static lines subjected to long periods of low temperature and should be used in conjunction with electrical tracing.

Thicknesses given in BS 5422 Table 23 are calculated specifically against the criteria noted in the table. Thicknesses are increased to the nearest typical available manufactured size in 5mm increments. These thicknesses may not satisfy other design requirements.

Some of the thicknesses may be too large to be applied in practice but are included to highlight the difficulty in protecting small diameter pipes against freezing. To provide the appropriate level of frost protection to certain sizes of pipes, it may be necessary to provide additional heat to the system, for example by thermostat-controlled circulation of the water or heat tracing

Thermal insulation workmanship:
Do not apply thermal insulation until installation has been fully tested and all joints proved sound.

Ensure that all materials are kept dry. Ensure clearance between insulated pipes.

Apply insulants, facings, coatings and protection strictly in accordance with manufacturer's instructions.

Neatly finish joints and corners, and ensure continuity over fittings and supports, with longitudinal split concealed.

Arrange insulation of feed and expansion cistern to allow removal of access covers.

Technical submissions

- Technical submission for insulation including material specification and finishes etc including protection from environment and thicknesses

7.0 Electrical Specification

7.1 Main Incoming Switchgear and LV Power Distribution

Performance Objectives

The appointed electrical contractor shall supply, install, test and commission a new switch board downstream from SB01 which is located in the Blackley office building. The new switchboard will serve all new supplies associated with this project in the crematorium and surrounding area.
The requirements and extents are indicated within the accompanying CWC drawings and detailed below.

Design Parameters

The new LV distribution shall comply with the requirements of:

- British Standard Specification and Codes of Practice.
- The CIBSE Guides, Codes and Technical Memoranda.
- Construction, Design and Management (CDM) Regulations 2015.
- The 18th edition of the IET Wiring Regulations BS 7671:2018 with all amendments.
- Current Building Regulations.

Proposed System Description

The Contractor shall supply, install, test and commission a complete new electrical infrastructure to the new and existing areas of the Blackley Office. The electrical infrastructure shall be provided in line with the CWC proposals, as detailed within this specification and the accompanying CWC design drawings.

The Contractor shall supply, install, test and commission a complete new 250A 8-way switchboard located in the plant room of the crematorium (B01-GF-021). The LV cabling will be installed from approximately 100m away from SB-01, located in the office building and is to be protected by a 250A MCCB.
Please refer to the single line diagram and cable schedules for additional details regarding the cabling and protective devices.

This switchboard shall then serve the following supplies via suitably sized sub mains cables to be fully verified by the successful contractor.
Please refer to drawing: 3384-CWC-XX-ZZ-DR-E-6101, for more detail.

Air Source Heat Pump 1
Air Source Heat Pump 2
Air Source Heat Pump 3
Photovoltaic Supply
Surge Protection

SB-03	
Brand	Eaton Electric
Model	EPBN1825
No. Ways	8-way TPN
Rating	250A
Circuit Breaker Technology	MCCB
Fault Current Withstand	50kA Icc, Icw 25kA 1s
Incomer	250A Switch Disconnector
Metered	kWhr meter
Entry Position	Bottom
Compliant Standard	BS EN 61439-2
Degree of Protection	IP3X
Location	B02-GF-021
Supplied from	SB-01 Switchboard

Please refer to the proposed cable schedule 3384-CWC-XX-ZZ-DR-E-6101 for information on outgoing ways and circuit breaker selections.

The Contractor shall note that all MCBs for use on this refurbishment shall be dual rated variants to BS EN 60947-2 and BS EN 60898. All MCBs shall be rated to 15kA or higher.

The Contractor shall supply, install, test and commission a full series of electrical accessories, containment, and final circuitry to provide a full and complete electrical installation as detailed within the CWC Tender Drawings.

Switch Boards & Metering

The Contractor shall supply and install where indicated within this design a 'lockable' distribution board, complete with integral isolators as detailed below and indicated on the Drawings.

Distribution boards shall be compliant with BS EN 61439-3, wall mounted with front access and finished with epoxy powder coating. The distribution board shall be provided with:

- Integral incoming Isolator
- Lockable hinges cover with keys common to all distribution boards
- Fully rated neutral bar
- Terminal kits and cabling boxes as necessary to accommodate the number, type and size of cables provided.
- Multi-layered phenolic plastic (such as Traffolyte) label fixed to the cover indicating designation, location served from and incoming cable size and type.
- Typed circuit chart protected by a Polymethyl methacrylate transparent cover (such as Perspex) fixed to the inside of the access door to each distribution board. The chart shall indicate circuit reference, devices size, device type, cable size, cable type and circuit descriptions. Electrical characteristics such as loop impedance (Zs), voltage and fault level at each distribution board shall also be displayed.

- MCB/RCBO outgoing protective devices to BSEN 60947-2, BSEN 60898, BSEN 61009-1 and IEC 61009-2.2.

Where RCBOs are to be used for circuit protection on final circuits, the residual current rating shall be 30mA.

Distribution board shrouds shall be provided to prevent contact with live metal and to enable ways to be wired whilst the board is live. Circuit protection devices in all distribution boards shall be MCB's or RCBO's as required by the current edition of BS 7671 and any unused ways shall be fitted with blanking modules.

In each distribution board an earth and neutral terminal block shall be provided with enough capacity to take all circuit conductors and circuit protective conductors emanating from the distribution board and in any case at least the same number as there are ways on the distribution board.

Where metering is specified, distribution boards shall be fitted with digital multifunction kWhr meters from the distribution board manufacturer's proprietary range.

Low Voltage Sub-Distribution Cabling

Sub main distribution cabling shall be supplied in line with the scope of work and in line with the accompanying CWC cable schedules.

Generally, sub main cabling is to be sized to provide the following:

- Current carrying capacity to the full rating of the protective device (including derating for grouping and the method of installation.
- Circuit impedance shall permit the protective device to operate within 0.4 or 5 seconds, as appropriate for the circuit designation under BS 7671, under phase to phase, phase to neutral, and phase to earth fault conditions at the furthest point of the circuit.
- Voltage drop at the furthest point on each final circuit shall not exceed the maximum possible under full load conditions (as stipulated within BS 7671).
- 20% spare capacity above the design loads shall be included for distribution boards, sub main cables, and all containment systems.
- Submain cabling shall be sized at a maximum operating temperature of 70degC in compliance with BS 7671 (Section 512.1.5) unless the switchgear, protective devices, accessories equipment manufacturer has confirmed in writing that the equipment is suitable for higher temperatures up to 90degC.

All general submain cabling shall be of a low smoke and zero halogen (LS0H) construction when routed throughout the building.

All steel wired armoured (SWA) cabling shall be BASEC approved and comply with BS 6724. When installed with a separate circuit protective conductor (CPC), the CPC shall be a green / yellow sheathed low smoke and zero halogen (LSZH) 6491b single insulated copper cable.

Submain cables shall be labelled with circuit references using Critchley markers or equal and approved fixed to either end of the cable, labels shall display circuit reference, cable size and type.

Use of non BASEC approved cabling shall not be acceptable for this scheme.

Cable Management Systems

Generally, throughout, galvanised steel containment shall be used for all electrical services requiring cabling. The exception to this rule is where only a small number of cables are required and can therefore be run through conduit or where cabling requires an additional degree of mechanical protection.

Electrical cable management systems shall be provided for the following and can be found within the CWC project Containment Layout Drawings:

- LV Submains ladders & Cable Tray.
- Small Power and Lighting galvanised trunking.
- Galvanised Steel Conduits shall be used for all secondary containment (unless SWA cabling is used).
- Data/Communications galvanised Steel Cable Basket.
- Fire Alarm cabling shall be installed on galvanised steel cable tray.

Cable ladders are used over switchboards and where cables run vertically, for example in risers, the cables are fixed to horizontal channel supports. Cables are not fixed to vertically running cable trays

Cable tray shall be supported using 10 mm diameter galvanised steel threaded rod on 41mm steel channel bracketry from Unistrut or equal and approved support bracketry manufacturer. Cable tray shall be high sided and cable trays are heavy duty with a return flange.

Spacing between containment support bracketry shall be a minimum of one every 1200 mm, or as recommended by the manufacturer for 150% of the intended load.

All containment shall be effectively cross bonded to each distribution board throughout its route. Copper saddles to be used at junctions, visible from beneath. Rockwool internal fire barriers shall be used where the containment passes through fire-rated compartments.

All cabling installed throughout the cable management system shall be securely affixed to the containment system utilising PVC cable ties.

Cable baskets, trays and ladders shall be compliant with BS EN 61537, and cable trunking with BS EN 50085.

Support systems shall consist of Unistrut channels suitably selected for the loadings and spacings. Services are to be installed to an enhanced standard throughout the building particularly where exposed ceilings are proposed. All Unistrut channels shall be provided with black end caps. Threaded rods were used to fix channels to soffits shall also be provided with black end caps. All Unistrut channels and threaded rods were installed in exposed ceilings shall be spray painted matt black RAL 9004.

Controls

N/A.

Technical submissions

The Contractor shall provide the following information for comment as part of the procurement:

- Coordinated Stage 5 working drawings and setting out of services.
- Technical submittals for distribution boards, switchgear and general electrical accessories intended for use as part of the works.
- Completed installation certificates of all works completed showing compliance with BS 7671.

7.2 General Small Power

Performance Objectives

Provide new small power systems to meet the mechanical services power requirements. These requirements and extents are indicated accompanying CWC drawings.

Design Parameters

The new small power installation shall comply with the requirements of

- Construction, Design and Management (CDM) Regulations 2015.
- The 18th edition of the IET Wiring Regulations BS 7671:2018 including all amendments.
- Building Regulations Part L.

System Description

New Eaton or equal and approved surface mounted IP67 rated thermoplastic lockable rotary isolators shall be installed adjacent to the new supply air source heat pump units.

Four pole and double pole isolators shall be utilised for three phase and single-phase equipment respectively ensuring all live conductors and neutral conductor are broken upon isolation.

13A Fused connection units shall be utilised for any appropriate single-phase equipment.

The Contractor shall familiarise themselves with the mechanical strategy and make sufficient allowance for all power supplies, final connections and associated containment for fixed items of equipment including but not limited to the following.

- Air Source Heat Pumps
- Plant Room Supplies
- Ancillaries including controls
- Associated Mechanical Equipment

Allow for liaison with the Architect, Builder, all chosen specialist system suppliers and mechanical contractor in order to ascertain the quantities, ratings and locations of all fixed equipment and equipment associated with specialist systems.

The Contractor shall ensure they familiarise themselves with the full extent of the scheme and incorporate any requirements which may not be specifically stated within the specification but are required to provide a complete and fully compliant installation.

New supplies to the proposed mechanical equipment shall emanate from the proposed distribution boards specified on the CWC layouts.

Mechanical Wiring

All wiring to mechanical controls equipment such as temperature controllers, thermostats and final connections from fused connection units to mechanical equipment etc. shall be undertaken by the mechanical/BMS contractor.

Mechanical equipment power supplies shall be provided by the electrical contractor including final connections form the local isolators to the appliance.

PVC/SWA/LS0H Cables

Unless stated otherwise. The new final circuit cabling to the proposed mechanical equipment shall be within 5 core PVC/SWA/LS0H for three phase units and 3 core XLPE/SWA/LS0H for single phase units.

Copper conductors, LS0H bedded wire armoured and PVC sheath overall. Manufactured in accordance with B.S.6724, 600/1000 Volt grade and complete with manufacturer's recommended and approved terminations. Cables supplied must be BASEC approved.

Final circuit connections from distribution boards to isolators shall be cross-linked polyethylene steel wire armoured low smoke and fume cable. Copper conductors, LS0H bedded wire armoured and PVC sheath overall. Manufactured in accordance with B.S.6724, 600/1000 Volt grade and complete with manufacturer's recommended and approved terminations. Cables supplied must be BASEC approved.

Sub-Circuit and Flexible Cables

The Electrical Contractor shall provide, install and connect sub-circuit and flexible cables as described in this Specification and of the ratings indicated on the drawings or in the Specification Schedules.

The following cable specifications are to apply for the appropriate application:

Final Circuits & General Equipment

The Electrical Contractor (in conjunction with the Mechanical Contractor) shall include for final on-site co-ordination of electrical services routes with mechanical services. Some areas, particularly floor voids, ceiling voids and riser spaces accommodate many elements of the mechanical and electrical services installations and shall require careful setting out in order that the systems being installed are able to perform optimally, and as intended, both upon completion of the works, and

moving forward across the life of the systems installations in the future. These details shall require to be produced early on in the Contractor(s) programme and shall be required to be submitted to both Architect and Consulting Engineers for comments/approval, well in advance of the intended installation period. All conduits or cables from trunking or tray are to be arranged and dressed to ensure the minimum of crossovers or bends.

The Electrical Contractor is also to liaise and co-ordinate fully with all other trades, in particular the Mechanical Contractor, to ensure that there are no clashes and that all routes are planned and agreed prior to installation. No additional costs shall be entertained due to failure to comply with this requirement.

Conduits are to be a minimum diameter of 20mm, and each final circuit is to include a separate protective conductor.

All cables, cable trays, trunkings, conduits, etc., are to be run parallel or at right angles to building features at all times. Under no circumstances shall the diagonal crossing of space be allowed in either the vertical or horizontal planes unless specifically detailed on the drawings.

Electrical installations shall be supported from the building walls, floors and soffits. The installation, except where specifically stated or indicated, must not be supported by or from suspended ceiling systems, mechanical plant, piped services support systems, ductwork, or ductwork support systems. Drilling of floors, soffits, and block works walls shall be permitted, to obtain fixings. Where fixings are required to steelwork or cladding, details of proposals are to be submitted by the Contractor for approval prior to carrying out the work.

The Electrical Contractor shall include for fabricating, providing and fixing all up stands, brackets, and secondary steelwork necessary for supporting electrical services and fittings.

The Electrical Contractor shall, where necessary, include for the provision and installation of extension boxes and rings in areas where the conduit/accessory box is recessed back from the finished wall or ceiling surface.

Where services are to be supported from steelwork, the Electrical Contractor shall, wherever possible, use patented adaptors and clamps rather than drill for fixings.

Locations of Points & Co-ordination

The term 'point' in this Specification applies to any electrical outlet, termination, accessory, control device, or equipment. All points must be fixed in locations described or indicated as precisely as the drawing scale shall permit. The right is reserved, however, to make such local adjustment or alterations as may be found expedient during the progress of the works, without incurring any additional cost, provided the Contractor is not committed by such instructions to the dismantling of any work already executed.

The Electrical Contractor shall obtain from site, all information available that is likely to affect the installation of any part of his works, including furniture details. Any points installed prior to such consultation become the Contractor's responsibility and the cost of any subsequent alteration shall then have to be borne by the Contractor.

The Electrical Contractor shall provide comprehensive information, in drawing form, relating to points and service runs in, on, and above suspended ceilings following co-ordination with other trades. The Contractor is to liaise, via the Main Contractor, with all other trades to ensure that electrical services are fully co-ordinated with other services and with the building structure and fabric. The Contractor is to produce such drawings as are necessary to demonstrate the results of this co-ordination exercise.

Where equipment is mounted in a horizontal line, the setting out is to be such that a common centre line can be drawn through the centre line of each individual item.

Where two or more items of equipment are mounted at different heights, but in close proximity on a common wall or surface, they are to be arranged such that a common vertical centre line can be drawn through the centre line of each individual item. This requirement is to be particularly observed where outlets/equipment for different service elements are shown on separate drawings for the same area, or where symbols for outlets on drawings have been indicated side by side for clarity.

Where there are no suspended ceilings, and services are exposed to view, neatness of installation and co-ordination of all M&E services is of paramount importance, and the Electrical Contractor shall liaise with the Mechanical Contractor to enable detailed co-ordination drawings showing all electrical works to be prepared and adhered to.

Mounting heights of accessory outlets shall be installed compliance with the requirements of Part M of the Building Regulations, generally to be 450mm AFFL for low level accessories, and 1200mm for light switch type devices etc

Weatherproof Equipment

Where weatherproof equipment and accessories are required, they are to be of the following types and manufacture:

- Isolators of the type and rating indicated on the drawings or elsewhere in this Specification. IP67 degree of protection (B.S.5490 and I.E.C.529).

Isolators

This sub-section is intended to cover isolators and contactors required as 'loose' items for local isolation and control of equipment.

Isolators shall be capable of breaking the full load capacity of the individual circuit and to have the facility to be padlocked in the 'OFF' position.

The Electrical Contractor shall provide, install and connect isolators of the ratings indicated on the drawings or described in this Specification.

Isolators are to be of Eaton or equal and approved.

General Cable Tray, Cable Trunking and Conduit

The Electrical Contractor shall install new 100x100mm galvanised steel trunking to provide a cabling route from the switch room to the stone masons office, providing a cabling route to the new small power detailed in each of the rooms. 20mm conduit is to be installed from the main run of trunking to allow cabling to be installed to the fused spurs. The conduit is to be secured either to the trunking and the fused spurs using conduit coupler and male bushes.

The electrical contractor shall install new 150mm heavy duty galvanised steel tray to the new air source heat pump enclosure located outside of the garden tool store.

All cuts made within galvanised tray or Unistrut are to be deburred and to be protected with the use of galvanised spray. All tray ends are to be protected with the use of PVC edging strip.

Where the electrical installation comprises existing fire rating within fire rated walls and/or protective measures installed within containment the contractor shall reinstate and 'make good' once work has been completed ensuring a minimum of 3 hours fire rating is retained.

Electromagnetic Compatibility

The recommended cable separations/equipment standards and installation practice recommended in the Contractors Association Document "Recommended Cable Separations to Achieve Electromagnetic Compatibility (EMC) in Buildings" are to be provided by the Contractor.

The equipment provided is to comply with the European Directive on EMC (89/336/EEC dated May 1989) and the amending Directive (92/31 EEC).

Controls

N/A.

Technical submissions

The Contractor shall provide the following information for comment as part of the procurement:

- Coordinated Stage 5 working drawings and setting out of services.
- Technical submittals for intended electrical small power accessories for use as part of the works.

7.3 Fire Detection Alarm System

Performance Objectives

Employ a BAFE accredited and registered specialist to design, supply, install, test and commission modifications and interfaces as necessary to meet the requirements of BS5839-1 and the building fire strategy. These requirements and extents are generally indicated below and within the accompanying indicative CWC drawings. Develop the proposals as part of CDP for full compliance with the design parameters.

Design Parameters

The completed fire alarm system shall be a fully addressable analogue system and fully comply with the requirements of the Local Fire Officer, Architectural fire strategy layouts and meet the following British Standards:

- BS EN 54 (All parts) Fire detection and fire alarm systems
- BS 5839: Part 1: 2017 - Fire Detection and Alarm Systems in Buildings

System Description

The Contractor shall employ a BAFE accredited and registered specialist to design, supply and install extended and modified fire alarm detection and alarm systems to suite the modified plantroom layout as a result of the proposed ASHP works.

The fire alarm and detection system shall be provided in accordance with BS5839 part 1 to achieve a building fire alarm category rating of L1.

Electronic sounders and flashing beacons shall be incorporated into detector bases in the plantroom areas.

Any structural steel down stands that are greater than 10% of the floor to ceiling area will require automatic smoke detection in between the steels.

Fire alarm interface units shall be provided to all necessary building services systems including but not limited to access control systems, security systems, Lifts, BMS/control panels.

The system shall be wired utilising 2 core (minimum 1.5mm2 specialist to confirm final sizes) soft skin cabling with red LS0H sheath meeting the 'enhanced' requirements of BS 5839-1 and tested / certified by the LPCB/BASEC to the latest edition of appropriate standards.

Cabling shall consist of fire rated soft skin cable directly clipped to the interior fabric of the building.

Controls

N/A.

Technical submissions

The Contractor shall provide the following information for comment as part of the procurement:

- Stage 4 detailed design drawings
- Coordinated Stage 5 working drawings and setting out of services.
- Technical submittals for the fire alarm system, including full detailed design, head end fire alarm panel, cabling and electrical accessories intended for the scheme.
- Completed installation certificate to BS 5839-1.

7.4 Earthing & bonding

Performance Objectives

The Electrical Contractor shall provide safe and secure earthing and bonding to minimise risk to life caused by contact with live electrical components, or rising voltages caused by short circuits. Reduce harmonics and interferences problems caused by electronics equipment.

Design Criteria

Provide earthing system for fit out system as per:

- BS 7671 - Requirements for electrical installations. IET Wiring regulations 18th Edition
- BS 7430 - Code of Practice for earthing
- IET Guidance Documents
- Electricity at Work Regulations

System Description

Earthing and bonding to all electrical services and incoming mechanical services shall be provided in accordance with the latest 18th edition of BS 7671.

Supplementary bonding shall be carried out utilising 2.5 mm2 LS0H green and yellow copper conductors protected to the point of termination. Where unprotected, the supplementary bonding conductors shall be 4 mm2 with a green and yellow PVC sheath.

Care shall be taken to ensure that all joints are properly made and bonded to ensure continuity. The main equipotential bonding conductors shall be connected to the earth bar mounted adjacent to the main switchboard.

The earthing terminal of every socket outlet and minor power accessory shall be connected to the protective conductor.

Where the protective conductor is formed by a conductor and auxiliary i.e. metal conduit, trunking, duct or metal sheaths of cables, the earthing terminal shall be connected by means of a green/yellow LS0H insulated copper earthing tail with bolted lug connection or proprietary fitting as appropriate.

An earthing terminal shall be provided at every lighting point and connected to the protective conductor.

All metal luminaires shall be connected to the protective conductor.

An earthing terminal shall be provided at every lighting switch position.

Main equipotential bonding conductors shall be taken to all incoming water service pipework, metal cabinets, metal work surfaces and lightning protection network if present.

Supplementary Equipotential Bonding

Supplementary bonding conductors shall be provided to ensure effectual equipotential earthing throughout the building.

Extraneous conductive parts in any room including ceiling grids which contain an electrical accessory shall be bonded.

All hot and cold pipework sinks and wastes shall be directly and independently bonded to the protective conductor.

All structural steelwork which shall remain accessible when the building is complete, together with fixed metal framework on which equipment or apparatus is mounted, shall be bonded to the protective conductor.

Exposed metal pipes shall be bonded to the protective conductor but where metal to metal joints exist and form a continuous electrical circuit of negligible impedance when tested.

Supplementary bonding conductors shall be copper cables, insulated with green/yellow LSOH/6491B. Where sizes are not indicated, bonding conductors shall have a cross-sectional area not less than the smallest circuit protective conductor, associated with the metalwork being bonded, subject to a minimum of 6.0mm^2.

All bonding connections shall be made with lug connector and brass nut, bolt and washer, minimum size M6 or with earth clamps complying with BS 951. At every bonding connection shall be provided a standard warning label.

Controls

Section not used.

Technical submissions

- Earthing schematic and technical proposals

7.5 Photovoltaic System

Performance Objectives

The Electrical Contractor shall appoint a specialist go design, supply, install, test and commission a Photovoltaic system for the new teaching unit including all associated PV panel arrays, fixing systems, internal inverter units, DC cabling and metering.

Design Criteria

Provide a disabled alarm system as per.

- BS 7671 - Requirements for electrical installations. IET Wiring regulations 18th Edition.
- IET Guidance Documents.
- Electricity at Work Regulations

System Description

The Appointed Electrical Contractor shall appoint a photovoltaic specialist to supply, install, test and commission a new roof mounted photovoltaic system as shown on the drawing layouts as per detailed below.

The system will comprise 50No. 450W monocrystalline Longi to provide and achieve a 22.0kWp output (or equal and approved) panels mounted on a bespoke Van De Vaulk (or equal and approved) roof support bracket system and ballast.

The new system shall comprise of the following.

- 450W Monocrystalline photovoltaic panels.34no panels
- 1No. PV 5 string junction box complete with diodes and surge protection device
- 63A Single pole direct current isolators.
- 63A 3-pole direct current isolator for the larger unit as this will be three phase input.
- 1No. 20kW single Phase Solis (or equal and approved) Inverters.
- Alternating Current (AC) Isolator's.
- Self-contained 32A Type C single pole30mA RCBO with dedicated metal enclosure.
- Self-contained 32A Type C three pole30mA RCBO with dedicated metal enclosure.
- New submains to new plant room PV distribution board.
- New Schneider PM1500 meters.

The above equipment shall be subject to being equal and approved. The contractor is free to provide alternatives.

The new AC isolators and standalone protective devices shall be installed located within the ground floor External Store/Games room area. The new inverters, DC isolators and PV string junction boxes shall also be installed within the External Store/Games room adjacent to the main distribution board.

All new cables from the junction box shall be sized in accordance with manufacturers recommendations. These shall be ELAND cables H1Z2Z2-4 cables with a minimum size of 4mm² CAS; or equal and approved.

Technical Submittals

The contractor shall provide the following information for comment as part of the design procurements:

- Full PV layouts and setting out.
- PV technical calculations to provide kWp, CO2 reduction and payback.
- Full PV fixing details.
- PV weighting details.
- Technical submittals for proposed equipment selections including manufacturers details and literature.

7.6 Lighting and Emergency Lighting

Performance objectives

Provide a new LED Lighting and emergency lighting installation to the air source heat pump enclosure.

Design Parameters

The new lighting and emergency lighting installations shall comply with the requirements of

- Construction, Design and Management (CDM) Regulations 2015.
- The 18th edition of the IET Wiring Regulations BS 7671:2018
- CIBSE Lighting Guides – in particular guide 1.
- BS5266 – All Parts.

Proposed System Description

New LED energy efficient artificial lighting will be provided within the air source heat pump enclosure and will be of linear type fittings.

The general lighting system shall utilise LED high efficiency luminaires throughout, as indicated on the associated drawings. The emergency lighting shall be provided with manual emergency lighting test key switches at the local distribution board locations for manual testing within the LV switch room kiosk

The lighting is to be ASD storm 1200 LED fittings and are to be installed on the structure of the air source heat pump enclosure. Angle brackets are to be installed to utilise the lighting output on floor level. 20mm galvanised steel conduit is to be installed between each of the light fittings around the enclosure to provide to provide a cabling route. The conduit is to be secured with the use of 20mm saddles, installed no more than 1200mm apart. The use of conduit couplers and male bushes are to be utilised when securing the conduit to each of the fittings. IP67 washers are to be installed between the conduit coupler and fittings to prevent water ingress.

All cuts in conduit are to be deburred to prevent cable damage during the installation stage of the project.

The lighting installation shall comply with BS EN 12464-2 :2014 Lighting of Outdoor Workplaces.

Luminaires shall be selected and installed to provide a high illuminance uniformity ratio, noise free operation, excellent visual comfort.

All luminaires shall be carefully installed in a manner appropriate to their nature and method of fixing. The metal work of luminaires shall be efficiently earthed.

The lighting controls shall be manual with an IP67 rated 1 gang 2-way switch located internal to the air source heat adjacent to the door.

Emergency lighting shall be provided along escape routes, high risk task areas.

All emergency luminaires shall have a three-hour battery capacity.

The entire emergency lighting installation shall be installed, commissioned and tested in accordance with BS 5266-1, and copies of the appropriate Test Certificate shall be handed over to the engineer prior to practical completion of the work.

Each emergency fitting shall be fitted with a typed address label and corresponding test sheets shall be included in the Operation & Maintenance Manual, in the form of an 'Emergency Test Log'.

Plant Areas
Surface mounted LED Linear shall be installed within the enclosure

Requirement 100 Lux and 0.4 uniformity shall be achieved at floor level.

Emergency lighting will take the fore of self-contained, non-maintained 3-hour battery backup throughout all areas.

All emergency luminaires will be tested via manual key switches positioned adjacent to the distribution board (DB-SW) within the LV switch room of the GRP enclosure

Final Circuit wiring
The final circuit wiring shall generally be carried out using 6491B LSZH single core cabling.

The Electrical Contractor shall include for fabricating, providing and fixing all up stands, brackets, and secondary steelwork necessary for supporting electrical services and fittings.

Where services are to be supported from steelwork, the Electrical Contractor shall, wherever possible, use patented adaptors and clamps rather than drill for fixings.

Controls

Section not used.

Technical submissions

The Contractor shall provide the following information for comment as part of the procurement:

- Coordinated Stage 4-5 working drawings and setting out of services.
- Lighting calculation report to provide evidence the required LUX levels are met
- Technical submittals of luminaires and lighting design if the contractor uses an alternative manufacturer to as shown in the tender drawings.
- Technical submission of the lighting control package.

8.0 Appendices

8.1 Information to be provided by Contractor(s)

Description	Design stage	Type of copy
Tender pricing schedule summary with sectional break down including schedule of rates	Tender	Electronic
List of proposed equipment selections and specialists and any associated energy sCOP, noise performance details.	Tender	Electronic
Mechanical/Electrical installation programme including commissioning	Tender	Electronic
Mechanical/Electrical procurement schedule based upon expected lead in times of plant with latest dates for finalisation of design against the proposed programme.	Tender	Electronic
Detailed design proposals where Contractor(s) Design Portion (CDP). Information to be provided as detailed in each work section.	Within a maximum of 12-weeks of contract award	Electronic
Coordinated working installation drawings	Within a maximum of 2-weeks prior to works commencing on site	Electronic
Builders work drawings	Within a maximum of 2-weeks prior to works commencing on site	Electronic
Method Statements for M&E elements of work	Within a maximum of 6-weeks prior to works commencing on site	Electronic
'As fitted' drawings	2-week prior to handover	Electronic
Results from LV load monitoring	Within a maximum of 2-weeks prior to works commencing on site	Electronic

Description	Design stage	Type of copy
Detailed commissioning programme and commissioning strategy along with final commissioning report upon completion	Within a maximum of 2-weeks of works commencing on site	Electronic
All test certificates, including HSE ACOP L8 and written scheme.	2-weeks prior to handover	Electronic
Schedule of training for end users as indicated below	Following soft landings approach	Electronic
O&M's / Asset registers CAFM input	Handover (final)	Electronic, 1 Hard
Schedule of spares	Handover	Electronic
Schedule of recommended tools	Handover	Electronic
Site Energy CIBSE logbook	Handover	1 Electronic, 1 Hard
BMS on-site and off-site (real-time energy monitoring platform live/operational etc) functional performance including meter and sub-meter connectivity and recorded/logging of data.	Handover	Electronic

8.2 Mechanical pipework standard jointing matrix

Typical pipework jointing standard – Contractor free to offer alternatives subject to approval by Main Contractor/CE/Client

Service	Pipe material	Pipe/fitting jointing method	Valve/appliance jointing method
Domestic Services	Copper EN 1057-R250 formerly to (British T-Marked Copper Tube to BS 2871 Part 1, Table X)	Soldered - Capillary lead-free tin/silver to BS 864 (kite marked) to plantroom, press fit elsewhere	Screwed/soldered as appropriate
Above Ground Drainage	General UPVC Condensate ABS	Solvent Weld/Ring Seal as appropriate	Solvent Weld/Ring Seal/Screwed as appropriate
LTHW Heating	External underground Pre-insulated P-EXa SDR11 pipework EN15632-1 and -2 made for a maximum peak operation temperature up to 95°C and 6 bar design pressure Plantrooms Medium grade steel to BS EN 10255 Elsewhere Copper EN 1057-R250 formerly to (British T-Marked Copper Tube to BS 2871 Part 1, Table X)	External underground Manufactures standard compression or welded joints Plantrooms Screwed up to 50mm. Welded 65mm and above Elsewhere Soldered - Capillary lead-free tin/silver to BS 864 (kite marked) to plantroom, press fit elsewhere	External underground Manufactures standard compression or welded joints Plantrooms Screwed up to 50mm. Welded 65mm and above Elsewhere Soldered - Capillary lead-free tin/silver to BS 864 (kite marked) to plantroom, press fit elsewhere